environmental investigation agency

Climate

Refrigerant myth busting

Tackling the myths spread by the F-gas industry

January 2025

Introduction

Fluorinated gases, or F-gases, are synthetic substances used in a range of applications, most commonly in refrigeration, air conditioning and heat pump systems as well as fire suppressants, foams and aerosols.

Currently, the most commonly used type of these gases are hydrofluorocarbons (HFCs), many of which have very high Global Warming Potentials (GWP).[1] The production and use of HFCs is being phased down under the Montreal Protocol and phased out more quickly in the EU through its F-Gas Regulation.

A new generation of F-gases are being promoted by the chemical industry to replace HFCs called hydrofluoroolefins (HFOs). While these do not have the same high GWPs as their predecessors, there are other climate, environmental and health concerns associated with them. Another group of alternatives, including CO_2, propane and ammonia, are commonly referred to as natural refrigerants. They have very low GWPs and can make suitable replacements in many of the sectors where HFCs currently dominate, without the risks of HFOs. Natural refrigerants do come with some challenges, but with good product design and a suitably trained installation and maintenance workforce, they can enable us to break our reliance on synthetic, environmentally damaging refrigerants.

Just like the fossil fuel giants, tobacco industry and many other destructive industries before them, F-gas producers are spreading disinformation, muddying the water, ignoring science and delaying climate action to maintain their bottom line and slow down the uptake of natural alternatives to their super polluting products.

This document tackles many of the most common myths the industry spreads about natural refrigerants. Below are the myth summaries. Navigate further down to find the full myth buster with citations for where the myth was published and evidence as to why it's incorrect or misleading.

LET'S BUST SOME OF THE MYTHS THEY'VE PUSHED ABOUT NATURAL REFRIGERANTS

MYTH ONE

Natural refrigerants are less efficient and therefore require more energy to work, meaning more emissions

FACT

Energy efficiency is predominantly driven by product design and higher quality components. Many new cooling technologies using natural refrigerants have shown an energy efficiency benefit compared to F-gases.

MYTH TWO

Emissions associated with the leakage of refrigerant gases is inconsequential compared to the climate impact of indirect emissions, associated with energy use over a product's lifetime.

FACT

Refrigerant leakage emissions account for around one third of a product's carbon footprint, meaning that switching to natural refrigerants can dramatically cut a product's carbon emissions – particularly as energy grids decarbonise.

MYTH THREE

F-gases have a lower environmental impact than natural refrigerants.

FACT

The lifetime climate impacts of F-gases are significantly higher than their natural counterparts and many F-gases are also associated with PFAS emissions.

MYTH FOUR

Production of some natural refrigerants contributes significantly to GHG emissions therefore giving them a higher environmental impact than F-gases.

FACT

Emissions associated with feedstocks and energy used to make F-gases are typically far more damaging.

MYTH FIVE

F-gases are vital for meeting the EU's climate targets and heat pump rollout.

FACT

Natural refrigerant heat pumps are widely available from some of the largest manufacturers and have negligible cost differences.

MYTH SIX

Natural refrigerants aren't actually natural.

FACT

The phrase 'natural refrigerant' signifies gases naturally present in Earth's systems, as opposed to 'synthetic refrigerants' that are entirely man-made.

MYTH SEVEN

CO_2 is toxic and presents unnecessary dangers to users and installers.

