

# Appendix A: Global Warming Potentials

When reporting emissions of non-CO<sub>2</sub> gases, the mass estimates of these gases must also be reflected in the public report on a CO<sub>2</sub>e basis. Converting emissions of non-CO<sub>2</sub> gases to units of CO<sub>2</sub>e allows GHGs to be compared on a common basis, i.e., the ability of each GHG to trap heat in the atmosphere. GWP factors represent the ratio of the heat-trapping ability of each GHG relative to that of CO<sub>2</sub>.

TCR relies on GWP defaults published by the IPCC. As part of its activities, the IPCC revisits and updates these defaults in periodic Assessment Reports. When reporting emissions to TCR, members may use GRPs from the Assessment Report that is most relevant to their operations providing the following conditions are met:

1. All GRPs must be 100 year values;
2. Where possible within an inventory, all GWPs must come from a single Assessment Report. If GWPs for a particular gas are not provided in the chosen Assessment Report, members must select the more recent GRP for that gas; and,
3. The source of all GRP values must be disclosed publicly.

Although not required, it is considered best practice to use GWP values from the most recent Assessment Report. However, when a base year has been set, it is best practice to use the same GWP values for the current inventory and the base year inventory.

Organizations that select a GWP different that is not from the most recent Assessment Report must justify their selection if they seek to conform with ISO 14064-1: 2018.

To convert emissions of non-CO<sub>2</sub> gases to units of CO<sub>2</sub>e, multiply the emissions of each gas in units of mass (e.g., metric tons) by the appropriate GWP factor in the following table.

TABLE A.1. GLOBAL WARMING POTENTIAL FACTORS FOR REQUIRED GREENHOUSE GASES

Common Name	Formula	Chemical Name	SAR	TAR	AR <sub>4</sub>	AR <sub>5</sub>
Carbon dioxide	CO <sub>2</sub>		1	1	1	1
Methane	CH <sub>4</sub>		21	23	25	28
Nitrous oxide	N <sub>2</sub> O		310	296	298	265
Nitrogen trifluoride	NF <sub>3</sub>		n/a	10,800	17,200	16,100

Common Name	Formula	Chemical Name	SAR	TAR	AR <sub>4</sub>	AR <sub>5</sub>
Sulfur hexafluoride	SF <sub>6</sub>		23,900	22,200	22,800	23,500
Hydrofluorocarbons (HFCs)						
HFC-23 (R-23)	CHF <sub>3</sub>	trifluoromethane	11,700	12,000	14,800	12,400
HFC-32 (R-32)	CH <sub>2</sub> F <sub>2</sub>	difluoromethane	650	550	675	677
HFC-41 (R-41)	CH <sub>3</sub> F	fluoromethane	150	97	92	116
HFC-43-10mee (R-4310)	C <sub>5</sub> H <sub>2</sub> F <sub>10</sub>	1,1,1,2,3,4,4,5,5,5-decafluoropentane	1,300	1,500	1,640	1,650
HFC-125 (R-125)	C <sub>2</sub> HF <sub>5</sub>	pentafluoroethane	2,800	3,400	3,500	3,170
HFC-134 (R-134)	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	1,1,2,2-tetrafluoroethane	1,000	1,100	1,100	1,120
HFC-134a (R-134a)	C <sub>2</sub> H <sub>2</sub> F <sub>4</sub>	1,1,1,2-tetrafluoroethane	1,300	1,300	1,430	1,300
HFC-143 (R-143)	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,2-trifluoroethane	300	330	353	328
HFC-143a (R-143a)	C <sub>2</sub> H <sub>3</sub> F <sub>3</sub>	1,1,1-trifluoroethane	3,800	4,300	4,470	4,800
HFC-152 (R-152)	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	1,2-difluoroethane	n/a	43	53	16
HFC-152a (R-152a)	C <sub>2</sub> H <sub>4</sub> F <sub>2</sub>	1,1-difluoroethane	140	120	124	138
HFC-161 (R-161)	C <sub>2</sub> H <sub>5</sub> F	fluoroethane	n/a	12	12	4
HFC-227ea (R-227ea)	C <sub>3</sub> HF <sub>7</sub>	1,1,1,2,3,3,3-heptafluoropropane	2,900	3,500	3,220	3,350
HFC-236cb (R-236cb)	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	1,1,1,2,2,3-hexafluoropropane	n/a	1,300	1,340	1,120

