HFC Inventory Report

South Africa

November 2017

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1 Introduction

This report has been prepared in line with the Guide for Preparation of The Surveys of Ozone Depleting Substances (ODS) Alternatives (Re-Issued) - MLF/IACM.2016/2/21.

The objective of surveys on ODS-alternatives is to assist South Africa and UNIDO to better understand the historical and predicted consumption trends for ODS-alternatives, including medium, low and high global warming potential (GWP) alternatives, and their distribution by sector and subsector.

The survey provides South Africa with an overview of the current national market for ODS-alternatives and an analysis of the recent consumption trends in relation to HCFC phase out and likely future trends taking account of embedded and emerging technologies in South Africa.

2 General information

South Africa has a land area of approximately 1.22 million sq. km with land boundaries of 4,862 km; Botswana 1,840 km, Lesotho 909 km, Mozambique 491 km, Namibia 967 km, Swaziland 430 km, Zimbabwe 225 km. The country is divided into 9 provinces; Eastern Cape, Free State, Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape, North-West, Western Cape. South Africa is a middle-income, emerging market with an abundant supply of natural resources; well-developed financial, legal, communications, energy, and transport sectors; a stock exchange that is the 18th largest in the world; and modern infrastructure supporting relatively efficient distribution of goods to major urban centres throughout the region.

South Africa has highly developed refrigeration and air-conditioning installation and service sector. Refrigeration and air-conditioning plays a vital role in the economy of South Africa with several sectors totally reliant on refrigeration for sustainability. The availability of user friendly HCFC refrigerants contributed to the development of a wide network of modern supermarkets and the growth in the export trade of perishable goods, which is now an important source of foreign revenue. Refrigeration and air-conditioning also plays a vital role in mineral extraction, as well as allowing for the development of living standards in areas, such as food security, hospitals, comfort cooling in buildings and refrigerated transport.

Before signing the Montreal Protocol, South Africa manufactured CFC-11 and CFC-12; however, production facilities were decommissioned as part of the voluntary phase initiative undertaken by industry in partnership with the Department of National Health and Population Development, in the period to 1 January 1996.

The phase out of CFCs led to an increase in the consumption of HCFCs. In particular, low temperature refrigeration applications switched to HCFC-22, although to a lesser extent some operators switched to HFC-134a and HFC-404A.

The calculated baseline HCFC consumption was calculated during the compilation of the HPMP as 369.7 ODP tonnes, based on consumption data for 2009 and 2010. The total consumption in 2010 was 5,354 metric tonnes (MT).

The implementation of the HPMP has, in turn, led to a rise in consumption of HFCs and to a minor extent low-GWP ODS-alternatives.

At the time of the HCFC survey, HFC penetration in the refrigeration sector was approximately 10-15%. Since then the consumption of HFCs in particular has grown rapidly, in 2016 HFCs and HFC-blends represented approximately 58% of the total consumption of refrigerants. Whilst there has been a general acceptance of hydrocarbons in domestic refrigeration there and some moves towards CO_2 in supermarket refrigeration, the rate of adoption of low-GWP ODS-alternatives remains relatively low.

South Africa is reliant on imports for all its requirement of HCFC, HFC and HFO refrigerants for air-conditioning and refrigeration systems, foam blowing, electronic component cleaning and fire fighting applications. It also as a supplier of refrigerants to neighbouring countries including Namibia, Botswana, Zimbabwe, Mozambique, Lesotho and Swaziland, as well as other countries in Africa with which it does not have borders.

3 Institutional Setup

3.1 Legal Framework

South Africa has established a number of legal instruments to control the imports, exports, consumption, and use of HCFCs. The Air Quality Act 39 of 2004 introduced a requirement for import and export licenses; the DEA Regulation 33925 of 2011 established a quota system to restrict HCFC imports to the Montreal Protocol limits starting 1 January 2013; and the National Standard 10147 of 1994 established a code of practice for the reduction of ozone depleting refrigerant emissions.

The ODS quota system is operated by the National Ozone Unit (NOU) (which is established within a branch of the Department of Environment Affairs (DEA).

The import and export of HCFCs and HFC are controlled under Schedule 2 of the Import Control Regulations 2012. The import or export HCFCs requires a permit approved by the NOU and issued by the International Trade Administration Commission (ITAC). The permit application must include the relevant HS (tariff) code as published by ITAC in the tariff schedule.

Although the import and export of HFCs is controlled for customs purposes and permits are issued by ITAC; there is currently no requirement for HFC permits to be approved by the NOU.

3.2 Industry Engagement

As part of the HPMP implementation, the NOU established an extensive stakeholder network and communication based on regular stakeholder meetings at which information on policy, regulation and phase out strategy is disseminated, and industry stakeholders are consulted. The stakeholder meetings and associated communications to the stakeholder group act as the primary engagement mechanism between government and industry.

3.3 Control of HFCs and other ODS-Alternatives

After an engagement with the industry stakeholders and with the assistance of UNIDO consultants, the DEA published updated ODS regulations (covering HCFCs) in the Government Gazette no 37621 of 8th May 2014. The key elements of which are:

- Phase down of ODS imports by the allocation of quotas to importers.
- Enforcement of existing regulations of import permits for all imports and exports of ODS.
- Ban on the importation of all packaged air-conditioning and refrigeration equipment charged with HCFC-22 from I July 2014.
- Declaration of all stockpiles of ODS as at 8th May 2014.
- Ban from 1 January 2015 on HCFC-22 charged in new refrigeration systems manufactured in South Africa.
- Submission of annual report by importers and exporters in January of each year, stating the tonnages, types and referenced against import/export declarations and permits of all ODS during the previous 12 months.
- Ban on the import of HCFC-141b either in pure form or as a component of blended chemicals; for the purpose of placing on the market or use in the production of polyurethane foams or as solvents or any other application from 1 January 2016.

4 Methodology

4.1 Data Sources

The HPMP analysis provides a reliable model for consumption breakdown because the consumption of HCFC-141b has been completely phased out in South Africa since 1 January 2016, and therefore 99% of all ODS and ODS-alternative consumption has since been used in the Refrigeration and Air-conditioning (RAC) sector.

Since over 95% of the consumption of ODS-alternatives now relates to the RAC sector in South Africa, most effort has been focused on this sector, although some analysis of the other sectors has been carried out through desk research and interviews with sector stakeholders.

South Africa has a sophisticated Import and Export Control system operated by ITAC and forms the foundation of the revenue collection system run by the South African Revenue Services (SARS).

The SARs database has been used as the primary source of import data for all ODS-alternatives. Analysis included downloading all available monthly import and export trade data, for the period of January 2013 to July 2017 for the various tariff codes covering HCFCs, substances containing HCFCs, HFCs and substances containing HFCs and/-or PFCs. This data has been compared to Article 7 data reports and DEA draft data on HFC consumption for prior years to establish a reliable overall consumption basis.

Due to the structure of the customs tariff codes in use in South Africa, the Tier 1 data alone is not sufficient to determine the breakdown of the consumption of different substances, such as the main HFC refrigerants; R-404A, R-407C, R-410A, R-507A, which are all imported under the same tariff heading.

The Tier 1 data obtained from the institutional sources above has therefore been compared to data obtained from major importers and distributors of ODS and ODS-alternatives, to establish a breakdown of substances within common tariff codes.

Further quantitative and qualitative data has been obtained from a wide range of public and institutional reports including the following key sources:

- HPMP for South Africa (DEA 2012)
- Verification Report on HCFC Consumption in South Africa, Period 2013 To 2015 (UNIDO 2016)
- 1st Draft Concept Document: Hydrofluorocarbons (HFCs) Management Regulations (DEA 2016)
- Official Trade Statistic of the South African Revenue Service SARS (SARS 2017)
- Import and export data provided by major importers and suppliers (various 2017)
- GHG emissions estimation carried out be Green House Consultants on behalf of (DEA2015)

Published information was also compared, supplemented and updated with information obtained through correspondence and face to face meetings with the stakeholders.

4.2 Analytical Approach

A tertiary level of analysis has then been carried out to develop reasonable estimates of the breakdown of use of ODS and ODS-alternatives by application. This analysis has been based on the extensive work done during the HCFC survey and development of the HPMP, where base models of consumption patterns and breakdowns were established through extensive field analysis and approved by the peer review.

A further "sense check" of the estimates and trends present in this report was done by comparing the overall activity in the RAC sector in over the past 5 years. Since the majority of all consumption of ODS and ODS-alternatives are used as refrigerants (primarily for

servicing with a small consumption in system assembly), the expected effect of HCFC phase out is the increase of consumption of the alternatives. This must of course take account of overall economic trends which impact the total consumption trend.

A key weakness in the data collection and analysis process has been the lack of verifiable data on the consumption of natural ODS-alternatives including cyclopentane, iso-butane, propane, ammonia and carbon dioxide. As these are not controlled substances and there is no requirement for either importers or consumers to report their consumption, it is difficult to obtain accurate consumption data. Furthermore, these substances are used in a wide range of applications which are unrelated to the sectors where ODS are being replaced by alternatives.

However, since the use of low-GWP refrigerants, such as propane and carbon dioxide, is still relatively modest and the use of ammonia remains limited to systems traditionally using ammonia, it is possible to make some assessment of the current trends and recommendations for future consideration.

5 Use of ODS and ODS-alternatives

5.1 Use of ODS

At the DEA Stakeholders meeting held in Pretoria on 3 October 2013 importers agreed that the annual quotas for ODS would be reduced by 5% per annum from 1 January 2014 until 31 December 2023. The reduction of 5% would keep South Africa below the maximum consumption set by the Montreal Protocol for Article 5 countries. Industry stakeholders were confident that the use of ODS-alternatives would not impose undue restraints on the national economy.

The annual quotas were allocated until 31 December 2040. From 2026 until final phase out in 2040, the % reduction will conform to that prescribed by the Montreal Protocol.

Since the phase out of HCFC-141b on 1 January 2016 the vast majority of ODS consumption in South Africa (99%) is now HCFC-22.