FACT

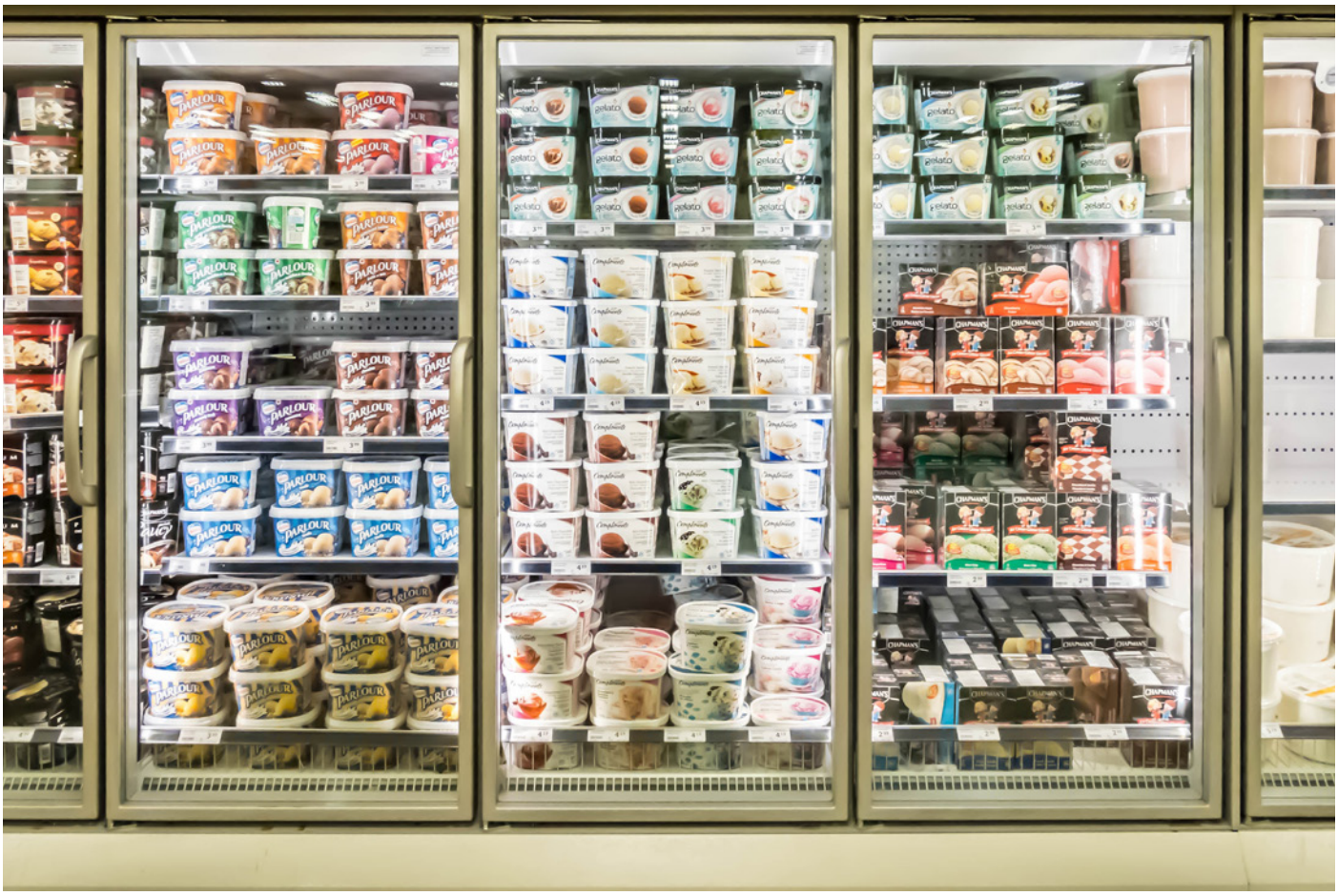
All refrigerants, including HFCs, HFOs, and CO_2, have safety risks and should be offset by strict safety standards.

MYTH EIGHT

Reclamation and resale of F-gases can prevent their environmental impacts.

FACT

F-gases will still be leaked during a product's lifetime and contribute to global warming.



MYTH ONE: Natural refrigerants are less efficient and therefore require more energy to work, meaning more emissions.[2]