Common Name	Formula	Chemical Name	SAR	TAR	AR <sub>4</sub>	AR <sub>5</sub>
HFC-236ea (R-236ea)	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	1,1,1,2,3,3-hexafluoropropane	n/a	1,200	1,370	1,330
HFC-236fa (R-236fa)	C <sub>3</sub> H <sub>2</sub> F <sub>6</sub>	1,1,1,3,3,3-hexafluoropropane	6,300	9,400	9,810	8,060
HFC-245ca (R-245ca)	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	1,1,2,2,3-pentafluoropropane	560	640	693	716
HFC-245fa (R-245fa)	C <sub>3</sub> H <sub>3</sub> F <sub>5</sub>	1,1,1,3,3-pentafluoropropane	n/a	950	1030	858
HFC-365mfc	C <sub>4</sub> H <sub>5</sub> F <sub>5</sub>	1,1,1,3,3-pentafluorobutane	n/a*	890	794	804
Perfluorocarbons (PFCs)						
PFC-14 (Perfluoromethane)	CF <sub>4</sub>	tetrafluoromethane	6,500	5,700	7,390	6,630
PFC-116 (Perfluoroethane)	C <sub>2</sub> F <sub>6</sub>	hexafluoroethane	9,200	11,900	12,200	11,100
PFC-218 (Perfluoropropane)	C <sub>3</sub> F <sub>8</sub>	octafluoropropane	7,000	8,600	8,830	8,900
PFC-3-1-10 (Perfluorobutane)	C <sub>4</sub> F <sub>10</sub>	decafluorobutane	7,000	8,600	8,860	9,200
PFC-318 (Perfluorocyclobutane)	c-C <sub>4</sub> F <sub>8</sub>	octafluorocyclobutane	8,700	10,000	10,300	9,540
PFC-4-1-12 (Perfluoropentane)	C <sub>5</sub> F <sub>12</sub>	dodecafluoropentane	7,500	8,900	9,160	8,550

Common Name	Formula	Chemical Name	SAR	TAR	AR <sub>4</sub>	AR <sub>5</sub>
PFC-5-1-14 (Perfluorohexane)	C <sub>6</sub> F <sub>14</sub>	tetradecafluorohexane	7,400	9,000	9,300	7,910
PFC-9-1-18 (Perfluorodecalin)	C <sub>10</sub> F <sub>18</sub>	n/a	n/a	n/a	>7,500	7,190

Source: Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report published in 1995, Third Assessment Report published in 2001, Fourth Assessment Report published in 2007, and Fifth Assessment Report published in 2013. Values are 100-year GWP values. For any defaults provided as a range, use exact values provided for the purpose of reporting to TCR. n/a=data not available.

**Please note:** complete reporters must include emissions of all Kyoto-defined GHGs (including all HFCs and PFCs) in inventory reports. If HFCs or PFCs are emitted that are not listed above, complete reporters must use industry best practice to calculate CO<sub>2</sub>e from those gases.

Example Calculation: Convert 10 metric tons of HFC-134a to CO <sub>2</sub> e using AR <sub>5</sub> values		
10	* 1,300	= 13,000
(metric tons HFC-134a)	(GWP of HFC-134a)	(metric tons CO <sub>2</sub> e)

TABLE A.2. GLOBAL WARMING POTENTIALS OF REFRIGERANT BLENDS

Refrigerant Blend	Gas	SAR	TAR	AR <sub>4</sub>	AR <sub>5</sub>
R-401A	HFC	18.2	15.6	16.12	17.94
R-401B	HFC	15	13	14	15
R-401C	HFC	21	18	18.6	20.7
R-402A	HFC	1,680	2040	2100	1902

