



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



### INTRODUCTION

Ever since the Montreal Protocol agreed to phase out hydrochlorofluorocarbons (HCFCs), there has been an increasing interest within the Protocol on climate issues. The now famous 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).

Current discussions on the Montreal Protocol potentially being amended to facilitate the phase-down of hydrofluorocarbons (HFCs) bring the issue of climate change and associated monitoring and reporting to the forefront of the Protocol.

### 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.

### 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.



In your work you may come across various GWP figures from technical experts, industry and other stakeholders which may not appear to be consistent. This could be due to the fact that the values quoted are from different sources or different sets of GWP values.

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 2 up to about 14,000. The GWPs of commonly used HFCs can range from <1 to about 12,500.

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 GWP values.

**TABLE 1 – EVOLUTION OF GWP VALUES**

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

† Assessment Report of the Intergovernmental Panel on Climate Change  
 \* Scientific Assessment of Ozone Depletion, World Meteorological Organization

**GWP VALUES AND THE MONTREAL PROTOCOL**

The GWP values illustrated 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.

In the case of ozone depleting potential values (ODP) the Montreal Protocol has incorporated agreed ODP 'reporting' values into the text of the Protocol (in Annexes). Similarly the Kyoto Protocol had fixed the use of GWP values published in the 2<sup>nd</sup> IPCC Assessment Report (1996). Future

agreements may stipulate use of a different specific set of GWP values.

**Under the Montreal Protocol there has been, to date, no formal agreement on which GWP values are to be used.** Such an agreement will likely constitute part of any agreement reached on an amendment to the Montreal Protocol to phase down HFCs.

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.

More information and tables of GWP values can be found in the

- IPCC Assessment Reports e.g. 2014: <https://ipcc.ch/report/ar5/>
- Scientific Assessment of Ozone Depletion, World Meteorological Organization, e.g. 2014: [www.wmo.int/pages/prog/arep/gaw/ozone\\_2014/ozone\\_asst\\_report.html](http://www.wmo.int/pages/prog/arep/gaw/ozone_2014/ozone_asst_report.html)

GWP values for blends can be found in the

- TEAP RTOC, 2014 Assessment Report: <http://ozone.unep.org/en/assessment-panels>

**TABLE 2 – EXAMPLE SET OF GWP VALUES (WMO 2014)**

Substance	GWP value (100 year)
<b>ODS</b>	
CFC-12	10 300
HCFC-22	1780
HCFC-123	79
HCFC-124	527
HCFC-142b	2070
<b>NON-ODS</b>	
HFC-23	12 500
HFC-32	704
HFC-125	3450
HFC-134a	1360
HFC-143a	5080
HFC-152a	148
HFC-1234ze(E)	<1
HFC-1234yf	<1
R-744 (CO <sub>2</sub> )	1
R-717 (Ammonia)	0
R-290 (Propane)	5

From: Scientific Assessment of Ozone Depletion, World Meteorological Organization, 2014 (100 year time horizons have been indicated for comparative purposes)

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