FACT

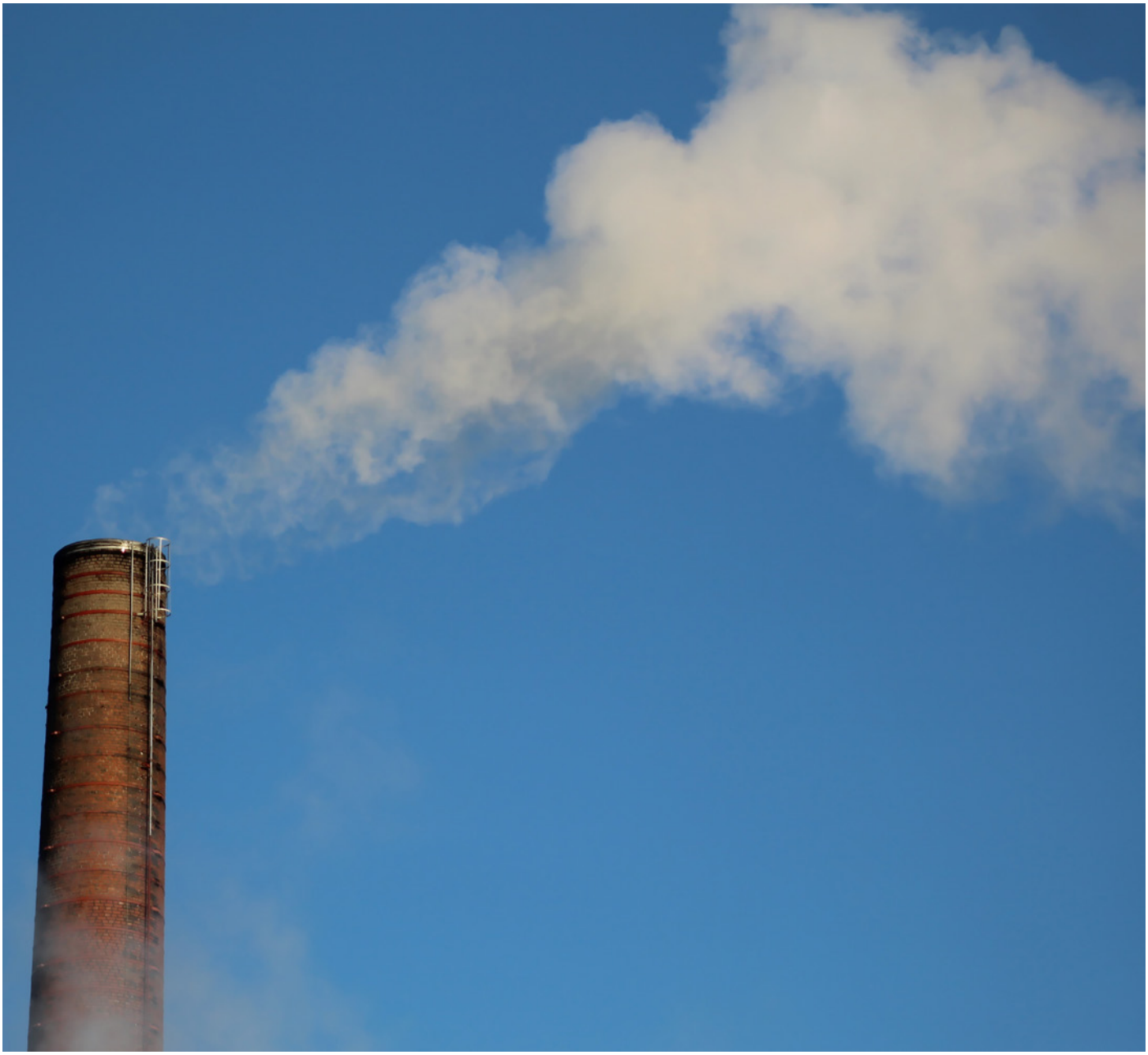
A product's energy efficiency is predominantly determined by its design and quality of components used within it. This is why the price of equipment can vary so much, with cheaper equipment often associated with inferior energy efficiency. Larger systems are also heavily influenced by how the cooling system is designed.

Having said that, equipment producers have invested a lot in developing best in class natural refrigerant technologies which outperform F-gas based technologies and there are plenty of examples of improved energy efficiency from utilising natural refrigerants. Below are just a few examples, and for more cases of business and other end users opting for the superior performance of natural refrigerants head to CoolTechnologies.org.

