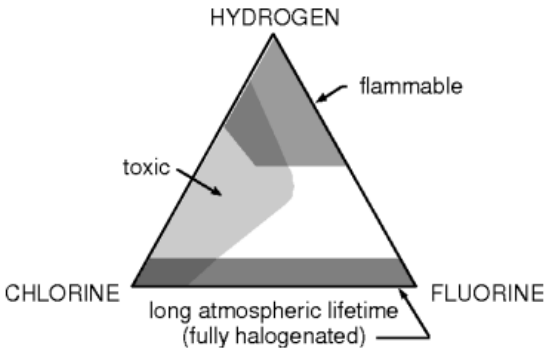
Are New GWP Values Needed?

The phase-out of HFCs by 2030 under the Kigali Amendment to the Montreal Protocol is a crucial step in mitigating the greenhouse effect. It is important that policymakers and stakeholders across the industry understand the basis for this phase-out and which actions are necessary during the transition. As we know, HFCs are still used in refrigeration and heat-pump systems.



Carbon dioxide equivalents are a measure of how much a gas contributes to global warming compared with CO_2, expressed through the GWP index (Global Warming Potential) of each gas. Refrigerant selection depends not only on chemical properties but also on thermal and transport properties. Thermal and transport characteristics affect energy efficiency (COP) and volumetric refrigeration capacity, while chemical properties determine environmental impact, safety, and material compatibility.

Figure 1. The influence of fluorine, chlorine and hydrogen on the properties of common refrigerants.

Based on the classical "triangle" diagram with one element in each corner, Fig. (1)[1], we can see how properties change when hydrogen atoms in a hydrocarbon such as methane or ethane are replaced by chlorine or fluorine. More chlorine increases the ozone-depleting potential (ODP), more hydrogen increases flammability, and more fluorine raises the GWP. The GWP index can be viewed as a measure of the total radiative energy added to the Earth system by a substance compared with the energy added by the same amount of CO_2.

GWP has become the standard metric for converting emissions of various gases to a common scale—CO_2 equivalents. Equation (1) shows how GWP for different gases is calculated for a given time horizon:

$$GWP_i(H) = \frac{AGWP_i(H)}{AGWP_{Co_2}(H)}$$

In this expression, *i* denotes the refrigerant, *H* the time horizon (commonly 20, 100, or 500 years), and AGWP is the **absolute global warming potential**, calculated by integrating the **radiative forcing** from an instantaneous emission pulse over the chosen time horizon[2].

GWP is most commonly reported for a 100-year horizon (GWP_{100}), which is the metric used in the UNFCCC and originally applied in the Kyoto Protocol (1997). The choice of time horizon greatly affects GWP values.