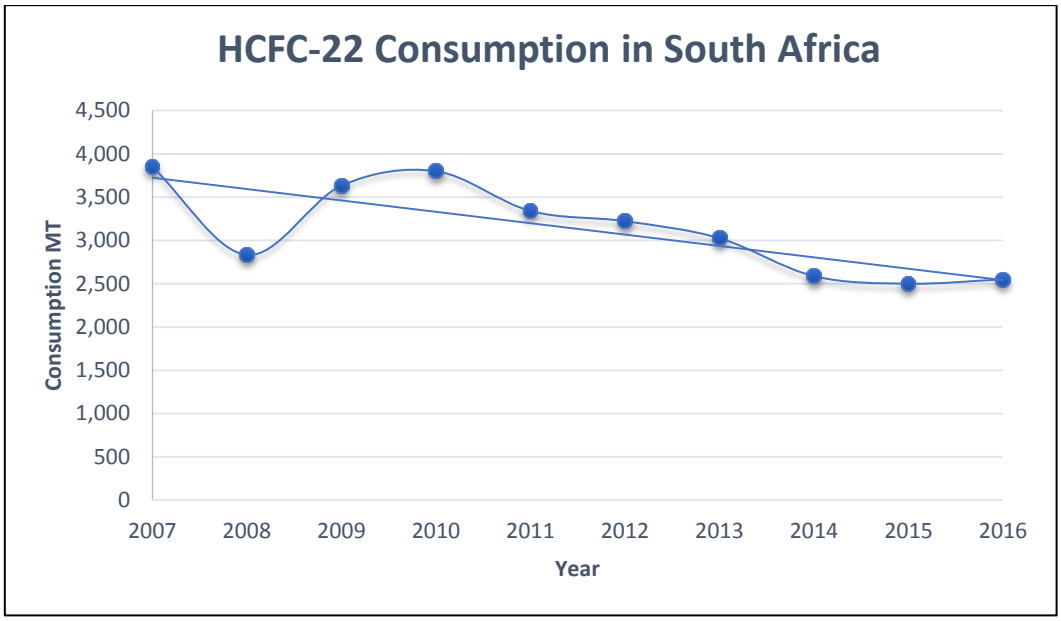
Table 1 ODS Consumption

Year	2013	2014	2015	2016	2017*
Consumption MT	3,026	2,588	2,501	2,550	2,112

**estimate*

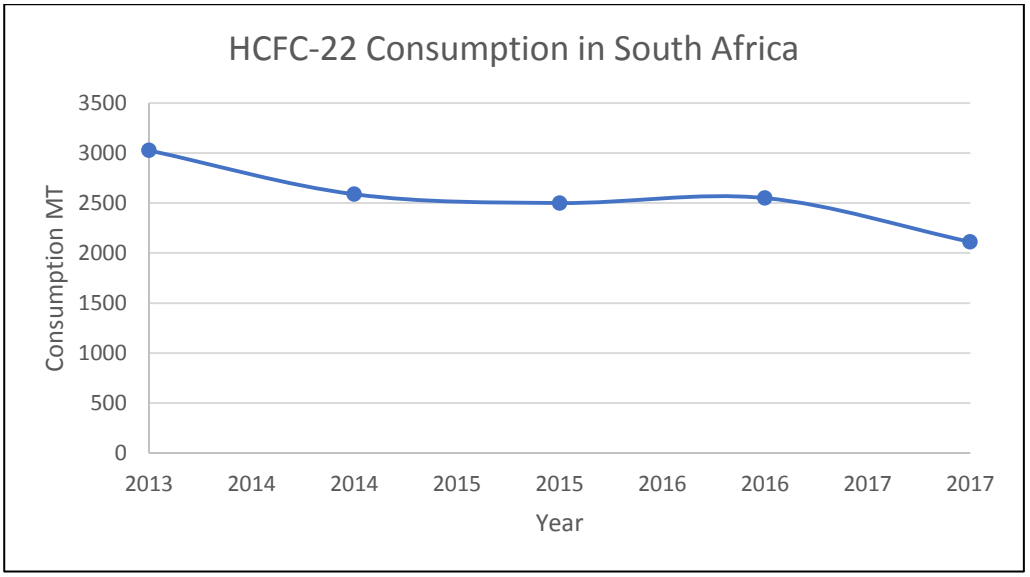
The overall consumption trend in HCFC-22 is shown below for the period 2007 to 2016. Since the majority of HCFC-22 is used in the RAC sector the graph effectively shows the trend in ODS consumption.

Figure 1



The recent consumption data indicates, as would be expected, an overall downward trend, but at a relatively slow rate of decline, in fact the consumption of HCFC-22 in 2014, 2015 and 2016 was roughly the same. Estimates of 2017 consumption based on projections of unaudited part year data, do seem to indicate that consumption will decline somewhat more rapidly in the coming years. The consumption trend appears to be in line with the control regime established by the HPMP, in particular the ban on the importation of all packaged air-conditioning and refrigeration equipment charged with HCFC-22 from 1 July 2014 and the ban from 1 January 2015 of manufacturing or assembly of new refrigeration systems using HCFC-22.

Figure 2



5.2 ODS-Alternatives

South Africa does not produce any ODS or ODS-alternatives, and relies solely on imports for domestic needs. The vast majority of ODS and ODS-alternatives are now consumed in the RAC sector and are supplied via a network of main importers and break-bulk distributors. The primary importers are:

- Afrox
- Agas
- Eurocool
- KovCo
- MACS
- Power Copressor Supplies
- Refcom
- TecsaReco

The three biggest importers (Agas, Afrox and KovCo) account for approximately 90% of the market. Due to the highly competitive nature of the market in South Africa and the commercially sensitive nature of the data Dewpoint is not permitted to attribute consumption data to importers and suppliers; however, suppliers have been interviewed and given permission to provide aggregated data. The output from the Tier 1 data analysis is given in Table 2 below, and Table 3, shows the previous estimated carried out by NOU.

Table 2. ODS-Alternative Consumption by Alternative 2013-2016

Alternative	Consumption MT			
	2013	**2014**	**2015**	**2016**
HFC-134a	1,069	1,180	1,312	1,460
R-404A	520	574	638	710
R-507A	457	504	561	624
R-410A	362	400	445	495
R-407C	92	102	113	126
HFC-227ea/HFC-365mfc	60	66	74	82
HFO-1234yf		1	1	80
HFC-152a	57	63	70	78
HFC-32	1	1	1	1
Total	**2,617**	**2,890**	**3,215**	**3,656**
HCFC-22	3,026	2,588	2,501	2,550
Total Refrigerant	**5,644**	**5,478**	**5,716**	**6,206**

Table 3. HFC Consumption 2007-2012 (NOU estimates)

HFC	2008	2009	2010	2011	2012
R-134a	557.7	461.92	484.87	606.68	697.42
R-152a	110.65	137.02	147.09	182.63	188.13
R-404A	119.27	135.39	162.65	182.13	154.62
R-407C	10.22	20.44	40.88	19.71	61.04
R-410A	9.92	17.38	38.2	26.71	49.69
R-507A	14.46	14.65	39.37	84.77	49.33
R-417	0.98	0.45	2.14	5.14	13.96
R-23	1.19	1.21	-	1.5	0.76
Total	**788.46**	**915.20**	**1,109.27**	**1,214.95**	**1,505.53**

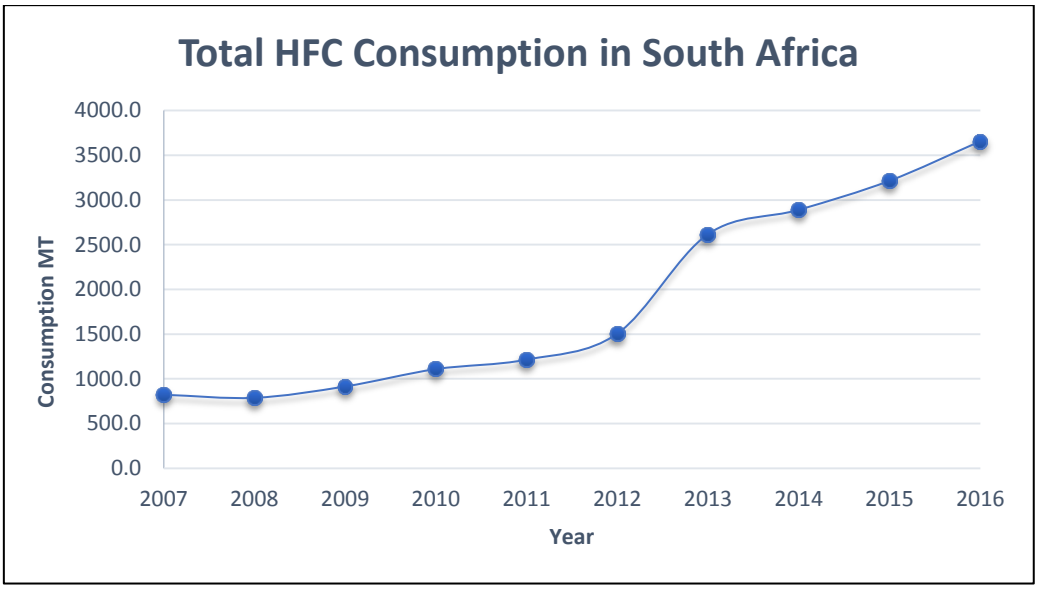
It can be seen from Table 2, that HFC consumption is dominated by imports of refrigerants: HFC-134a, R-404A, R-410A, and R-507A. The primary applications are as follows:

Table 4 HFC Refrigerant Use by Application

Refrigerant	Composition (wt.%)	GWP* 100 yr	Main Applications
HFC-134a	100% HFC-134a	1,430	Domestic and commercial Mobile Air-Conditioning, Commercial Refrigeration, Transport Refrigeration
R-404A	44% HFC-125 4% HFC-134a 52% HFC-143a	3,900	Commercial Refrigeration, Industrial refrigeration, Transport Refrigeration
R-407C	22 – 24% HFC-32 24 – 26% HFC-125 51 – 54% HFC-134a	1,774	Commercial Refrigeration, stationary air-conditioning, chillers
R-410A	50% HFC-32 50% HFC-125	2,088	Stationary Air-Conditioning
R-507A	50% HFC-143a 50% HFC-125	3,985	Commercial Refrigeration, Industrial Refrigeration

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

Figure 3



5.3 Non-HFC Alternatives

Quantitative data on non-HFC alternatives is hard to verify, but anecdotal evidence has been reviewed to establish the trends and likely future scenario for the consumption of non-HFC ODS-alternatives.

It is notable that the foam sector has entirely phased out the use of HCFC-141b without the adoption of any HFC based blowing agents. A small number of manufacturer's trialled HFC-365mfc in the lead up to the 1 January 2016 deadline for HCFC phase out, but the high cost of the material was a significant disincentive in a competitive market. In the majority of cases foam manufacturers have adopted methyl formate, cyclopentane or CO_2 / water as blowing agents.

The RAC sector dominates the consumption of both ODS and ODS-alternatives and, therefore, the consumption of non-HFC alternatives. Whilst the adoption of the latter remains relatively modest, there has been a significant increase in interest in recent years. The main applications of non-HFC alternatives in South Africa are summarised below.

Table 5 non-HFC Use by Application

Substance	GWP	Sectors	Main Applications in South Africa
Methyl formate	<5	Foam	Methyl formate is widely used as a blowing agent in polyurethane foam manufacturing and was the most commonly adopted phase out solution amongst small and medium sized enterprises

Substance	GWP	Sectors	Main Applications in South Africa
HC-290	3.3	RAC	Limited applications to date, but the use of HC-290 is on the increase in small commercial systems, and self-contained supermarket vending cabinets. Additionally, trials are underway to replace R-404A with HC-290 in refrigerated transport systems. Whilst some stakeholders have expressed safety concerns others are actively marketing HC equipment in the field.
HC-600a	3	RAC	Used as the primary refrigerant in the manufacture of domestic refrigerators and freezers (Defy, Whirlpool)
Pentane (C,N,I)	<10	Foam	Cyclopentane has been adopted by some of the larger manufactures of polyurethane foam including Bumbo, Whirlpool, Defy and Aerothane applications.
CO_2 (R-744)	1	RAC Fire Suppression Foam	Initial trials such as those undertaken in 2010 by the Pick & Pay supermarket chain proved very successful and carbon dioxide is becoming increasingly popular as the refrigerant for medium to large-scale supermarkets and chains, with most of the large companies now planning on CO_2 systems. Today there are at least 100 operating systems and several chains such as Makro that have already converted, or are planning to convert, all systems to CO_2. This move has also prompted an increase in the pool of technical expertise and the development of new training facilities. There has been a minor use in automotive air-conditioning but this has been a transient move as the industry has now settled on HFO-1234yf
R-717	0	RAC	Ammonia is very commonly used in South Africa in large industrial refrigeration installations with low temperature storage of frozen fish, meat, vegetables, poultry and processed foods, predominantly use ammonia. Many of the large stores for chilling fruit and dairy products also use ammonia refrigeration systems. The number of ammonia installations is estimated to exceed 4,000 and the oldest has been in service since the 1940s. There is scope for introducing smaller-scale ammonia systems although there is limited activity at this stage.

Substance	GWP	Sectors	Main Applications in South Africa
HFO-1234yf	6	MAC	This has emerged as the main low-GWP alternative for automotive air-conditioning (MACS) with all South African based manufactures adopting this alternative. It is likely that the majority of European and Japanese vehicles imported into South Africa will be fitted with this in the near future. In the meantime, HFC-134a represents the biggest consumption in the MACs sector due to the installed base of vehicle fitted with these systems.

