



## Global Warming Potential (GWP) of Refrigerants: Why are Particular Values Used?



Post-Kigali Update

### INTRODUCTION

Ever since the Montreal Protocol agreed to phase out hydrochlorofluorocarbons (HCFCs), there has been an increasing interest within the Protocol on climate issues. Decision XIX/6, taken in 2007, to adjust the Protocol to accelerate the phase out of HCFCs includes language to encourage the promotion of alternatives that minimise environmental impacts, in particular impacts on climate, as well as to prioritise funding for projects, *inter alia*, which focus on substitutes and alternatives that minimise other impacts on the environment, including on the climate, taking into account global-warming potential (GWP).

In 2016, the Montreal Protocol was amended to phase-down the production and consumption of hydrofluorocarbons (HFCs) which are commonly used alternatives to ozone depleting substances.

While not ozone depleting, HFCs are greenhouse gases which can have high or very high global warming potentials.

This amendment requires a country's consumption and production of HFCs and HCFC baseline to be expressed in CO<sub>2</sub> equivalents (GWP-weighted tonnes). Therefore GWP values have now been assigned to each HFC and selected HCFCs and CFCs in the amended Montreal Protocol text.

In your work you may come across various GWP figures from technical experts, industry and other stakeholders which may not appear to be consistent with the Montreal Protocol 'reporting values'. This factsheet aims to provide a brief description and some context for the different sources or different sets of GWP values.

### WHAT IS GWP?

Global warming potential (GWP) is a measure of the relative global warming effects of different gases. It assigns a value to the amount of heat trapped by a certain mass of a gas relative to the amount of heat trapped by a similar mass of carbon dioxide over a specific period of time. Carbon dioxide was chosen by the Intergovernmental Panel on Climate Change (IPCC) as the reference gas and its GWP is taken as 1.

The higher the GWP value, the more that particular gas warms the Earth compared to carbon dioxide.

GWP values for ozone depleting substances can range, for example, from about 5 up to 14,400. The GWPs of commonly used HFCs can range from 12 to 14,800.

### WHY ARE THERE DIFFERENT SETS OF GWP VALUES?

Calculation of global warming potential (GWP) values of refrigerants is a complex issue. For the great majority of cases there are a number of different values of GWP for each specific refrigerant. This is due to a number of reasons, including the following:

- There is variety of sources from which the GWP values could be obtained
- GWP values are periodically updated, based on the most recent research and as scientific understanding improves
- GWP values are calculated over different time horizons. Typically GWP values are quoted over a 100 year time horizon, although 20 year and to a lesser extent 500 year integrated values are also commonly provided.



It is also important to note that a GWP value can include a range to reflect the uncertainty of the value (for example the GWP value for HCFC-22 according to the 2011 WMO Scientific Assessment of Ozone Depletion is  $1790 \pm 630$ , i.e. between 1160 and 2420).

Table 1 (overleaf) provides some sample GWP values. Examples of CFC-12, HCFC-22 and HFC-134a have been selected to illustrate the progression in knowledge over time leading to the updating of the GWP values. The examples also indicate some of the different sources of values.

**TABLE 1 – EVOLUTION OF GWP VALUES**

Substance	GWP time horizon (years)	2 <sup>nd</sup> IPCC Assessment Report <sup>1</sup> (1995)	4 <sup>th</sup> IPCC Assessment Report (2007)	WMO <sup>2</sup> (2010)	5 <sup>th</sup> IPCC Assessment Report (2014)	WMO* (2014)	Montreal Protocol 'reporting values' <sup>3</sup> (2016)
CFC-12	20	7800	11 000	-	10 800	10 800	-
	100	8100	10 900	10 900	10 200	10 300	10 900
	500	-	5200	-	-	-	-
HCFC-22	20	4000	5160	-	5280	5310	-
	100	1500	1810	1790	1760	1780	1810
	500	-	549	-	-	-	-
HFC-134a	20	3400	3830	-	3710	3810	-
	100	1300	1430	1370	1300	1360	1430
	500	420	435	-	-	-	-

1- Assessment Report of the Intergovernmental Panel on Climate Change; 2- Scientific Assessment of Ozone Depletion, World Meteorological Organization; 3- GWP values are assigned to each HFC and selected HCFCs and CFCs in the recently amended Montreal Protocol text

**GWP VALUES AND THE MONTREAL PROTOCOL**

The GWP values shown in columns 3 - 7 in Table 1 above are based on international scientific assessments and reflect the latest scientific consensus on potential climate impacts at the time of publication of the particular report/assessment.

Following the 2016 Kigali Amendment, **the Montreal Protocol has adopted standard 'reporting values' for GWPs of HFCs and selected HCFCs and CFCs** which have been incorporated into the text of the Protocol (in Annexes A, C and F).

When calculating a country's annual levels of production, consumption, imports, exports and emissions of HFCs and HCFCs (and CFCs) these will be expressed in CO<sub>2</sub> equivalents (GWP-weighted tonnes) and each Party will need to use the GWP values in the Montreal Protocol text (Annexes A, C and F) to calculate these.

The GWP values in Table 2 are for single component refrigerants. In the case of refrigerants which are mixtures (or blends) of more than one refrigerant, the GWP is calculated as a mass-weighted average of the individual components.

**TABLE 2 – GWP VALUES (Montreal Protocol)**

Substance	GWP value (100 year)
<b>HFCs</b>	
HFC-134	1100
HFC-134a	1430
HFC-143	353
HFC-245fa	1030
HFC-365mfc	794
HFC-227ea	3220
HFC-236cb	1340
HFC-236ea	1370
HFC-236fa	9810
HFC-245ca	693
HFC-43-10mee	1640
HFC-32	675
HFC-125	3500
HFC-143a	4470
HFC-41	92
HFC-152	53
HFC-152a	124
HFC-161	12
HFC -23	14 800

Substance	GWP value (100 year)
<b>HCFCs</b>	
HCFC-21	151
HCFC-22	1810
HCFC-123	77
HCFC-124	609
HCFC-141b	725
HCFC-142b	2310
HCFC-225ca	122
HCFC-225cb	595

Source: Montreal Protocol Annex C and Annex F.  
N.B. GWP values for five selected CFCs have been added to Annex A.