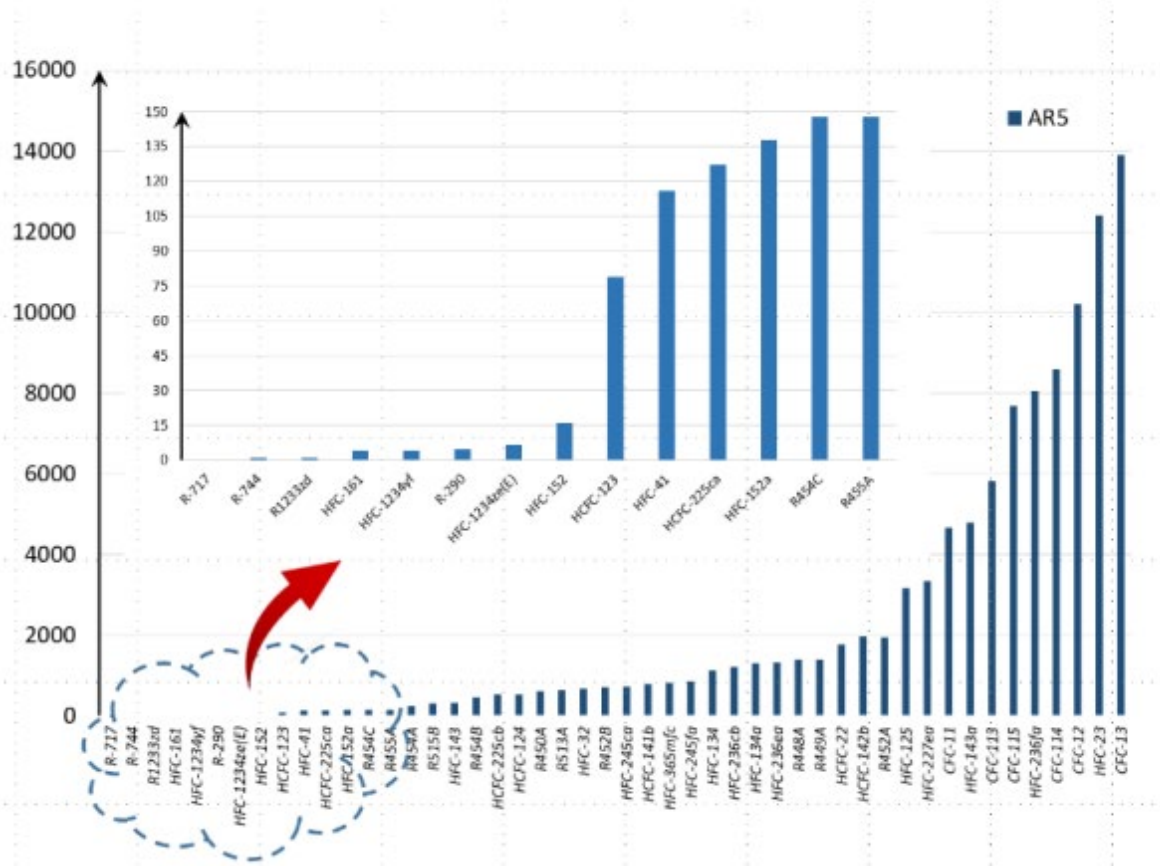


Figure 2. Comparison of different refrigerants' GWP within a 100-years horizon

Figure 2 shows GWP values for HFCs and HFOs according to the IPCC Fifth Assessment Report (AR5, 2013), still in standard use today. These values are based on a 100-year horizon (GWP_{100}). The inset includes only substances with GWP_{100} below 150.

Is GWP_{100} Still the Best Choice?

The extreme weather events of recent years—record-breaking floods, fires, droughts, more frequent and intense tornadoes and hurricanes—underline the urgency of mitigating global warming. A 100-year perspective may no longer be the most relevant. For this reason, some propose using a **20-year horizon** instead (GWP_{20}), which better reflects political commitments to reach climate neutrality within 10–30 years.

Using a 20-year horizon changes the relative ranking of refrigerants. Substances with a strong short-term warming effect but rapid atmospheric breakdown receive significantly **higher GWP_{20}** compared with their GWP_{100} values. Conversely, long-lived gases are comparatively "penalized" less.

For example:

- GWP_{20} is **~50% higher** than GWP_{100} for **R404A**,
- **R32**, which is short-lived, has a GWP_{20} more than **three times** higher than GWP_{100}.

This shift could influence the order in which refrigerants should be phased out.

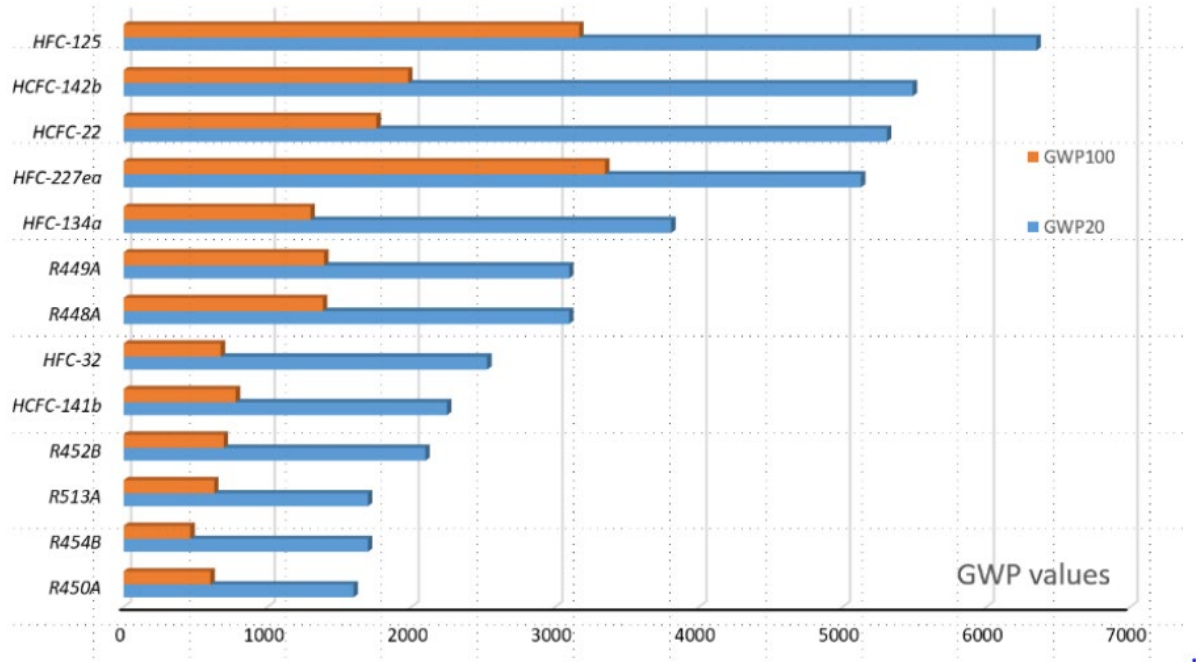


Figure 3: GWP_{20} vs. GWP_{100} for selected refrigerants.

Greenpeace and others have advocated for GWP_{20} adoption. However, not everyone agrees. Critics argue that in the long run it is most important to minimize emissions of long-lived substances. Emphasizing short-lived gases could allow increased emissions of persistent gases—effectively shifting the burden onto future generations.

The debate is ongoing, and at present there is **no indication** that the new EU F-gas Regulation will switch from GWP_{100} to GWP_{20}.

If you wish to read our earlier publications in *Kyla & Värme*, they are available here: https://www.energy.kth.se/sv/applied-thermodynamics