5.4 Refrigeration and Air-Conditioning

The refrigeration and air-conditioning sector dominates the consumption of ODS-alternatives and is made up of a number of two subsectors, manufacturing/assembly and service, each of which is subdivided into main applications:

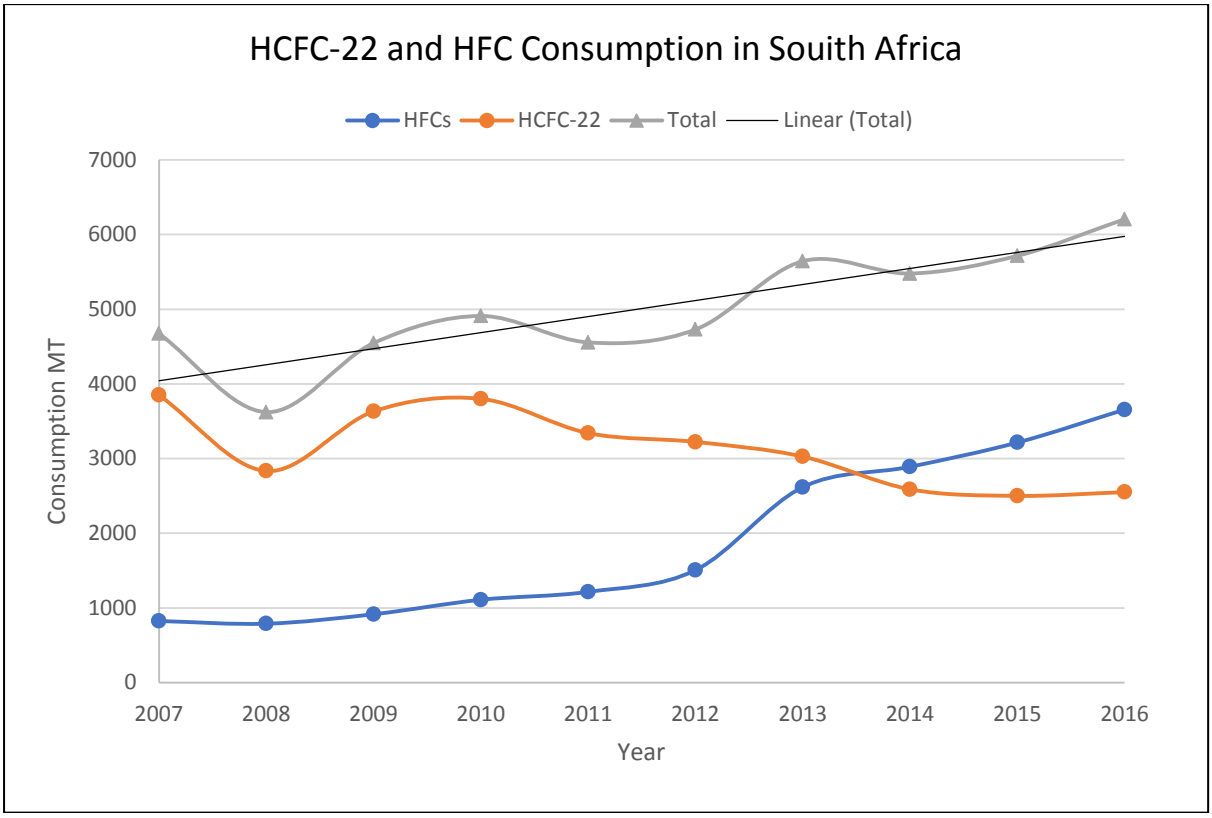
Table 6. Refrigeration and Air-Conditioning Main Refrigerants Used

Application	Description	Main Refrigerants Used in new units	
		until-2015	Since 2015
Small commercial and residential air-conditioning	Unitary and split air-conditioners up to 18 kW installed in residential homes, restaurants, hotels, guest houses, offices, shops, schools, computer rooms, clinics, laboratories etc.	HCFC-22	R-410A, HFC-134a
Commercial air-conditioning	Systems with air handling units and chillers or large VRF (Variable Refrigerant Flow) systems above 18 kW installed in hospitals, hotels, office buildings, shopping malls, cinemas, fitness centers	HCFC-22, R-407C, R-410A	R-407C, R-410A
Light commercial refrigeration	Under bar fridges, vending cabinets, display cabinets, small cold rooms in restaurants, hotels, convenience stores, fast food outlets, retail butchers, florists, food processors and suppliers to the catering industry.	HCFC-22, R134a,	HFC-134a
Large commercial refrigeration	Large Commercial Refrigeration: Central station Supermarkets, fruit and vegetable pack houses, food manufacturers, wineries etc. (charges greater than 100kg)	HCFC-22, R134a, R-404A, R-507A	HFC-134a, R-404A, R-507A, R407C
Industrial refrigeration and process cooling	Cooling in petrochemical, food processing, injection moulding, brewing etc. and installation of water chillers.	HCFC-22, ammonia, HFC-134a,	Ammonia, HFC-134a,
Mobile Air-Conditioning (MAC)	Passenger cars. Luxury coaches and passenger buses, earth moving equipment, driver cabins of overhead cranes. airport apron buses,	HFC-134a	HFC-134a HFO-1234yf
Transport refrigeration	Refrigerated commercial road vehicles.	HCFC-22, R-404A	R-404A

Application	Description	Main Refrigerants Used in new units	
		until-2015	Since 2015
Marine refrigeration	Fishing vessels, deep sea trawlers, foreign owned fishing vessels, fishing in South African waters, stevedore services to visiting vessels.	HCFC-22	HFC-134a
Mine cooling	Cooling of underground mines.	HCFC-123, HCFC-22, HFC-134a,	HFC-134a, VIM

Given the predominance of refrigeration and air-conditioning in terms of ODS and ODS-alternative consumption, the overall pattern of consumption of HCFC-22 and HFCs shows a clear overall trend of continuing growth of the RAC sector in South Africa

Figure 4



5.4.1 Refrigeration System Assembly and Installation

The majority of refrigerants are used in the RAC service sector, although it is estimated that approximately 15-20% of all refrigerant is used in the assembly of refrigeration and air-conditioning systems.

The range of equipment manufactured and systems assembled in South Africa includes ductless and ducted air-conditioning systems, packaged AC units, condensing units, large

and small-scale commercial refrigeration equipment, cold stores, and process cooling systems. Chillers are imported through distributors and joint venture companies. There are also several companies supplying large-scale and industrial refrigeration systems on a design and build basis to a relatively well developed industrial refrigeration sector serving food processing, brewing, fishing, cold storage, chemicals and other process industries.

South African RAC companies have been capable of producing, selling, and exporting non-HCFC equipment for since at least 2010. However, the market for HCFC-22 equipment remained strong until the ban on new HCFC based equipment came into force in 2015, this was because manufacturers found it difficult to convince end users about the benefits of new high efficiency systems with variable refrigerant volume (VRV) or inverter technology, and many installers and contractors tended to specify the cheapest system in order to maximise sales. Since the ban on new HCFC-22 systems, these have been replaced primarily with HFC systems

5.4.2 Refrigerant Trends in Assembly and installation

The following estimated breakdown is based on the usage patterns determined during the HPMP development 2010-2012, and updated to take into account qualitative and quantitative data obtained from stakeholders during this survey. No light residential or light commercial air-conditioners are manufactured in South Africa.

Table 7. Breakdown of Refrigerant Use in Manufacture & Assembly

Application	HFC-134a	R-404A	R-507A	R-410A	R-407C	HFO 1234yf	Total Assembly MT	% of Total
Commercial Air-Conditioning				7	38		45	4%
Commercial Refrigeration	130	124	51				305	29%
Industrial Refrigeration	88	4	37				129	12%
Transport Refrigeration		0					0	0%
Marine Refrigeration	2	1					3	0%
Mine Cooling	2		6				8	1%
Mobile Air-Conditioning	485					78	563	53%
Total	**707**	**129**	**94**	**7**	**38**	**78**	**1,053**	

Light Commercial and Residential Air-Conditioning

An estimated 95% of users in this sector buy purely on price and until the recent ban on imports of R-22 units they remained the cheapest and most popular option. However, the effects of the HPMP have been significant in recent years and R-410A units are now the most commonly procured. There will be a significant service demand for R-22 for some time to come, as the expected life span of unitary units is at least 10 years and up until 2014 these were being imported at a rate of 195,000 approximately per annum. The demand for these units remains high and stock of R-410A units is growing rapidly, the service demand will therefore also continue to grow.

Large Air-Conditioning Installations

Larger commercial air-conditioning systems are now primarily charged with R-407C which provides the simplest conversion from R-22 due to its similar pressures. The most common refrigerant for new light commercial unitary air-conditioning systems is R-410A, but these are not assembled in South Africa at present.

Commercial Refrigeration

The chain supermarket groups dominate this sector and two of the major role players, Pick n Pay and Woolworths have phased out HCFC-22 in new installations and refurbishments. HFC-134a and 404A are now widely used in this sector closely followed by CO_2 cascade systems which will soon be the most common choice in the largest supermarkets.

Industrial Refrigeration and Process Cooling

Ammonia is the most commonly used in this sector and is now being selected for some smaller systems than previously, systems that would traditionally have been charged with HCFC-22 or an HFC. This has been brought about by better availability of small compressors designed for ammonia and partly due to increasing awareness of environmental issues and the low global warming impact of ammonia. However, the continuing development of small-scale ammonia systems means that there are more new opportunities for using ammonia in South Africa.

A number of large installations in the petro-chemical sector have flooded HCFC-22 systems with limited options for conversions. These remain under consideration.

Transport Refrigeration

The majority of new equipment is charged with R-404A. Of the estimated 8,500 refrigerated road vehicles operating in South Africa less than 20 use liquid nitrogen.

The demonstration project supported by GIZ has shown the efficiency advantages of using HC-290 in trucks over the current most common alternative, R-404A. However it is still unclear whether manufacturers will adopt the new technology.

Mobile and Automotive Air-Conditioning

The vast majority of vehicles are charged with HFC-134a and the service demand in this sector will continue for some time. However, the switchover to HFO-1234yf by all European and Japanese manufacturers has had an immediate effect in South Africa and imports of 80 tonnes in 2016 from only 1 tonne in 2015 indicate the beginning of a growing trend.

Marine Refrigeration

HCFC-22 is widely used for on board refrigeration in this sector. Many of the foreign owned vessels fishing in South African water have a high demand for HCFC-22 because of leakage

as a result of poor maintenance. There is little data on the trends in news marine systems although it appears that R-507A and HFC-134a is the most common ODS-alternative currently in use by South African service companies.

Mine Cooling

The HPMP pointed out that there have been no new HCFC-22 installations for mine cooling for some years although a number of installations operating will need to be kept in service until the end of their economic life. A limited number of mines with systems charged with R123 seem to have mostly phased out. The primary refrigerants are now HFC-134a and R-410A.

5.4.3 Refrigeration and Air-Conditioning Servicing

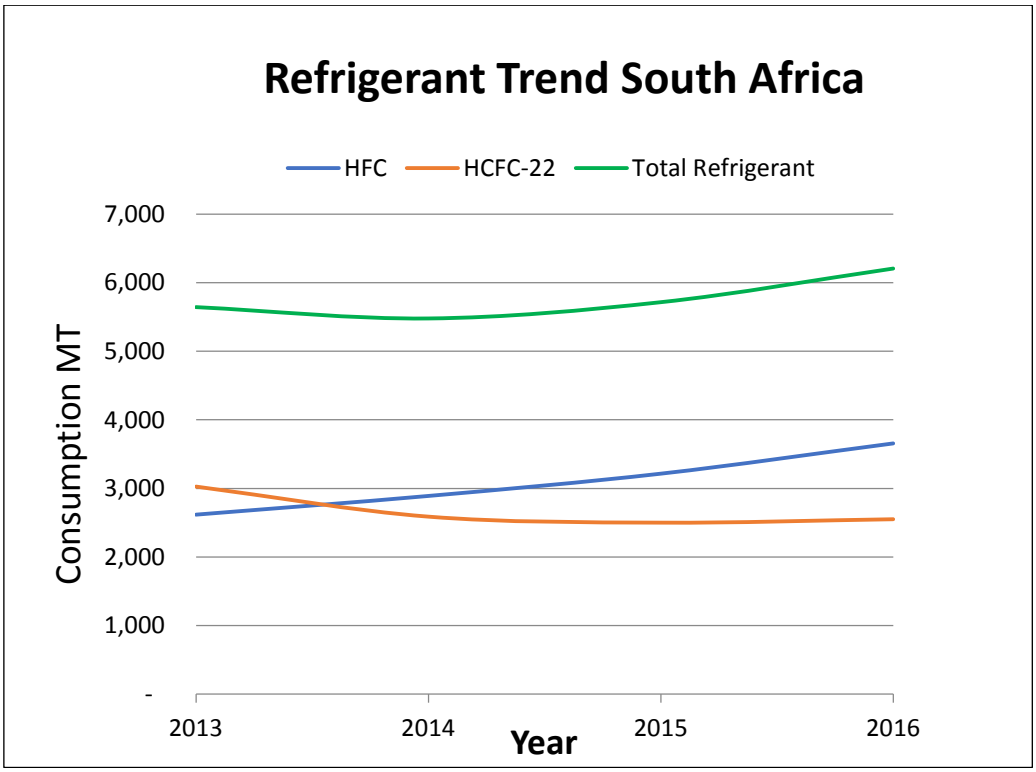
The single largest component of ODS and ODS-alternative consumption in South Africa is in the service and maintenance of refrigeration and air-conditioning equipment, even more so since the phase out of HCFC-141b at the beginning of 2016.