For example, in its 2023 CDP (Carbon Disclosure Project) report, Carrefour, the world's second largest retailer, stated that their replacement of F-gas systems with those utilising CO_2 led to an 8% increase in energy efficiency.[3]

Another study focusing on refrigeration in delivery vans showed a 27% annual energy efficiency improvement, measured as Coefficients of Performance (COP), when using CO_2 as a refrigerant rather than the F-gas HFC-134a. This study also found that the lifetime CO_2e emissions of the natural refrigerant system were 34% lower than the F-gas system.[4]

A study on refrigerants used in geothermal heat pumps found that natural refrigerants produce significantly better COPs when compared to HFC-134a. Ammonia came out as the most energy efficienct refrigerant with a COP of 4.663. The hydrocarbon, n-butane's COP was 4.606. Overall, the natural refrigerants had COPs 4.5%-5.8% higher than HFC-134a.[5]



MYTH TWO: Direct emissions associated with the leakage of refrigerant gases is inconsequential compared to the climate impact of indirect emissions, associated with energy use over a product's lifetime.

FACT

On average, direct emissions account for just over one-third of a product's total lifetime GHG emissions.[6] Therefore switching to natural refrigerants can significantly reduce the system's climate impact.

Given many countries' net zero commitments, the proportion of renewables is set to grow globally. The UK, for example, aims to decarbonise its electricity grid by 2035.[7] As grids decarbonise the emissions intensity will drop, meaning that the relative impact of direct emissions on a product's carbon footprint will grow.

MYTH THREE: Most F-gases are removed from the atmosphere quickly compared to the natural refrigerant CO_2, making lifecycle emissions from natural refrigerants higher in comparison.[8]

FACT

F-gas manufacturers suggest that because many F-gases have short atmospheric lifetimes their impacts on the climate are diminished. In the case of HFOs, this is in part true. HFOs break down quickly in the atmosphere and tend to have low Global Warming Potential (GWP) values. GWP is a metric that indicates the contribution of a substance to global warming in comparison to CO_2 over a given timeframe. In contrast to HFOs, HFCs have high GWP values. Historically the 100-year GWP has been used. However, as the average lifetime of the HFCs in use today is 21.7 years,[9] the 100-year timeframe doesn't give an accurate picture of how HFCs affect near term global warming.

Scientists have alerted us to the danger of potential climate tipping points, where global temperatures could cross a threshold that make warming snowball and difficult to stop.[11] To prevent this, we need to ensure we're taking every opportunity to reduce our climate impacts as rapidly as possible, including by eliminating gases that have particularly damaging climatic impacts in the near term. F-gases are a perfect example.

Although HFOs have a lower GWP than HFCs, it is important to recognise that the GWP value alone does not consider the full lifecycle impacts of the gas (see next myth below).

Table 1: *Shows how different the global warming impact of HFCs are when considered over a 20-year and 100-year timeframe.*[10]

Type	Refrigerant	100-year GWP	20-year GWP
F-gas	R404A	4,808	7,258
	R134a	1,470	4,060
	R32	749	2,620
Natural refrigerant	CO_2 (R744)	1	
	Propane (R290)	<1	
	Ammonia (R717)	<1	

