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The Global Standard: 100-year GWP and Refrigerant Impacts

Recently some marketers of selected industrial gas refrigerants have proposed switching to a 20-year integrated time horizon (ITH) basis for GWP values when comparing refrigerant solutions, rather than the 100-year GWP values that have been the well-established scientific consensus for decades. Some marketing groups have gone further, misleadingly referring to a 20-year time horizon as the "Real GWP."[1]

However, assessing the atmospheric effect of refrigerants over the span of just two decades distorts their true impact—downplaying the long-term effects of CO_2 (R-744) while overstating the relatively transient effects of fluorinated gases (F-gases).

The U.S. EPA defines global warming potential (GWP) as "a measure of how much energy the emissions of 1 kg of a gas will absorb over a given period of time, relative to the emissions of 1 kg of carbon dioxide (CO_2)."[2]

20-year GWP measurements overestimate the effect of F-gases while ignoring the majority of the impact of CO_2.

Here are the facts:

A 100-year time horizon is the global consensus standard.

The 100-year GWP is by far the most-used metric for assessing the climate impacts of emissions of refrigerant gases. In fact, 100 years is the only time horizon mentioned in the Paris Agreement, the Montreal Protocol, the Kyoto Protocol, the EU F-Gas Regulations, the Kigali Amendment, and the U.S. AIM Act.

A 20-year time horizon grossly understates the contribution of CO_2 to climate change.

More than 95% of the impact of CO_2 occurs well outside the 20-year time horizon.[3] In other words, using a 20- vs. a 100-year time horizon accounts for virtually all of the impact of a short-lived F-gas, while ignoring the vast majority of CO2's contribution to global warming.

CO_2 has a much longer atmospheric lifespan than fluorinated refrigerants.

While it is true that about 60% of CO_2 emissions are removed from the atmosphere relatively quickly (≈100 years), the rest remain stubbornly in place for an extremely long time. In fact, after 1,000 years more than 25% of the originally emitted CO_2 remains in the atmosphere.[4] On the other hand, most refrigerant F-gases are removed from the atmosphere within a time span of less than a year up to a few decades.[5]

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The bottom line

GWP values based on the 100-year ITH account for essentially the entire impact of most refrigerant F-gases and hence are a better measure of their true impact. Using 20-year GWP values not only distorts the facts but could give industries, governments, and other entities a misinformed incentive to refrain from or delay deep and long-overdue CO_2 reductions.

Reining in emissions of short-lived F-gases may slow the rate of global warming in the near term, but over subsequent decades and centuries, their effects will be massively outweighed by the additional warming caused by higher atmospheric concentrations of CO_2 and other persistent greenhouse gases.[6]

GWP values based on the 100-year time horizon are a better gauge of the lifetime impact of refrigerant gases.

All solutions must have a place at the table if the world is to achieve net-zero emissions and avert the worst effects of climate change. A multi-gas strategy including new-generation F-gases offers flexibility and potential cost savings along with the promise of reducing emissions across industry sectors, geographies, and time.

[1] ATMOsphere, "Real GWP: 20 years vs, 100 years: Impact of Refrigerants Fact Sheet #1 (V.1.1.)," https://atmosphere.cool/fact_sheets/impact-of-refrigerants-fact-sheet-1-v-1-1/, accessed January 23, 2023.

[2] U.S. EPA, "Understanding Global Warming Potentials," 2016, https://www.epa.gov/ghgemissions/understanding-global-warming-potentials, accessed January 23, 2023.

[3] Based on equation 11 of reference 4.

[4] Joos, F., et al., "Carbon dioxide and climate impulse response functions for the computation of greenhouse gas metrics, a multi-model analysis," *Atmospheric Chemistry and Physics*, vol. 13, 2793–2825, 2013.

[5] World Meteorological Organization, "Scientific Assessment of Ozone Depletion: 2010," Global Ozone, Research and Monitoring Project, Report 52, 5.30, 2010.

[6] Pierrehumbert, R.T., "Short-Lived Climate Pollution," *Annual Review of Earth and Planetary Sciences*, vol. 42, no. 1, 341–379, 2014; Daniel, J., et al., "Limitations of single-basket trading: lessons from the Montreal Protocol for climate policy," *Climatic Change*, Springer, vol. 111, no. 2, 241–248, 2012; Bowerman, N., et al., "The role of short-lived climate pollutants in meeting temperature goals," *Nature Climate Change*, vol. 3 (12), 1021-1024, 2014; Rogelj, et. al., "Disentangling the effects of CO_2 and short-lived climate forcer mitigation," *PNAS*, vol. 111(46), 16325 (2014).