It is clear from the overall refrigerant consumption analysis that the consumption of HCFC-22 is declining slowly due to the significant ongoing service demand, but the consumption of HFCs is increasing as all new equipment must use an ODS-alternative. The chart below shows the overall consumption of R-22 compared to all HFCs for the period 2013 to 2016.

Table 8. Breakdown of Refrigerant Use in Service

HFC	2013	2014	2015	2016
HFC-134a	1,069	1,180	1,312	1,460
R-404A	520	574	638	710
R-507A	457	504	561	624
R-410A	362	400	445	495
R-407C	92	102	113	126
HFC-227ea/HFC-365mfc	60	66	74	82
HFO-1234yf		1	1	80
HFC-152a	59.6	58.8	70	78
R-417A	0.2	59.9		
HFC-23	1.9	48.5		
Total HFC	**2,621**	**2,993**	**3,214**	**3,655**
HCFC-22 A7 Data	**3,026**	**2,588**	**2,501**	**2,550**
Total Refrigerant	**5,648**	**5,582**	**5,715**	**6,205**

Figure 5



According to the SARS trade Statistics for the period Jan to July 2017, the total import of HCFC-22 was 1,306 MT and the total export was 73.9 MT. Projecting to the end of 2017 on a proportionate basis would indicate the continuing gradual decline in HCFC-22 consumption.

Table 9. Import/Export HCFC-22 (SARS data)

SARS Data HCFC-22	Year	Import	Export	Consumption	Export %
Full Year	2016	2,655.7	105.3	2,550.3	4.0%
Part year	2017	1,306.3	73.9	1,232.4	5.7%
Full Year Estimate	2017	2,239.4	126.7	2,112.7	5.7%

The estimated full year consumption of HCFC-22 in 2017 of 2,112 MT represents a further decline of 17% from 2016 data. It should be noted that these figures have been obtained directly from the SARS/ITAC database and do not represent official data. These statistics will have to be processed and verified by NOU before official data can be released. The exercise does however support the trends observed in the official data and the bottom up data provided by importers and Tier 3 consumers.

The service consumption breakdown has been reviewed, using the HPMP model as a basis, and assessment of the inventory estimated for 2016. Using the service demand model shown below, the total refrigerant requirement for 2016 was estimated to be 4,810 MT for HCFC-22 and all HFCs.

The model cannot be totally accurate as it is not possible to analyze the exact charge amount of every type of equipment and the relative difference in charge per kW for HFC refrigerants compared to the HCFC-22 equipment they replace. However, the total estimate using this approach has been updated taking into consideration the most recent consumption data and the approximate breakdown of usage of refrigerants provided by service companies and refrigerant suppliers.

Table 10. Percent Use of Refrigerant Use by Subsector

Sector	Service Demand 2016	Assembly Demand 2016	Total Refrigerant	Service as % of Total	Assembly as % of Total
Residential and Light commercial AC	374	0	374	6.1%	0.0%
Commercial A/C	672	162	834	11.0%	2.7%
Commercial Refrigeration	2,912	398	3,310	47.7%	6.5%
Industrial refrigeratio	236	183	419	3.9%	3.0%
Transport Refrigeration	0.72	0.72	1	0.012%	0.012%
Marine	30.8	9.5	40.3	0.5%	0.2%
Mine cooling	4.18	13.75	18	0.1%	0.2%
MACs	582	522	1,104	9.5%	8.6%
TOTAL	**4,810**	**1,289**	**6,100**	**78.9%**	**21.1%**

HFC-134a accounts for the greatest single share of HFC consumption, and refrigerants R-404A, R-410A and R-507C are widespread with growing demand. By comparison the non-refrigerant F-gases account for less than 3% of national HFC consumption.

Table 11. Use of ODS-Alternatives by sector

Substance	RAC Manufacture	MACs	RAC Servicing	Fire fighting	Aerosol	Solvent
HFC						
HFC-134a	219	631	610			
HFC-32	0.15		0.85			
HFC-152a	11.7		66.3			
HFC-161	0		0			
HFC-227ea/HFC-365mfc	0		0	82		
HFC blends						
R-404A	106.5		603.5			
R-407C	18.9		107.1			
R-410A	74.25		420.75			
R-507A	93.6		530.4			
Others (specify)	0		0			
HFO						
HFO-1234yf		80				
Total	**524.1**	**711**	**2338.9**	**82**	**0**	**0**
	14%	19%	64%	2%	0%	0%

5.5 RAC Service - Refrigerant Use by Subsector

The following subsector breakdown has been compiled using the detailed HPMP service demand model and updating it to account for the ban on the production and import of new equipment using HCFC-22 and the increase in popularity of HFC based equipment, resulting reduction in HCFC-22 equipment in service. It also takes account of the latest feedback from the HCFC stakeholder group and key importers, distributors and gas suppliers.

Table 12. Refrigerant Service Use by Subsector

Application	HCFC-22	HFC-134a	R-404A	R-507A	R-410A	R-407C	HFO 1234yf	Total service	% of total
Residential & small Commercial AC	89	3			424	1		517	10%
Commercial Air-Conditioning	453	13			64	87		617	12%
Commercial Refrigeration	1791	210	551	315				2867	57%
Industrial Refrigeration	157	78	24	214				473	9%
Transport Refrigeration	1.2	0.7	3.2	0.5				5.6	0%
Marine Refrigeration	42	1.6	3.2					46.8	1%
Mine Cooling	8.7	3.5		0.4				12.6	0%
Mobile Air-Conditioning	8.6	443					2	454	9%
Total	**2550**	**752.8**	**581.4**	**529.9**	**488**	**88**	**2**	**4993**	

5.6 Other Uses

Collection of data on non-refrigerant uses has been limited due to the very small quantities of ODS-alternatives being used, the small scale of businesses (other than foam) and a poor response rate to requests for information. However, since all other applications represent only 3-4% of consumption, it is clear that the priority for consideration is the RAC sector.

5.6.1 Aerosols

Filling of aerosols is predominantly done in-house by large industry players, such as Revlon and Unilever, whilst smaller companies typically outsource to third party contractors, which account for 35% to 45% of local aerosol manufacturing. Some of the bigger manufacturers also outsource in the event that they require a can or ingredients that is not compatible with their production equipment.

HFC use as a propellant and/or solvent in aerosols is estimated to be on average 12.8 tonnes of HFC-134a between 2010 and 2015 (Greenhouse 2016). In addition to this approximately 78 tonnes of HFC-152a was used in the manufacture of aerosols in 2016. The majority (80%) of HFC consumption arises from commercial aerosol products, such as cosmetics, insect

repellents, sun screen, paint, degreaser, and other industrial products. Medical aerosols account for around 17% of trade but are imported already charged. Very small amounts of HFC-227ea were reported in the Greenhouse survey of 2016, but the volumes are considered insignificant.

5.6.2 Foam

HFC use as a foam blowing agent contributes very little to the estimated national HFC consumption. Using data from two large system houses and the estimated supply of HFC-134a by the major South African gas suppliers to the foam market it is estimated that Foam-related emissions accounted for just 0.06% of estimated national HFC consumption in 2015. Unlike the other applications, HFC use in foam blowing does not show an increasing trend. Use of blends of HFC-227ea and HFC-365mfc appear to be declining worldwide and HFC-134a has never been used in South Africa.

5.6.3 Fire protection

The estimated ODs-alternative in the fire protection sector has been estimated as 82 MT of HFC-227ea/HFC-365mfc and some anecdotal suggestions that very small amounts of R125 have been used although no verifiable data has been found.

Table 13. Availability of HCFCs, HCFC blends, and alternative chemicals in South Africa

Chemical	Container	Standard Quantity kg	Price ZAR per kg	Price US$ per kg	AGas Price US$ per kg (2017)
HFC-134a Bulk (ISO)	bulk	18,000	55.38	7.45	6.20
R-404a Bulk (Drum)	bulk	730	75.97	10.21	6.19
R-407c Bulk (Drum)	bulk	720	77.03	10.36	6.02
R-600a Bulk (Drum)	bulk	455	22.50	3.03	4.23
R-410a Bulk (Drum)	bulk	720	76.32	10.26	5.25
R-507 Bulk (Drum)	bulk	700	78.10	10.50	5.96
R-417a Bulk (Drum)	bulk	870	113.60	15.27	
R-22 - disposable	disposable	13.0	35.00	4.71	
HFC-134a Disposable	disposable	13.6	58.47	7.86	
R-404a Disposable	disposable	10.9	75.56	10.16	
R-407c Disposable	disposable	11.3	76.65	10.31	
R-600a Disposable	disposable	0.42	243.76	32.77	
R-410a Disposable	disposable	11.3	76.33	10.26	
R-507 Disposable	disposable	11.3	78.46	10.55	
R-417a Disposable	disposable	11.4	113.60	15.27	

6 Future Consumption Trends

6.1 General

HFC producers worldwide are moving their production from established blends like HFC-404a, HFC-407a, and HFC-410a to blends containing HFOs. This is in response to European F Gas regulations which impose production quotas on HFC production. Lower GWP HFO blends, such as R-448A and R-449A (sold as Solstice N40 and Opteon XP40 – virtually identical fluids from rival manufacturers with GWPs of about 1300) contain less HFC and thus enable producers to make their HFC quotas go further.

As the high GWP fluids, these were designed to replace a key part of the refrigerant mix in South Africa. Therefore, it is likely that these HFO/HFC blends will be seen in South Africa in the near future. They are suitable for retrofit into HFC-404a systems directly, and HCFC-22 systems provided the mineral oil lubricant is changed.

The South African market for non-ODS alternatives is dominated by the refrigeration sector, which is extensive and growing. Interviews with key stakeholders including suppliers, designers and end users were conducted for the preparation of this report generated mixed feedback about the likely future scenarios in different subsectors. A key point of contention is the take up of hydrocarbon refrigerants in systems other than domestic refrigeration. Whilst there seems to be a small majority of stakeholders who believe that the South African market is not ready for HC based systems, primarily due to the lack of technical skills of technicians, there is a significant minority who support their adoption and it seems likely that the use of R-290 will increase in small commercial systems, domestic refrigerators, self-contained supermarket vending cabinets and new residential air-conditioners, examples of which are already present in the field.

The RAC sector is generally frustrated with uncertainty in supply, and what some refer to as the "green movement" and the ongoing environmental law developments, which create a constant state of flux in the market. Despite or perhaps because of this frustration, there is a general consensus that the use of natural refrigerants will increase. As little as 5 years ago, it was thought that CO_2 systems in South Africa were purely academic, but today there are at least 100 operating systems and plans for many more. As a result the pool of expertise is increasing, as are appropriate training facilities.

Anecdotally, the majority of stakeholders are swayed mostly by pricing and availability of ODS-alternatives, and they predict the medium to long-term swing will be, wherever possible, to natural refrigerants and to HFCs where necessary.

The phase out of HCFC-22 is well underway and one definite factor in the future consumption trends in all sectors will be the reduction in its consumption.

6.2 Residential and Light Commercial Air-Conditioning

A number low-GWP (<675) HFO/HFC blends are in development by manufacturers but not yet available. These are more flammable than R-448A and R-449A (they contain more HFO)

and have been given the new A2L classification under the ASHRAE and EN 378 standards. One R-444B (Solstice L20) is a replacement for HCFC-22 so may well find widespread use in South Africa in due course. Another intended as an HFC-134a replacement (actually with an A1 safety classification) has been developed for chillers. Another, Solstice L41 (GWP < 500; A2L safety classification) is being developed as a low-GWP replacement for HFC-410a for tropical climates where the high discharge temperatures of HFC-32 can present a problem. It is likely therefore that it will find an application in South Africa.