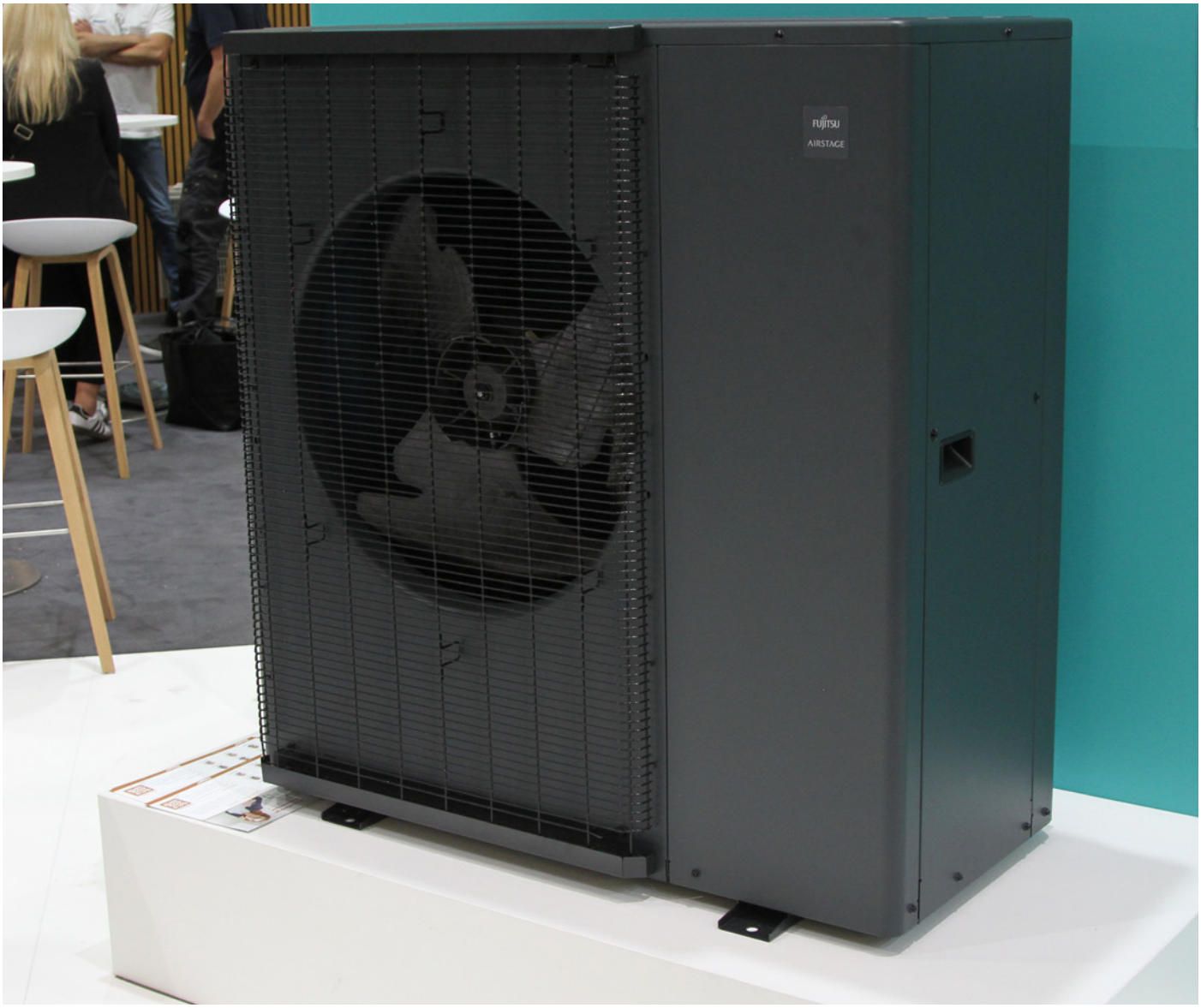
MYTH FOUR: Production of some natural refrigerants contributes significantly to greenhouse gas (GHG) emissions therefore giving them a higher environmental impact than F-gases.[12]

FACT

Production of both F-gas and natural refrigerants results in GHG emissions, including emissions associated with feedstocks and the energy used in manufacturing. HFO and HFC production results in a cocktail of additional feedstock emissions, including emissions of CFCs which are powerful ozone depleting substances.[13] Worse still, production of one tonne of the most commonly used F-gas feedstock, HCFC-22, releases GHG by-product emissions of at least 170 tonnes CO_2e.[14]

The complexity of manufacturing HFOs is particularly energy intensive. Although lifecycle analysis data is lacking, production of HFO-1234yf has been estimated to emit 10.9kg CO_2e per kg of refrigerant.[15] This is more than four times greater than the production emissions of natural refrigerants ammonia and CO_2 which produce roughly 2.4kg CO_2e per kg of refrigerant produced.[16,17] Propane, the most commonly used natural refrigerant in residential heat pumps, has been estimated to emit as little as 0.55 kg CO_2e per kg.[18]

That doesn't mean that there aren't improvements to be made in the production of natural refrigerants. There are several projects looking to create 'green ammonia' with lower embedded production emissions.[19]



MYTH FIVE: F-gases are vital for meeting the EU's climate targets. Without them the rollout of sustainable technologies like heat pumps will grind to a halt.[20]

FACT

Here the industry has three main arguments as to why the uptake of heat pumps would be affected by natural refrigerants:

1. Natural refrigerants will 'slow adoption'

There is no reason that this should be the case. In 2022-23, most heat pumps installed in Europe were air to water systems.[21] These are the easiest to retrofit to the existing residential building stock throughout much of Europe because they can often replace gas boilers in a home's heating system.

