Opteon™

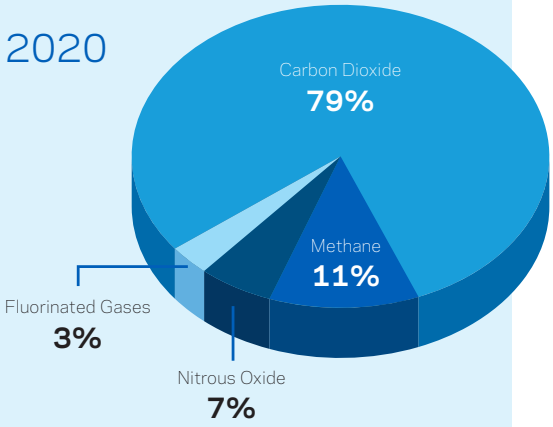
F-gases: A critical climate solution

Innovation in response to climate change has led to the development of new-generation fluorinated gases (F-gases) that are high performing and climate friendly. Called hydrofluoroolefins (HFOs), these new refrigerants have a low to ultra-low global warming potential (GWP), zero ozone depletion potential (ODP), low toxicity, and low or no flammability. They are safe and efficient solutions for a number of critical applications, including:

- Heat Pumps
- Air Conditioning
- Food & Pharmaceutical Cold Chains
- Data Center Cooling
- Building Insulation

Overview of U.S. Greenhouse Gas Emissions in 2020

The U.S. Environmental Protection Agency publishes an inventory of greenhouse gas emissions every year. In 2020, fluorinated gases accounted for just 3% of U.S. emissions. This value is expected to drop over time as new HFOs are introduced and the market moves to these environmentally friendly options.



"Inventory of U.S. Greenhouse Gas Emissions and Sinks," U.S. EPA, updated April 14, 2022, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks, accessed November 18, 2022.

Alternative Refrigerants Have Issues

Ammonia is used in industrial applications where specially trained operators can manage its acute toxicity. Ammonia leaks have led to business shutdowns, evacuations, emergency responses, hospitalizations, and fatalities. Standards generally restrict the use of ammonia in residential homes, offices, and supermarkets due its safety risks.

CO_2 is an inefficient refrigerant at moderate and high ambient temperatures like those required for air conditioning and medium-temperature refrigeration. Efficiency is a critical factor in a refrigerant's overall climate impact. Low efficiency means higher electricity consumption and thus higher greenhouse gas emissions. Mitigation technologies exist today to improve the efficiency of CO_2 systems, but in most cases they require the use of water or other natural resources to compensate.

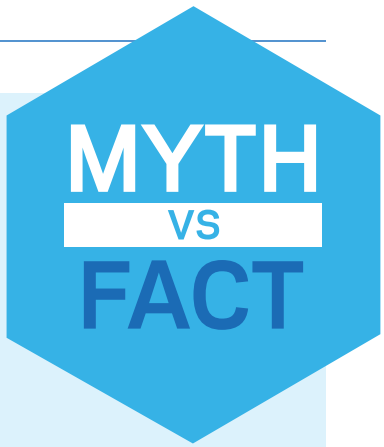
Propane is a fossil fuel. Furthermore, the European Commission states that propane is not a viable F-gas alternative in heat pumps due to safety concerns, component availability issues, and a lack of qualified installers.

Chemours™

LOW GWP ©

F-gases vs. Industrial Gases aka "Naturals"

So-called "natural" alternatives to F-gases exist, but none offer the same benefits as HFOs.



MYTH **CO_2 (carbon dioxide), hydrocarbons, and ammonia are "natural" refrigerants.**

FACT "Natural" is a marketing buzzword and not based on engineering or sound science. The refrigerant-grade CO_2, hydrocarbons, and ammonia used by the HVAC industry are not extracted from nature. They are made through industrial processes like all other refrigerants.

MYTH **"Natural" gases are the best solution because of their GWP.**

FACT Many HFOs have long-term GWP values that are equivalent to or lower than "naturals." While sometimes used by marketers, a 20-year time horizon for GWP understates the lifetime contribution of CO_2 (over 95% of it is ignored) and distorts the impact of F-gases. Most F-gases are removed from the atmosphere quickly compared to CO_2, so shorter time horizons overstate their relative contribution to global warming. A 100-year time horizon is a more appropriate gauge of a gas's long-term effects.

MYTH **CO_2 is "natural," so leaks are inconsequential.**

FACT Refrigerant-grade CO_2 is not "natural" and its source is usually of fossil origin. Leaked CO_2 resides in the atmosphere for several hundred years. Moreover, CO_2 systems operate at high pressures and are susceptible to loss of full charge during power outages and maintenance. To avoid business disruptions, most retailers install costly back-up systems that use traditional F-gases or store full CO_2 charges on-site. The high-pressure operation of CO_2 systems also limits refrigerant recovery at the end of a system's life.

F-gases Support Modern Priorities

Decarbonization: Food waste accounts for 8–10 percent of global greenhouse gas emissions. Thanks to their reliability compared to failure-prone technologies like CO_2, F-gas refrigerants do a superior job combating food spoilage and thus help efforts to minimize waste. Another opportunity for decarbonization is residential heating. As energy-efficient heat pumps replace carbon-intensive technologies like gas boilers, F-gas refrigerants are providing a safe and convenient cooling medium to support the anticipated double-digit yearly growth of domestic heat pumps in Europe and the United States.[1]

Mobility: New F-gases such as HFO-1234yf lower the GWP of mobile air conditioning significantly. This breakthrough technology reduces the global warming impact of mobile refrigerants by more than 99% compared to previous-generation refrigerants. By the end of 2019, HFO-1234yf was used in 68 million cars worldwide, equivalent to taking 10 million cars off the road each year.

Digitization: Large data centers use massive amounts of energy, and demand for them is rising. F-gases play a critical role in air cooling for server applications. They are also an essential tool in the adoption of 2-phase immersion cooling technology for data centers—the most sustainable cooling solution known today.

F-gases Are Essential to a Sustainable Future

Thanks to their efficient performance, safety, and low GWP, next-generation F-gases are the preferred refrigerants in many critical applications. HFO refrigerants improve the comfort, health, and safety of modern life, help address environmental challenges, and provide significant economic benefits. They are playing an important role in achieving the current administration's climate goals, the objectives of the European Green Deal, and the United Nations' Sustainable Development Goals. These innovative technologies also promote American competitiveness and allow for continued investment in jobs and skills.

[1] EHPA and Air Conditioning, Heating and Refrigeration Institute projections.