6.3 Large Air-Conditioning Installations

Larger commercial air-conditioning systems are now primarily charged with R-407C which provides the simplest conversion from R-22 due to its similar pressures. The most common refrigerant for new light commercial unitary air-conditioning systems is R-410A, but these are not assembled in South Africa at present.

6.4 Commercial Refrigeration

R744 (carbon dioxide CO_2) has become a key contender for supermarket applications and it is likely that it will be present in the majority of large (chains) stores in the near future. The chain supermarket groups dominate this sector and two of the major role players, Pick n Pay and Woolworths have phased out HCFC-22 in new installations and refurbishments. HFC-134a and HFC-404A are now widely used in this sector closely followed by CO_2 cascade systems which will soon be the most common choice in largest supermarkets. Early CO_2 cascade systems used HFC-134a in the upper stage; more recent designs are understood to be using ammonia.

As HFC refrigerants are non azeotropic blends[1] controls have to be adjusted on some systems like central station supermarket packs or efficiency levels are not maintained. These features are difficult for technicians trained before the advent of refrigerants with “glide” to appreciate and training courses in their proper application will need to be provided.

At this stage the market is still adjusting to the latest HFC blends and now to the use of CO_2 in some systems. However, it is likely that as the international suppliers begin to adopt these products the South African market will adapt.

From a thermodynamic standpoint HC-290 (propane) is an ideal drop-in for HCFC-22, but its flammability limits use to larger refrigerators used in catering, integral display cases and small air-conditioners. Though practical in terms of meeting safety requirements, HC-290 has been little used for the latter. HFC-32 (GWP 675) is now being used as a replacement for HFC-410a in unitary and split air-conditioners from Japanese manufacturers, and is liable to enter the South African market at some point in the near future.

[1] i.e. boil and condense over a range of temperatures, known as the temperature “glide”

6.5 Industrial Refrigeration

Ammonia is the most commonly used in this sector and is now being selected for some smaller systems (and packaged systems) than it would have previously, systems that would traditionally have been charged with HCFC-22 or an HFC. This has been brought about by better availability of small compressors designed for ammonia and partly due to increasing awareness of environmental issues and the low global warming impact of ammonia. However, the continuing development of small-scale ammonia systems means that there are more new opportunities for using ammonia in South Africa. There is growth in the low temperature cold store sector and all new stores are based on ammonia systems. This trend will continue and if the supply of ammonia were more advanced it would spread further into Africa.

6.6 Transport Refrigeration

The majority of new equipment is charged with R-404A. Of the estimated 8,500 refrigerated road vehicles operating in South Africa less than 20 use liquid nitrogen.

The demonstration project supported by GIZ has shown the efficiency advantages of using HC-290 in trucks over the current most common alternative, R-404A; however, it is still unclear whether manufacturers will adopt the new technology.

6.7 Mobile and Automotive Air-Conditioning

The vast majority of vehicles are charged with HFC-134a and the service demand in this sector will continue for some time. However, the switchover to HFO-1234yf by all European and Japanese manufacturers has had an immediate effect in South Africa and imports of 80 tonnes in 2016 from only 1 tonne in 2015 indicate the beginning of a growing trend.
The auto a/c sector is switching to HFO-1234yf and it is likely that by end of 2017 all cars produced in South Africa will be 1234yf.

6.8 Marine Refrigeration

HCFC-22 is widely used for on board refrigeration in this sector. Many of the foreign owned vessels fishing in South African water have a high demand for HCFC-22 because of leakage as a result of poor maintenance. There is little data on the trends in news marine systems although it appears that R-507A and HFC-134a is the most common ODS-alternative currently in use by South African service companies.

Several international manufacturers use R-404A refrigerant in marine reefers but in 2016 some began to offer the option of using R-452A, a lower global warming potential (GWP) alternative that can be implemented on new and existing units without the need to change any components or settings. This sort of development is yet to be seen in South Africa, but it is likely that service companies will gear up as and when these units are presented.

6.9 Mine Cooling

The HPMP pointed out that there have been no new HCFC-22 installations for mine cooling for some years although a number of installations operating will need to be kept in service until the end of their economic life. A limited number of mines with systems charged with R-123 seem to have mostly phased out. The primary refrigerants are now HFC-134a and R-410A. However, a major gold mine in South Africa operates the world's largest vacuum ice maker (VIM) installation, with a capacity of approximately 27MW. The system pre-cools water with conventional chillers and the VIM then produces ice by subjecting the cooled liquid to a very low pressure using a high swept volume compressor. This results in the evaporation of a small portion of the cooled water which causes the formation of small ice crystals in the water. This slurry of water and ice can then be pumped to provide cooling where required using conventional pumps and heat exchangers.

6.10 Summary

The mix of alternatives described above that will be implemented in South Africa, is subject to a great many variables such as the rate at which different types of foreign made equipment enter the market, and not least the economic situation, which will dictate whether environmentally friendly options become established or whether the cheapest permissible fluids predominate.

7 Growth Projections

7.1 Projection of current trends

The recent consumption trends have been analysed in conjunction with a) the prevailing economic conditions in South Africa and b) the sector based trends in sales and performance experienced by a range of RAC stakeholders. The simple projection below shows the possible total consumption in future years if an overall increase in total volumes are applied on a year by year basis.

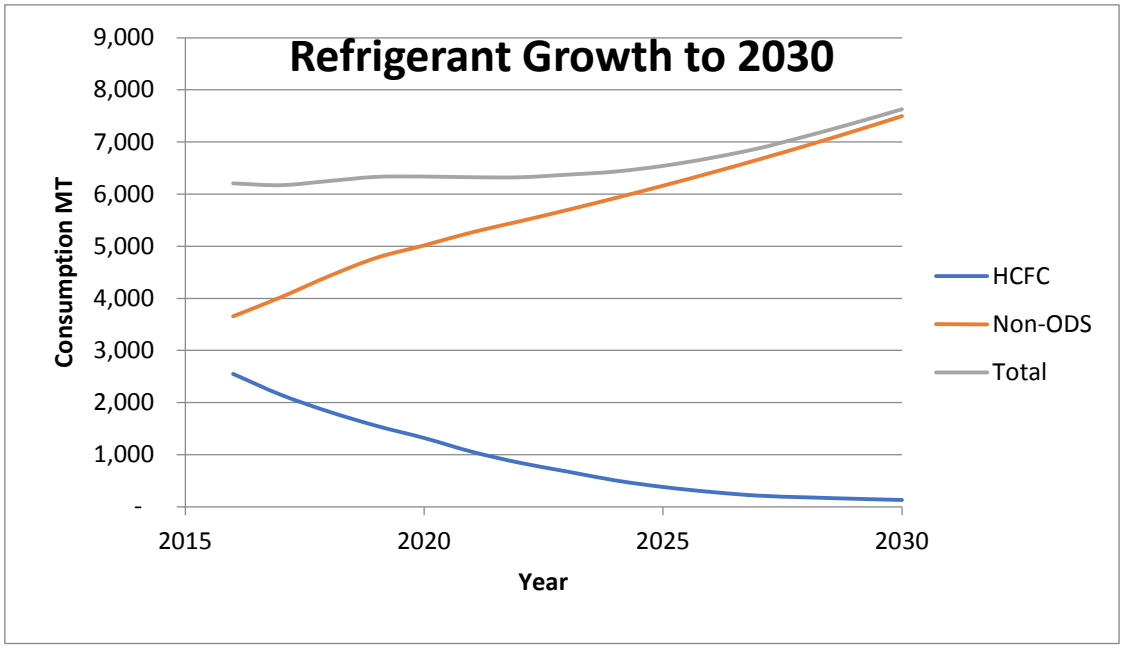
Table 14. HCFC and non-ODS Fluids. Projected use to 2030

Simple Projection			
Year	**HCFC**	**Non-ODS**	**Total**
2016	2,550	3,656	6,206
2017	2,150	4,022	6,172
2018	1,828	4,424	6,252
2019	1,554	4,778	6,331
2020	1,321	5,017	6,337
2021	1,057	5,267	6,324
2022	845	5,478	6,323
2023	676	5,697	6,373
2024	507	5,925	6,432
2025	380	6,162	6,542
2026	285	6,409	6,694
2027	214	6,665	6,879

2028	182	6,932	7,113
2029	155	7,209	7,363
2030	131	7,497	7,629

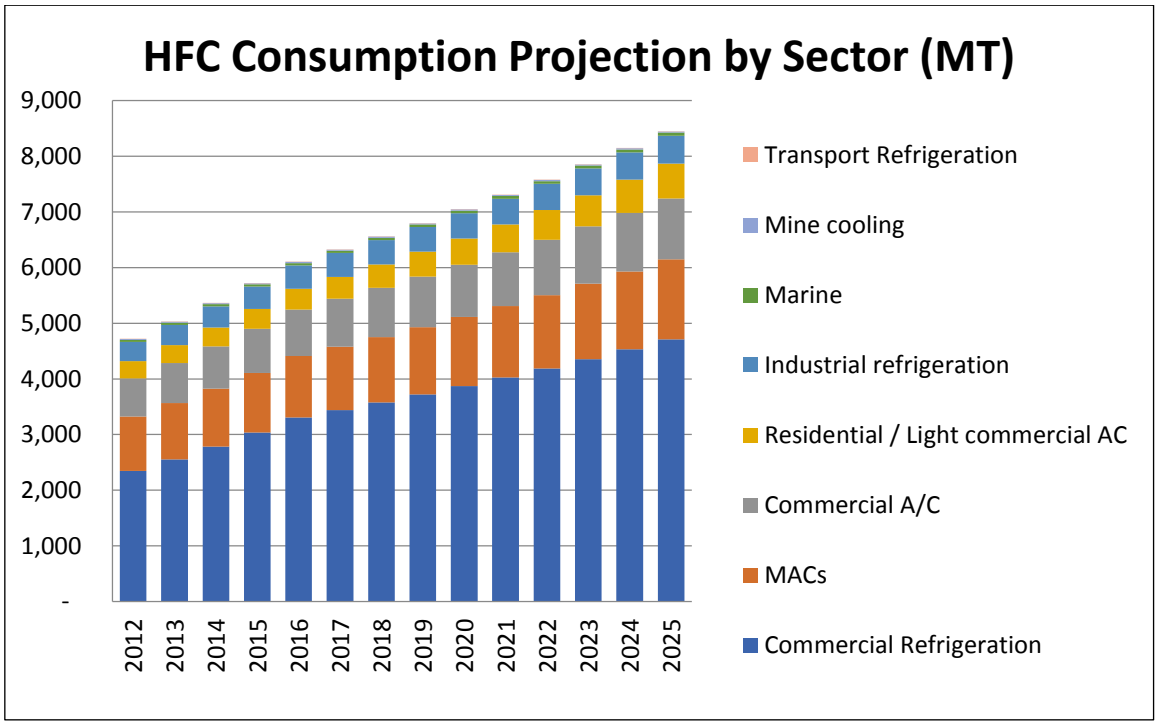
It is very difficult to make accurate predictions of future event which might disrupt the current market trends and, therefore a relatively conservative model seems to be preferred amongst industry players.

Figure 6



However, taking a sector by sector approach and applying in the individual growth expectations within each subsector yields a somewhat different projection, with higher growth rates. On the one hand, this might be considered more accurate as the projections are made by sector specific stakeholders. On the other hand, there is a tendency for subsector specialist to overestimate growth prospects.

Figure 7



The South African economy has been relatively turbulent in the past few years and most sector have experienced little growth or decline, the RAC sector has not been immune to this effect but seems to have been less impacted than other sectors. One known factor is the phase out of HCFC-22, and all the indications at present show that without institutional intervention it is likely, with a few small exceptions such as CO_2 in supermarkets, that the majority of the gap left by the phase out will be filled with a combination of the existing HFC refrigerants.

7.2 Impact of the Kigali Amendment

The 28th Meeting of the Parties (MOP 28) to the Montreal Protocol met in Kigali (Rwanda) in October where it was agreed that HFCs would be subject to control by virtue of their high GWP. As an article 5 country South Africa agrees to a freeze on HFC imports from 2024 followed by progressive reductions on the baseline (average 2020-22 imports) of 10% in 2029.

