# Artificial GHG and other niche industrial process emissions

## Background information

Artificial GHG and other niche industrial process emissions include both ozone-depleting substances (ODS) and non-ozone depleting substances (non-ODS). ODS encompass a wide range of substances including chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) as well as hydrobromoflurocarbons (HBFCs), halons, methyl bromide, carbon tetrachloride and methyl chloroform. Non-ODS such as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) are used as alternatives to the ODS. Although HFCs and PFCs do not contribute to the depletion of the stratospheric ozone layer, they do have high global warming potentials, ranging from 140 to 11,700, contributing to global climate change.

ODS and non-ODS substances are used for refrigeration, air conditioning, fire extinguishers, foam and aerosol propellants. Refrigeration and air-conditioning accounts more than 80% of global HFC consumption (in tonnes CO2eq), with foams and aerosols accounting for 11% of HFC consumption (in tonnes CO2eq) (Seidel *et al.*, 2016).

### Historic consumption

Prior to the signing of the Montreal Protocol, South Africa manufactured both CFC-11 and CFC-12. However, as part of the voluntary phase out initiative, production facilities were decommissioned (UNIDO, 2017). Following the phase out of CFCs, the consumption of HCFCs increased, predominantly HCFC-22 (Table 1) (for low temperature refrigeration applications) and, to a lesser extent, HFC-134a and HFC-404A (UNIDO, 2017). Following amendments to the Montreal Protocol which was updated to include the phase out of HCFCs, the consumption of HFCs increased. By 2016, HFCs and HFC-blends accounted for approximately 58% of the total consumption of refrigerants (UNIDO, 2017).

Table : ODS and Non-ODS Consumption [Mt]

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year | 2013 | 2014 | 2015 | 2016 | 2017\* |
| **ODS** |  |  |  |  |  |
| HCFC-22 | 3,026 | 2,588 | 2,501 | 2,550 | 2,112 |
| **Non-ODS** |  |  |  |  |  |
| 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 Non-ODS** | **2,617** | **2,890** | **3,215** | **3,656** |  |

\*estimate

Source: (UNIDO, 2017)

## Montreal Protocol and Kigali Amendment

The Montreal Protocol on Substances that Deplete the Ozone Layer is a multilateral environmental agreement that regulates the production and consumption of about 100 artificial chemicals referred to as ozone-depleting substances (ODS). It is one of the world’s most effective environmental treaties, ending 98% of production and consumption of ODS (Andersen, Brack and Depledge, 2014). The Montreal Protocol, signed in 1987, began with the phasing out of CFCs and halons, prompting large uptake in the usage of HCFC’s. In 1992, the Protocol was updated to include the phasing out of HCFCs, leading to a large increase in HFC usage (and to a limited extended PFCs) as a replacement for both CFCs and HCFCs (UNEP, 1991).

### Kigali Amendment

HFCs are non-ozone depleting substances used as replacements for CFCs and HCFCs that were phased out as a result of the Montreal Protocol. Although HFCs do not deplete the stratospheric ozone layer, they have high GWP and thus contribute to global climate change. Consequently, the Kigali Amendment, which was entered into force on the 1 January 2019, aims to phase down HFCs between 80-85% by 2050.

## Alternatives

### Current alternatives

Currently, the main alternatives to ODS are HFCs and, to a lesser extent, PFCs. Before the implementation of the Montreal Protocol, the use of HFCs was limited to HFC-23 and HFC-152a (IPCC, 2006). However, since the phase-out of ODS, the use of HFCs, especially HFC-134a, has increased significantly (IPCC, 2006). Blends of HFCs are also commonly used, especially in the refrigeration and air conditioning sector, and contain varying concentrations of HFC-23, HFC-125, HFC-134a and HFC-143a.

### Potential future alternatives

Alternatives to HFCs and PFCs include both in-kind alternatives (alternatives that are similar or the same as what they are replacing, for example fluorocarbons) such as hydrofluoroolefins (HFOs) and hydrofluoro ethers (HFEs), and not-in-kind alternatives (non-fluorinated or non-brominated alternatives), such as hydrocarbons (HCs) and different technologies. The replacement options differ depending on the application (Table 2) and present their own challenges and costs.

Table : In-kind and Not-in-kind alternatives

|  |  |  |
| --- | --- | --- |
| Application category | In-kind alternatives | Not-in-kind alternatives |
| Solvents | HFOs  HFEs | HCs, aqueous and semi-aqueous cleaners |
| Aerosols | HFOs  HFEs | HCs, compressed air and nitrogen, pumps, sprays, dry sprays, wicks and creams, medical patches |
| Foam blowing | HFOs  HFEs | CO2, water, HCs, methyl formate, natural insulations, fibre glass |
| Refrigeration and air-conditioners | HFOs  HFEs | HCs, natural refrigerants, evaporate cooling, electromagnetic cooling |
| Fire protection |  | Inert gases, dry powders, foams, water, reducing or eliminating combustible materials and sources of ignition |

Source: (Andersen, Brack and Depledge, 2014; Seidel *et al.*, 2016)

## Phase down of ODS and non-ODS

### Phase down of HCFCs

The phase-out schedule for HCFCs in South Africa is outlined in the table below. Since of the phase out of HCFC-141b on the 1 January 2016, the vast majority (99%) of ODS consumption in South Africa is now HCFC-22

Table 3: Phase-out schedule for HCFCs

|  |  |  |
| --- | --- | --- |
| Deadline | Reduction | Maximum annual consumption |
| 2008 | Monitor consumption | Not applicable |
| 2009/2010 | Baseline consumption established (average of 2 years) | Not applicable |
| 2013 | Consumption freeze at baseline level | Baseline (2013 – 2014) |
| 2015 | 10% reduction from baseline | 90% of baseline (2015 – 2019) |
| 2020 | 35% reduction from baseline | 65% of baseline (2020 -2024) |
| 2025 | 67.5% reduction from baseline | 32.5% of baseline (2025 – 2029) |
| 2030 | 97.5% reduction from baseline | 2.5% of baseline (2030 – 2040) |
| 2030 – 2039 | Maximum consumption 2.5% servicing only | 2.5% of baseline (2030 – 2040) |
| 2040 | Full phase-out | 0% |

Source: (DEA, 2011)

### Phase down of HFCs

Under the Kigali Amendment, South Africa is classified as an Article 5 Group 1 country. Consequently, the following time was established for the phase down of HFCs (also shown in Figure 1):

|  |  |
| --- | --- |
| Deadline | Reduction |
| 2016 – 2020 | Ratification process |
| 2020 – 2022 | Baseline years |
| 2024 | Freeze |
| 2029 | 10% below baseline |
| 2035 | 30% below baseline |
| 2040 | 50% below baseline |
| 2045 | 80% below baseline |

Source: (UNDP, 2020)

The baselines are calculated based on past HCFC consumption/production baseline plus consumption/production of HFCs (65%) over the baseline period (2020 – 2022).

|  |
| --- |
|  |
| Figure 1: HFC phase-down schedule, South Africa is classified as an Article 5 Group 1 country (UNDP, 2020) |