R-402B	HFC	1,064	1292	1330	1205
R-403A	PFC	1,400	1720	1766	1780
R-403B	PFC	2,730	3354	3444	3471
R-404A	HFC	3,260	3784	3922	3943
R-407A	HFC	1,770	1,990	2,107	1,923
R-407B	HFC	2,285	2,695	2,804	2,547
R-407C	HFC	1,526	1,653	1,774	1,624
R-407D	HFC	1,428	1,503	1,627	1,487
R-407E	HFC	1,363	1,428	1,552	1,425
R-407F	HFC	1555	1,705	1,825	1,674
R-408A	HFC	1,944	2,216	2,301	2,430
R-410A	HFC	1,725	1,975	2,088	1,924
R-410B	HFC	1,833	2,118	2,229	2,048
R-411A	HFC	15	13	14	15
R-411B	HFC	4.2	3.6	3.72	4.14
R-412A	PFC	350	430	442	445
R-415A	HFC	25.2	21.6	22.32	24.84
R-415B	HFC	105	90	93	104
R-416A	HFC	767	767	843.7	767
R-417A	HFC	1,955	2,234	2,346	2,127

R-417B	HFC	2,450	2,924	3,027	2,742
R-418A	HFC	3.5	3	3.1	3.45
R-419A	HFC	2,403	2.865	2.967	2688
R-419B	HFC	1,982	2,273	2,384	2,161
R-420A	HFC	1,144	1,144	1,258	1,144
R-421A	HFC	2,170	2,518	2,631	2,385
R-421B	HFC	2,575	3,085	3,190	2,890
R-422A	HFC	2,532	3,043	3,143	2,847
R-422B	HFC	2,086	2,416	2,526	2,290
R-422C	HFC	2,491	2,983	3,085	2,794
R-422D	HFC	2,232	2,623	2,729	2,473
R-422E	HFC	2,135	2,483	2,592	2,350
R-423A	HFC	2,060	2,345	2,280	2,274
R-424A	HFC	2,025	2,328	2,440	2,212
R-425A	HFC	1,372	1,425	1,505	1,431
R-426A	HFC	1,352	1,382	1,508	1,371
R-427A	HFC	1,828	2,013	2,138	2,024
R-428A	HFC	2,830	3,495	3,607	3,417
R-429A	HFC	14	12	12	14
R-430A	HFC	106.4	91.2	94.24	104.88

R-431A	HFC	41	35	36	40
R-434A	HFC	2,662	3,131	3,245	3,075
R-435A	HFC	28	24	25	28
R-437A	HFC	1,567	1,684	1,805	1,639
R-438A	HFC	1,890	2,151	2,264	2,059
R-439A	HFC	1,641	1,873	1,983	1,828
R-440A	HFC	158	139	144	156
R-442A	HFC	1,609	1,793	1,888	1,754
R-444A	HFC	85	72	87	88
R-445A	HFC	117	117	128.7	117
R-500	HFC	37	31	32	36
R-503	HFC	4,692	4,812	5,935	4,972
R-504	HFC	313	265	325	326
R-507 or R-507A	HFC	3,300	3,850	3,985	3,985
R-509 or R-509A	PFC	3,920	4,816	4,945	4,984
R-512A	HFC	198	179	189.3	196.1

Source: Refrigerant blend GWPs are calculated using a weighted average from the blend composition and the IPCC GWP values. The blend compositions are from ASHRAE Standard 34-2013. The GWP values are 100-year values from the IPCC Second Assessment Report (SAR) published in 1995, Third Assessment Report (TAR) published in 2001, Fourth Assessment Report (AR4) published in 2007, and Fifth Assessment Report (AR5) published in 2013.

TABLE A.3. REFRIGERANT BLENDS (CONTAIN HFCS AND PFCS)

Blend	Constituents	Composition (%)
R-405A	HCFC-22/HFC-152a/HCFC-142b/PFC-318	(45.0/7.0/5.5/42.5)
R-413A	PFC-218/HFC-134a/HC-600a	(9.0/88.0/3.0)
R-508A	HFC-23/PFC-116	(39.0/61.0)
R-508B	HFC-23/PFC-116	(46.0/54.0)

Source: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 3, Table 7.8, page 7.44.