This will clearly affect the scenario presented above since from 2024 all increases in overall demand will have to be met by low-GWP (GWP < 1500) fluids, a group which includes those, such as HFC448A and 449A, as well as the very low-GWP fluids (GWP < 700), such as R-444B and R-450A, not to mention HFC32, all of which *a priori* are set to figure largely in the solution to phase out HCFCs in South Africa.

The Table below provides the amounts of non-HFCs that would be required to meet South Africa's refrigerant demand according to the scenario based on the metric tonnes presented above.

Table 15. Non-HFCs required (MT) meeting Refrigerant Demand from 2024

Year	2024	2025	2026	2027	2028	2029	2030
Non-HFCs required	0	908	1,155	1,411	1,678	2,480	2,769

Converting the sectoral consumptions to a CO_2 equivalent consumption highlights the global warming impact on a sectoral basis. It is noted that when ranked in this way the commercial refrigeration sector is seen to be the biggest consumer by tonnage and by GWP, but significance of industrial refrigeration is elevated to second place ahead of MACs.

Table 16. ODP tonne Usage 2016 and 2025

Sector	Total $ktCO_{2eq}$ 2016	Total $ktCO_{2eq}$ 2025
Commercial Refrigeration	4,577	5,972
Industrial Refrigeration and process cooling	1,347	2,275
Mobile Air-Conditioning	1,327	1,328
Light Commercial and Residential Air-Conditioning	891	1,269
Commercial Air-Conditioning	389	507
Mine Cooling	33	36
Marine Refrigeration	20	26
Transport Refrigeration	16	19
Total $ktCO_{2eq}$	8,601	11,433

Given these projections, there are certainly challenges ahead for South Africa, if it is to meet the requirement of the Kigali agreement. However, there are significant opportunities for replacing high GWP refrigerants with low and very low-GWP alternatives. The following scenario presents a stretching but technically possible picture of the changes that could take place on a sector by sector basis, given the appropriate levels of stimulus and support.

Table 17. Speculative Prediction of Refrigerant Use by 2025

Application	Description	Main Refrigerant Pre 2016	Main Refrigerants since 2016	Potential Shift in Refrigerants By 2025	Comments
Light Commercial and Residential Air-Conditioning	Unitary and split air-conditioners up to 18 kW installed in residential homes, restaurants, hotels, guest houses, offices, shops, schools, computer rooms, clinics, laboratories etc.	HCFC-22	R-410A	80% still on HFC-410A 16% HFC-32 4% HC-290	HFC-32 is A2L Safety training reqd for HCs

Application	Description	Main Refrigerant Pre 2016	Main Refrigerants since 2016	Potential Shift in Refrigerants By 2025	Comments
Commercial Air-Conditioning	Systems with air handling units and chillers or large VRF (Variable Refrigerant Flow) systems above 18 kW installed in hospitals, hotels, office buildings, shopping malls, cinemas, fitness centres	HCFC-22, R-407C, R-410A	HFC-134a, R-407C, R-410A	50% on HFC-134a, R-407C, R-410A 50% HFC- 450A	HFC – 450A not a drop-in – 13% drop in capacity.
Commercial Refrigeration	Light Commercial: Under bar fridges, vending cabinets, display cabinets, small cold rooms in restaurants, hotels, convenience stores, fast food outlets, retail butchers, florists, food processors and suppliers to the catering industry. Large Commercial Refrigeration: Supermarkets with plant rooms, fruit and vegetable pack houses, food manufacturers, wineries etc. (charges greater than 100kg)	HCFC-22, R134a, R-404A, R-507A	HFC-134a, R-404A, R-507A	50% on HFC-134a, R-404A, R-507A 40% R448A/449A 10% HCs	Safety training reqd for HCs Training reqd for 448A/449A retrofits on smart systems to avoid efficiency penalty
Industrial Refrigeration and process cooling	Cooling in petrochemical, food processing, injection moulding, brewing etc. and installation of water chillers.	HCFC-22, ammonia, HFC-134a,	Ammonia, HFC-134a,	50% on Ammonia 30% R448a/449A 15% R450A 5% HFO 1234ze	Training reqd for 448A/449A retrofits See Spanish article on HFO 1234ze grape/carrot chilling
Transport Refrigeration	Refrigerated commercial road vehicles.	HCFC-22, R-404A	R-404A	80% 404A 15% R448a/449A 5% HC 290	Safety training reqd for HCs
Marine Refrigeration	Fishing vessels, deep sea trawlers, foreign owned fishing vessels, fishing in South African waters, stevedore services to visiting vessels.	HCFC-22	HFC-134a, R-404A	80% 404A 10% R448a/449A 10% HFC-450A	Training reqd for 448A/449A retrofits
Mine Cooling	Cooling of underground mines.	HCFC-123, HCFC-22, HFC-134a,	HFC-134a, R-507A	50% HFC-134a 30% VIM 10% HFC-450A 10% HFO 1234ze	HFO 1234ze can be used with external located chiller (as grape chiller above)
Mobile Air-Conditioning	Passenger cars. Luxury coaches and passenger buses, earth moving equipment, driver cabins of overhead cranes. airport apron buses,	HFC-134a	HFC-134a HFO-1234yf	10% HFC-134a 90% HFO-1234yf	

However, given the highly speculative nature of these predictions nothing can be said with any certainty. The performance of the South African economy, the energy with which the government promotes HC use, developing refrigeration technologies worldwide will all play a part.

8 Conclusions and recommendations

8.1 Institutional Setup

A key recommendation of the findings of this report relates to the nature of the task ahead for South Africa in monitoring and controlling the use of HFCs. As has been demonstrated by the attempts of the authors of this and other reports in South Africa, the systems in place for capturing and analyzing the import, export and consumption of Non-ODS substances are not adequate for the level of control that will be required.

Whilst the data presented in this report represents a good snapshot of current activities and a well reasoned analysis of consumption based partially on SARS data and partially on qualitative and quantitative Tier 3 data, a more robust and institutional approach will be needed urgently if the Government is to be able to implement the Kigali agreement in South Africa.

A “key weakness” in the current institutional system is the lack of precision afforded by the 6 digit customs codes currently used for HFCs and substances containing HFC. It is recommended that South Africa takes steps to develop the tariff book, making use of the appropriate subordinates digits and suffixes to allow for the detailed identification of substances.

In addition to this it is recommended that a computerized system is developed to record and track permit applications and approvals for both ODS and HFC imports and exports.

Another key issue to be addressed in the institutional setup will be the appropriate integration and/or coordination of institutional responsibilities within the Department of Environmental Affairs and between the various government agencies and departments. The control of ODS already requires a significant degree of coordination and communication and implementation ODS phase out activities is often slowed by the necessity for cross-departmental agreement. The implementation of the Kigali agreement and for that matter the stage II HPMP will require technical and institutional resources across a wide range of substances and applications, some of which currently fall outside the remit of the NOU. A key example is the use and safety standards for hydrocarbon refrigerants, similarly the codes of practice for the use of ammonia. Since these substances will be a part of future phase out activities under the Montreal Protocol, it will be necessary to establish the appropriate institutional structure to deal with these issues.

8.2 Promotion of Low-GWP alternatives

Ammonia is very commonly used in South Africa in large industrial refrigeration installations with low temperature storage of frozen fish, meat, vegetables, poultry and processed foods,

predominantly use ammonia. Many of the large stores for chilling fruit and dairy products also use ammonia refrigeration systems. The number of ammonia installations is estimated to exceed 4,000 and the oldest in service since the 1940s. There is scope for introducing smaller-scale ammonia systems although there is limited activity at this stage.

As South Africa has a well-established code of practice and safety standards relating to the use of ammonia as a refrigerant, as well as regulations covering the installation and operation of pressure systems (SANS 1047), the use of ammonia and carbon dioxide refrigerants is perfectly viable.

It is recommended that work is done to establish the feasibility of extending the reach of ammonia based refrigeration systems and the extent to which it might offset the future demand for HFCs.

HC-290 has some applications but the majority of stakeholders interviewed during this survey have significant concerns over safety standards, primarily related to the qualifications and competence of service technicians from the small and medium sized service companies.

Global opinion varies on the extent to which HC refrigerants and other moderately flammable substances such as HFC-32 will be part of the future landscape of refrigeration and air-conditioning; however, there is a global acceptance that they will be at least some part of that landscape and as a minimum in a major proportion of residential air-conditioning.

It is therefore recommended that South Africa takes steps potentially as part of the ongoing activities under the HPMP to assess the current weaknesses in training and development in the RAC service and installation sector and develop strategies to plug the gap. The future workforce should be capable of safely handling the whole range of potential refrigerants including flammable, toxic and high-pressure refrigerants. (Hydrocarbons, Ammonia, CO_2, HFO and new blends)

It is recommended that awareness raising of the forthcoming issues of HFC control is planned strategically and started early. There is already a well attended stakeholder engagement mechanism in place and this should be used to the greatest extent possible to develop policy and disseminate information, both from government to industry and vice versa.

Early demonstration projects will also be of great benefit in building institutional and technical capacity, particularly in the area of hydrocarbons, ammonia or HFOs. The particular subsectors to be targeted depend 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.

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. This is particularly relevant to South Africa

as it has a well-developed break bulk distribution system and component supply infrastructure, but current recovery and recycling rates are low. It is recommended that recovery and recycling activities under the HPMP and supported and promoted and the feasibility of extending these activities to HFC recovery along with the development to F-Gas type regulations is considered.

Please note the report is not formally endorsed/cleared by Department of Environmental Affairs, National Ozone Unit

Annex 1 - Key Data Tables

Table1. ODS-Alternative Consumption by Alternative 2013-2016

Non-ODS Alternatives	Consumption			
	2013	2014	2015	2016
HFC-134a	1,069	1,180	1,312	1,460
HFC-32	0.7	0.8	0.9	1.0
HFC-152a	57	63	70	78
HFC-227ea/HFC-365mfc	60	66	74	82
R-404A	520	574	638	710
R-407C	92	102	113	126
R-410A	362	400	445	495
R-507A	457	504	561	624
HFO-1234yf		1	1	80
Total	**2,617**	**2,890**	**3,215**	**3,656**
HCFC-22	**3,061.0**	**2,638.0**	**2,616.0**	**2,656.0**
Total Refrigerant	**5,678.4**	**5,528.1**	**5,830.9**	**6,312.0**

Table 2. Summary of use in all sectors for each year between 2013 to 2016 (mt)

Use of ODS-Alternatives by sector						
Substance	**RAC Manufacture**	**MACs**	**RAC Servicing**	**Fire fighting**	**Aerosol**	**Solvent**
HFC						
HFC-134a	219	631	610			
HFC-32	0.15		0.85			
HFC-152a	11.7		66.3			
HFC-161	0		0			
HFC-227ea/HFC-365mfc	0		0	82		
HFC blends						
R-404A	106.5		603.5			
R-407C	18.9		107.1			
R-410A	74.25		420.75			
R-507A	93.6		530.4			
Others (specify)	0		0			
HFO						
HFO-1234yf		80				
Total	**524.1**	**711**	**2338.9**	**82**	**0**	**0**
	14%	19%	64%	2%	0%	0%

ODS-alternatives supply scenario

Table 3. Import amounts of ODS-alternatives 2013-2016

Non-ODS Alternatives	Imports (mt)			
	2013	2014	2015	2016
HFC-134a	1,069	1,180	1,312	1,460
HFC-32	0.7	0.8	0.9	1.0
HFC-152a	57	63	70	78
HFC-227ea/HFC-365mfc	60	66	74	82
R-404A	520	574	638	710
R-407C	92	102	113	126
R-410A	362	400	445	495
R-507A	457	504	561	624
HFO-1234yf		1	1	80
Total	**2,617**	**2,890**	**3,215**	**3,656**
HCFC-22	**3,061.0**	**2,638.0**	**2,616.0**	**2,656.0**
Total Refrigerant	**5,678.4**	**5,528.1**	**5,830.9**	**6,312.0**

Table 4 Exports

Note: export data is not available or indicates negligible amounts, consumption therefore estimated to be equal to import.