Thanks to the EUs progressive stance on phasing out F-gas, many manufacturers in, or importing into, the EU now offer F-gas free heat pumps. These include many of the biggest EU manufacturers such as Vaillant, NIBE and Viessman.[22]

2. Natural refrigerants will 'increase transition costs'

While the upfront costs for natural refrigerant heat pumps are can be higher than HFC heat pumps, this is not solely related to the refrigerant selection. EIA's research into the UK heat pump marketplace found that natural refrigerant heat pumps demonstrated improved energy efficiencies and maximum flow temperatures as well as lower noise levels. When these performance metrics were accounted for, the HFC systems were more expensive.[23] All but a few of these heat pumps were also widely available in the EU. Higher flow temperatures are particularly important when retrofitting to older, less well insulated buildings, which includes much of the existing EU housing stock.

The relative energy efficiencies of natural refrigerant heat pumps help to counterbalance the higher upfront costs and save money in the long-term. So, while some natural refrigerant heat pump systems may be more expensive to install than their F-gas alternatives, the choice for consumers is similar to choosing to spend a little more on any other energy-efficient device.

Moreover, Germany is leading the way by offering additional 5% grant to citizens who install natural refrigerant heat pumps, further reducing the upfront costs.

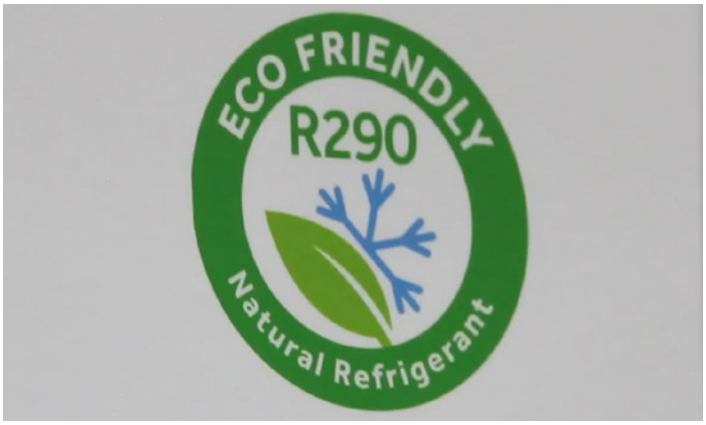
3. Natural refrigerants will 'create an incredible amount of material waste'

Here the F-gas industry claim that installed F-gas equipment will become redundant if we transition to natural refrigerants and therefore all these systems will go to waste.

In reality, this only supports the need for EU heat pump manufacturers and consumers to transition to natural refrigerants in all new equipment as soon as possible. The EU has already passed legislation that would ban F-gases with a GWP greater than or equal to 150 in self-contained (monobloc) systems from 2027 and in smaller split systems from 2029. It will also eventually outlaw the use of any F-gases in several types of heat pumps.[24] Existing F-gas reliant heat pumps can still be used. However, the gradual HFC phase-out means that HFCs will become scarcer and more expensive, significantly adding to heat pump running costs.

This means transitioning to natural refrigerants as soon as possible would not only, in fact, reduce material waste in the long run but also save consumers money in running costs.