Table 5 Production of ODS-Alternatives

Note: South Africa does not produce any ODS-alternatives

Annex 2 Raw SARs Data

HFC 2016						
Country Of Origin	Tariff	Year Month	Calendar Year	Tariff Description	Quantity kg	Customs Value ZAR
Germany	29033990	201603	2016	29033990 - Other	0.1	1,169
Germany	29033990	201606	2016	29033990 - Other	0.3	835
Germany	29033990	201601	2016	29033990 - Other	0.3	379
Germany	29033990	201611	2016	29033990 - Other	0.3	276
Germany	29033990	201609	2016	29033990 - Other	0.4	377
Germany	29033990	201604	2016	29033990 - Other	0.4	452
Germany	29033990	201604	2016	29033990 - Other	0.5	220
Germany	29033990	201606	2016	29033990 - Other	0.7	825
United States	29033990	201605	2016	29033990 - Other	0.7	10
Germany	29033990	201607	2016	29033990 - Other	0.7	915
Germany	29033990	201605	2016	29033990 - Other	0.7	2,045
Germany	29033990	201605	2016	29033990 - Other	0.8	433
United Kingdom	29033990	201604	2016	29033990 - Other	0.8	783
United States	29033990	201604	2016	29033990 - Other	0.9	1,329
United States	29033990	201601	2016	29033990 - Other	1.0	9,747
Belgium	29033990	201605	2016	29033990 - Other	1.1	381
Germany	29033990	201602	2016	29033990 - Other	1.1	2,885
Germany	29033990	201612	2016	29033990 - Other	1.3	2,090
Belgium	29033990	201608	2016	29033990 - Other	1.5	279
Germany	29033990	201601	2016	29033990 - Other	1.7	1,660
United Kingdom	29033990	201607	2016	29033990 - Other	1.9	418
Japan	29033990	201602	2016	29033990 - Other	2.0	35,103
United States	29033990	201610	2016	29033990 - Other	2.0	28,709
Japan	29033990	201610	2016	29033990 - Other	2.0	31,750
Germany	29033990	201608	2016	29033990 - Other	2.2	1,868
Germany	29033990	201610	2016	29033990 - Other	2.7	461
Netherlands	29033990	201609	2016	29033990 - Other	2.8	545
United Kingdom	29033990	201610	2016	29033990 - Other	2.9	547
Germany	29033990	201612	2016	29033990 - Other	3.3	1,986
United States	29033990	201612	2016	29033990 - Other	4.0	55,482
United Kingdom	29033990	201608	2016	29033990 - Other	4.2	867
Japan	29033990	201601	2016	29033990 - Other	4.3	527,322
Germany	29033990	201611	2016	29033990 - Other	4.4	7,303
United Kingdom	29033990	201611	2016	29033990 - Other	4.6	274
Belgium	29033990	201610	2016	29033990 - Other	5.1	864
Germany	29033990	201608	2016	29033990 - Other	5.8	9,847
Germany	29033990	201611	2016	29033990 - Other	6.1	5,959
Japan	29033990	201603	2016	29033990 - Other	10.0	15,243
Germany	29033990	201607	2016	29033990 - Other	10.1	1,752

HFC 2016						
Country Of Origin	Tariff	Year Month	Calendar Year	Tariff Description	Quantity kg	Customs Value ZAR
Germany	29033990	201608	2016	29033990 - Other	10.8	10,029
Germany	29033990	201603	2016	29033990 - Other	11.3	18,140
Germany	29033990	201602	2016	29033990 - Other	11.4	21,675
Germany	29033990	201610	2016	29033990 - Other	11.8	13,702
United States	29033990	201610	2016	29033990 - Other	13.2	1,967
Germany	29033990	201607	2016	29033990 - Other	14.0	13,216
United States	29033990	201606	2016	29033990 - Other	16.0	34,704
United Kingdom	29033990	201606	2016	29033990 - Other	16.0	25,455
Germany	29033990	201606	2016	29033990 - Other	18.2	35,087
Germany	29033990	201604	2016	29033990 - Other	19.1	13,797
United Kingdom	29033990	201605	2016	29033990 - Other	21.0	3,492
United States	29033990	201609	2016	29033990 - Other	24.3	45,953
Germany	29033990	201609	2016	29033990 - Other	24.5	8,919
United Kingdom	29033990	201603	2016	29033990 - Other	28.2	70,775
United Kingdom	29033990	201607	2016	29033990 - Other	31.0	9,424
United States	29033990	201607	2016	29033990 - Other	41.6	2,240
United States	29033990	201601	2016	29033990 - Other	46.4	22,911
Germany	29033990	201609	2016	29033990 - Other	66.7	11,580
France	29033990	201610	2016	29033990 - Other	500.0	53,386
United States	29033990	201611	2016	29033990 - Other	576.3	28,792
Netherlands	29033990	201601	2016	29033990 - Other	846.0	926,457
China	29033990	201603	2016	29033990 - Other	1,000.0	191,040
Hong Kong	29033990	201609	2016	29033990 - Other	1,050.0	184,753
China	29033990	201610	2016	29033990 - Other	1,090.0	62,230
United States	29033990	201611	2016	29033990 - Other	1,207.0	206,091
Netherlands	29033990	201604	2016	29033990 - Other	2,538.0	2,426,668
Singapore	29033990	201601	2016	29033990 - Other	2,759.6	74,626
China	29033990	201605	2016	29033990 - Other	4,624.0	200,055
United States	29033990	201605	2016	29033990 - Other	6,400.2	1,096,280
Japan	29033990	201608	2016	29033990 - Other	8,460.0	7,257,050
Germany	29033990	201612	2016	29033990 - Other	9,600.0	1,022,538
China	29033990	201603	2016	29033990 - Other	13,575.7	702,346
India	29033990	201607	2016	29033990 - Other	14,720.0	235,108
China	29033990	201612	2016	29033990 - Other	15,504.0	640,885
China	29033990	201605	2016	29033990 - Other	16,800.0	268,740
United States	29033990	201608	2016	29033990 - Other	17,890.0	1,056,163
France	29033990	201602	2016	29033990 - Other	18,000.0	1,082,230
Germany	29033990	201602	2016	29033990 - Other	18,000.0	1,088,845
Germany	29033990	201604	2016	29033990 - Other	18,000.0	1,326,083
France	29033990	201604	2016	29033990 - Other	18,000.0	1,003,735
France	29033990	201605	2016	29033990 - Other	18,000.0	968,973

HFC 2016						
Country Of Origin	Tariff	Year Month	Calendar Year	Tariff Description	Quantity kg	Customs Value ZAR
Germany	29033990	201606	2016	29033990 - Other	18,000.0	1,348,404
Germany	29033990	201609	2016	29033990 - Other	18,000.0	1,146,490
France	29033990	201610	2016	29033990 - Other	18,000.0	924,691
Germany	29033990	201611	2016	29033990 - Other	18,000.0	902,447
France	29033990	201612	2016	29033990 - Other	18,000.0	888,275
India	29033990	201609	2016	29033990 - Other	18,400.0	259,809
India	29033990	201610	2016	29033990 - Other	18,400.0	254,781
China	29033990	201604	2016	29033990 - Other	18,692.0	1,022,156
India	29033990	201602	2016	29033990 - Other	20,000.0	317,365
China	29033990	201610	2016	29033990 - Other	20,760.0	904,273
Japan	29033990	201609	2016	29033990 - Other	22,850.0	21,023,602
China	29033990	201606	2016	29033990 - Other	26,664.0	12,043,151
China	29033990	201603	2016	29033990 - Other	33,201.5	1,087,847
China	29033990	201602	2016	29033990 - Other	33,504.0	1,508,177
China	29033990	201612	2016	29033990 - Other	33,725.0	1,430,368
France	29033990	201601	2016	29033990 - Other	34,920.0	1,948,215
France	29033990	201603	2016	29033990 - Other	35,360.0	2,067,743
France	29033990	201611	2016	29033990 - Other	35,960.0	1,856,357
France	29033990	201607	2016	29033990 - Other	36,000.0	2,037,060
China	29033990	201611	2016	29033990 - Other	38,080.0	1,631,567
China	29033990	201601	2016	29033990 - Other	39,665.0	2,033,535
China	29033990	201609	2016	29033990 - Other	43,254.5	2,337,706
China	29033990	201602	2016	29033990 - Other	43,410.0	2,157,225
China	29033990	201601	2016	29033990 - Other	47,323.0	2,322,786
China	29033990	201604	2016	29033990 - Other	47,873.6	5,908,105
China	29033990	201601	2016	29033990 - Other	49,259.7	2,904,359
China	29033990	201607	2016	29033990 - Other	51,195.2	12,832,797
India	29033990	201604	2016	29033990 - Other	54,400.0	2,761,785
China	29033990	201606	2016	29033990 - Other	57,569.9	3,958,684
China	29033990	201609	2016	29033990 - Other	58,182.0	2,643,206
China	29033990	201604	2016	29033990 - Other	58,958.0	2,634,110
China	29033990	201611	2016	29033990 - Other	67,797.0	16,223,063
China	29033990	201610	2016	29033990 - Other	68,460.0	2,949,455
China	29033990	201605	2016	29033990 - Other	71,279.0	3,485,761
France	29033990	201609	2016	29033990 - Other	71,367.0	3,703,381
China	29033990	201611	2016	29033990 - Other	71,472.0	2,634,392
China	29033990	201606	2016	29033990 - Other	85,190.7	4,049,651
China	29033990	201607	2016	29033990 - Other	85,281.7	3,872,900
China	29033990	201612	2016	29033990 - Other	92,378.2	4,034,356
China	29033990	201602	2016	29033990 - Other	95,452.0	3,727,218
China	29033990	201608	2016	29033990 - Other	109,538.0	5,266,547

HFC 2016						
Country Of Origin	Tariff	Year Month	Calendar Year	Tariff Description	Quantity kg	Customs Value ZAR
China	29033990	201608	2016	29033990 - Other	130,412.0	5,534,806

38247800 - Containing Perfluorocarbons (PFCs) Or Hydrofluorocarbons (HFCs), But Not Containing Chlorofluorocarbons (CFCs) Or Hydrochlorofluorocarbons - 2016					
Country Of Origin	**Tariff**	**Year Month**	**Calendar Year**	**Quantity kg**	**Customs Value ZAR**
United Kingdom	38247800	201601	2016	1,300.0	117,708
China	38247800	201601	2016	29,440.2	1,390,367
United States	38247800	201601	2016	7,820.0	372,704
Netherlands	38247800	201601	2016	445.0	16,276
United States	38247800	201602	2016	19.0	47,639
United Kingdom	38247800	201602	2016	2.0	496
Belgium	38247800	201602	2016	4.0	2,087
China	38247800	201602	2016	9,040.0	489,466
China	38247800	201602	2016	133,714.1	7,433,771
China	38247800	201603	2016	9,530.0	504,431
China	38247800	201603	2016	23,020.0	1,282,322
Netherlands	38247800	201603	2016	885.0	39,193
France	38247800	201603	2016	1,920.0	223,205
Mauritius	38247800	201603	2016	498.0	188,664
United States	38247800	201603	2016	2.3	5,173
China	38247800	201603	2016	11,212.0	572,471
China	38247800	201604	2016	122,223.2	6,206,416
China	38247800	201604	2016	25,150.0	1,095,512
China	38247800	201604	2016	61,118.0	3,016,333
United States	38247800	201605	2016	88.0	73,683
China	38247800	201605	2016	1,090.0	53,901
United States	38247800	201605	2016	165.0	5,633
Belgium	38247800	201605	2016	5.0	1,278
United Kingdom	38247800	201605	2016	3,900.0	418,611
China	38247800	201605	2016	39,952.6	1,859,598
China	38247800	201605	2016	16,000.0	780,777
Belgium	38247800	201606	2016	11.8	1,517
China	38247800	201606	2016	95,641.0	5,167,868
China	38247800	201606	2016	24,152.0	1,227,206
United States	38247800	201606	2016	2,605.0	143,177
Netherlands	38247800	201606	2016	1,495.0	87,630
United Kingdom	38247800	201606	2016	2.2	383
United States	38247800	201607	2016	22.8	25,351
United Kingdom	38247800	201607	2016	12.2	2,714
China	38247800	201607	2016	19,844.0	1,085,775
China	38247800	201607	2016	22,157.3	1,164,971
China	38247800	201607	2016	41,783.0	2,224,234
China	38247800	201608	2016	38,450.0	1,958,059
China	38247800	201608	2016	88,410.0	4,687,170
Netherlands	38247800	201608	2016	491.7	12,361
China	38247800	201608	2016	24,919.0	1,264,014

38247800 - Containing Perfluorocarbons (PFCs) Or Hydrofluorocarbons (HFCs), But Not Containing Chlorofluorocarbons (CFCs) Or Hydrochlorofluorocarbons - 2016					
Country Of Origin	**Tariff**	**Year Month**	**Calendar Year**	**Quantity kg**	**Customs Value ZAR**
Belgium	38247800	201608	2016	6.1	1,267
United States	38247800	201608	2016	2,764.3	145,807
United Kingdom	38247800	201608	2016	11.2	1,938
China	38247800	201609	2016	16,916.0	812,989
China	38247800	201609	2016	8,295.0	446,918
Belgium	38247800	201609	2016	40.3	6,340
Netherlands	38247800	201609	2016	97.2	2,058
Norway	38247800	201609	2016	388.9	30,820
United States	38247800	201609	2016	388.9	7,311
China	38247800	201609	2016	24,850.0	1,175,310
Belgium	38247800	201609	2016	2.1	418
United Kingdom	38247800	201609	2016	1.0	157
China	38247800	201609	2016	4,739.0	238,566
United States	38247800	201610	2016	120.0	36,674
United Kingdom	38247800	201610	2016	1.1	203
Hong Kong	38247800	201610	2016	2.0	10,645
China	38247800	201610	2016	17,130.0	639,928
China	38247800	201610	2016	21,622.0	934,938
China	38247800	201610	2016	46,821.9	2,127,686
China	38247800	201611	2016	33,913.7	1,806,848
Germany	38247800	201611	2016	27.4	2,684
China	38247800	201611	2016	112,331.9	5,934,229
United States	38247800	201611	2016	2,158.3	118,338
Belgium	38247800	201611	2016	1.3	227
China	38247800	201611	2016	55,462.0	2,603,755
Germany	38247800	201611	2016	2.6	19,463
United Kingdom	38247800	201611	2016	51.0	6,746
China	38247800	201612	2016	11,920.0	472,006
Netherlands	38247800	201612	2016	161.0	5,173
United States	38247800	201612	2016	32.6	8,713
China	38247800	201612	2016	26,075.0	1,257,148
China	38247800	201612	2016	28,737.0	1,576,962

29037100 - Chlorodifluoromethane 2016						
District Office Name	Country Of Origin	Tariff	Year Month	Calendar Year	Quantity kg	Customs Value ZAR
Durban	China	29037100	201601	2016	91,188	2,579,644
Cape Town	China	29037100	201601	2016	95,464	2,418,931
Johannesburg	Seychelles	29037100	201601	2016	15,504	382,555
Johannesburg	China	29037100	201601	2016	41,208	1,038,281
Johannesburg	India	29037100	201601	2016	17,500	661,290
Johannesburg	India	29037100	201602	2016	10,880	379,973
Cape Town	China	29037100	201602	2016	46,512	1,391,643
Durban	China	29037100	201602	2016	22,607	691,975
Johannesburg	China	29037100	201602	2016	15,368	487,294
Durban	China	29037100	201603	2016	182,128	5,518,606
Cape Town	China	29037100	201603	2016	44,914	1,180,912
Johannesburg	China	29037100	201603	2016	17,680	466,967
Durban	China	29037100	201604	2016	162,384	4,230,422
Durban	India	29037100	201604	2016	10,880	341,898
Cape Town	China	29037100	201604	2016	65,258	1,739,143
Cape Town	India	29037100	201604	2016	10,880	349,362
Johannesburg	China	29037100	201604	2016	34,952	939,677
Johannesburg	India	29037100	201604	2016	43,520	1,352,782
Johannesburg	China	29037100	201605	2016	9,520	224,212
Durban	China	29037100	201605	2016	127,690	3,197,718
Cape Town	China	29037100	201605	2016	66,729	1,756,002
Cape Town	China	29037100	201606	2016	179,245	4,436,024
Durban	China	29037100	201606	2016	145,010	3,967,924
Johannesburg	China	29037100	201606	2016	15,504	445,556
Johannesburg	China	29037100	201607	2016	44,618	1,204,595
Durban	China	29037100	201607	2016	99,353	2,648,355
Cape Town	China	29037100	201607	2016	92,692	2,402,663
Cape Town	China	29037100	201608	2016	71,499	1,633,740
Durban	China	29037100	201608	2016	39,576	982,476
Johannesburg	China	29037100	201608	2016	58,072	1,535,332
Johannesburg	France	29037100	201608	2016	10,880	284,285
Cape Town	China	29037100	201609	2016	86,331	2,052,204
Durban	China	29037100	201609	2016	66,640	1,648,972
Johannesburg	China	29037100	201609	2016	31,008	679,684
Port Elizabeth	China	29037100	201609	2016	4,624	102,427
Cape Town	China	29037100	201610	2016	9,345	316,084
Durban	China	29037100	201610	2016	79,276	1,785,601
Cape Town	China	29037100	201611	2016	87,069	1,722,408
Durban	China	29037100	201611	2016	126,820	2,896,739
Cape Town	Singapore	29037100	201611	2016	18,000	420,772

29037100 - Chlorodifluoromethane 2016						
District Office Name	Country Of Origin	Tariff	Year Month	Calendar Year	Quantity kg	Customs Value ZAR
Johannesburg	China	29037100	201611	2016	15,640	511,482
Johannesburg	Singapore	29037100	201612	2016	15,504	396,966
Durban	India	29037100	201612	2016	41,643	858,372
Johannesburg	China	29037100	201612	2016	15,504	384,718
Durban	China	29037100	201612	2016	50,592	1,205,200
Cape Town	China	29037100	201612	2016	118,487	2,472,825

29037100 - Chlorodifluoromethane Exports 2016						
Country Of Origin	Destination	Tariff	Year Month	Calendar Year	Quantity kg	Customs Value ZAR
China	Zimbabwe	29037100	201601	2016	68	3,720
South Africa	Democratic Republic Of Congo	29037100	201601	2016	68	21,951
South Africa	Ship/Aircraft	29037100	201601	2016	207	3,953
South Africa	Ship/Aircraft	29037100	201601	2016	174	3,840
South Africa	Zambia	29037100	201601	2016	3,602	112,844
China	Botswana	29037100	201601	2016	1,680	91,411
South Africa	Botswana	29037100	201601	2016	72	6,862
South Africa	Mozambique	29037100	201601	2016	1,020	247,803
South Africa	Democratic Republic Of Congo	29037100	201602	2016	42	4,949
South Africa	Ship/Aircraft	29037100	201602	2016	109	4,883
South Africa	Ship/Aircraft	29037100	201602	2016	218	4,417
South Africa	Zimbabwe	29037100	201602	2016	193	6,900
South Africa	Tanzania	29037100	201602	2016	14	3,750
China	Botswana	29037100	201602	2016	470	34,798
South Africa	Angola	29037100	201602	2016	2,043	85,201
South Africa	Namibia	29037100	201603	2016	2,040	86,250
China	Botswana	29037100	201603	2016	863	68,218
South Africa	Zambia	29037100	201603	2016	3,690	85,927
South Africa	Ship/Aircraft	29037100	201603	2016	88	1,604
United Kingdom	Democratic Republic Of Congo	29037100	201603	2016	13	6,056
South Africa	Zimbabwe	29037100	201603	2016	7,684	303,188
South Africa	Democratic Republic Of Congo	29037100	201603	2016	230	12,801
China	Zambia	29037100	201604	2016	500	27,845
South Africa	Ship/Aircraft	29037100	201604	2016	66	1,309
South Africa	Zimbabwe	29037100	201604	2016	1,632	108,600
South Africa	Ship/Aircraft	29037100	201604	2016	164	3,375
South Africa	Zambia	29037100	201604	2016	2,100	50,730
South Africa	Botswana	29037100	201604	2016	5,000	289,170
South Africa	Ship/Aircraft	29037100	201605	2016	33	662
China	Zambia	29037100	201605	2016	123	8,122
South Africa	Ship/Aircraft	29037100	201605	2016	142	2,827
South Africa	Zambia	29037100	201605	2016	1,531	47,440
South Africa	Namibia	29037100	201605	2016	8	100
China	Botswana	29037100	201605	2016	385	19,497
South Africa	Mozambique	29037100	201605	2016	7,344	289,170
South Africa	Namibia	29037100	201606	2016	1,706	88,000
China	Unclassified	29037100	201606	2016	129	60,295
China	Botswana	29037100	201606	2016	23	2,669

29037100 - Chlorodifluoromethane Exports 2016						
Country Of Origin	Destination	Tariff	Year Month	Calendar Year	Quantity kg	Customs Value ZAR
South Africa	Zambia	29037100	201606	2016	4,872	143,520
South Africa	Ship/Aircraft	29037100	201606	2016	174	3,570
South Africa	Ship/Aircraft	29037100	201606	2016	98	3,240
South Africa	Zimbabwe	29037100	201606	2016	130	7,440
China	Malawi	29037100	201606	2016	2,700	63,887
South Africa	Ship/Aircraft	29037100	201607	2016	44	871
South Africa	Ship/Aircraft	29037100	201607	2016	438	8,767
India	Democratic Republic Of Congo	29037100	201607	2016	204	11,295
South Africa	Democratic Republic Of Congo	29037100	201607	2016	17	1,700
South Africa	Mozambique	29037100	201608	2016	34	36,412
South Africa	Ship/Aircraft	29037100	201608	2016	885	19,864
South Africa	Ship/Aircraft	29037100	201608	2016	87	1,620
South Africa	Democratic Republic Of Congo	29037100	201608	2016	169	9,570
South Africa	Zambia	29037100	201608	2016	1,282	29,466
China	Unclassified	29037100	201608	2016	856	48,199
China	Unclassified	29037100	201609	2016	130	4,808
South Africa	Zambia	29037100	201609	2016	2,150	63,180
South Africa	Democratic Republic Of Congo	29037100	201609	2016	136	10,530
South Africa	Ship/Aircraft	29037100	201609	2016	223	12,600
South Africa	Ship/Aircraft	29037100	201609	2016	87	1,649
China	Zambia	29037100	201609	2016	100	28,872
China	Zambia	29037100	201610	2016	320	29,278
South Africa	Zambia	29037100	201610	2016	136	10,212
South Africa	Namibia	29037100	201610	2016	40	4,713
South Africa	Ship/Aircraft	29037100	201610	2016	22	3,764
India	Democratic Republic Of Congo	29037100	201610	2016	340	18,825
China	Zambia	29037100	201610	2016	1,000	70,268
South Africa	Ship/Aircraft	29037100	201610	2016	44	810
South Africa	Zambia	29037100	201610	2016	6,068	159,950
China	Unclassified	29037100	201610	2016	452	40,299
South Africa	Botswana	29037100	201610	2016	180	37,482
South Africa	Mozambique	29037100	201610	2016	7,510	366,120
South Africa	Swaziland	29037100	201610	2016	70	3,000
South Africa	Angola	29037100	201610	2016	9	7,040
South Africa	Angola	29037100	201611	2016	1,940	112,727
China	Unclassified	29037100	201611	2016	372	31,397
South Africa	Botswana	29037100	201611	2016	4,335	168,141

29037100 - Chlorodifluoromethane Exports 2016						
Country Of Origin	Destination	Tariff	Year Month	Calendar Year	Quantity kg	Customs Value ZAR
South Africa	Zambia	29037100	201611	2016	2,185	48,350
South Africa	Ship/Aircraft	29037100	201611	2016	153	2,835
South Africa	Ship/Aircraft	29037100	201611	2016	185	6,892
China	Nigeria	29037100	201611	2016	2,856	356,846
China	Zambia	29037100	201612	2016	503	11,711
South Africa	Ship/Aircraft	29037100	201612	2016	192	3,045
South Africa	Ship/Aircraft	29037100	201612	2016	44	810
South Africa	Mozambique	29037100	201612	2016	15,504	723,900
South Africa	Botswana	29037100	201612	2016	600	58,594