MYTH SIX: The term 'natural refrigerant' is a lie because these refrigerants aren't really 'natural'.[25]



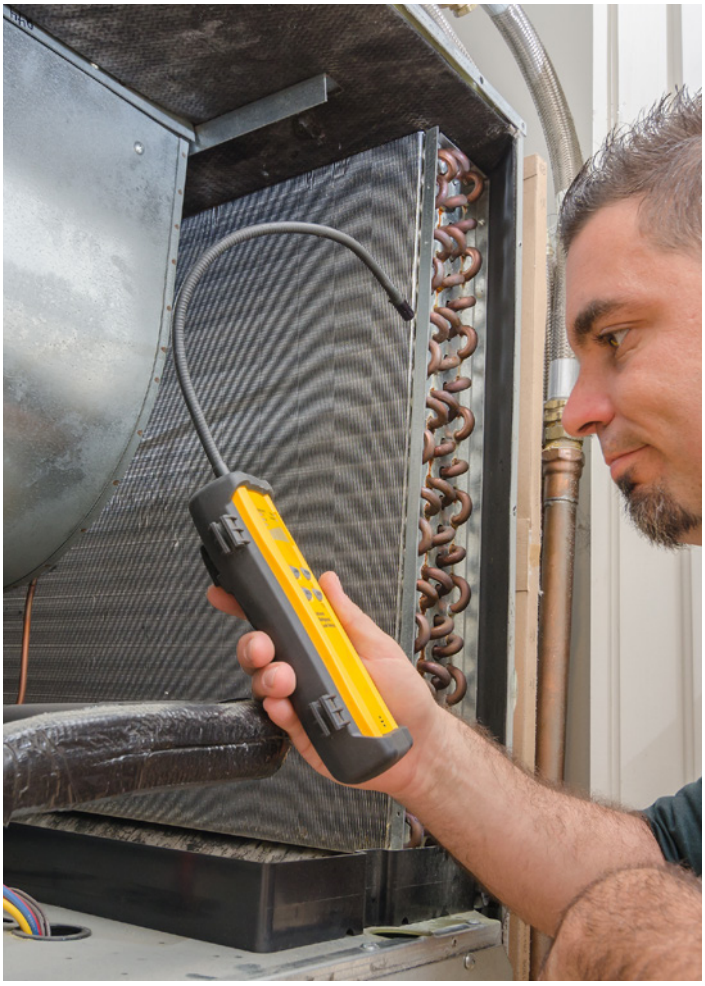
FACT

The F-gas industry claims that the term "natural refrigerants" is greenwashing because these substances are not taken directly from nature and pumped into appliances. In reality, the natural refrigerant label is useful to describe compounds that are circulating naturally in the biosphere as opposed to synthetic compounds such as F-gases, which do not appear in the biosphere without human intervention.

This is particularly concerning as many F-gases are also classified as per- or polyfluoroalkyl substances (PFAS). These are known commonly as 'forever chemicals' due to their resistance to breakdown in the natural environment. Some F-gases by themselves are not PFAS but break down in the atmosphere into PFAS, most concerningly trifluoroacetic acid (TFA).

TFA is a type of PFAS that is generated when F-gases break down in the atmosphere. While its full impacts are not yet known, recent studies have revealed concerning evidence suggesting that it is toxic to human health, including to the reproductive system and liver.[26]

MYTH SEVEN:
Because CO_2 is toxic it presents greater dangers to installers and end users.[27]



FACT

The toxicity of CO_2 is well known. This is why there are stringent safety standards in place with legal requirements to meet them. Similarly, there are also standards to ensure the safety of F-gas refrigerants, which have been involved in fatal accidents. Historically, these have most commonly occurred through asphyxiation from R22 leaks and, less commonly, compressor explosions containing flammable and non-flammable HFCs.[28,29,30]

The avoidance of asphyxiation and acute exposure effects from all refrigerants, including CO_2 and F-gases, is ensured by adherence to safety standards and good practice, and is to be expected of trained air conditioning and heat pump (ACHP) engineers.

MYTH EIGHT: F-gases can be recovered and reused in a circular system that eliminates their environmental impact.[31]

FACT

While the collection and destruction of F-gases is important to minimise emissions from currently installed F-gas reliant systems, the fact is that there will always be some leaks of the gases during the installation, operation and end-of-life of heating and cooling appliances. Effective leak prevention and end-of-life management of HFC/HCFC systems could prevent 39 Gt CO_2e from being released between 2025 and 2050.[32] That's more than the annual emissions from the 10 highest GHG emitting countries and the EU27 combined.[33] However, these figures are based on best practises which only reduce leakage rates by 20-50% and end-of-life emissions by 70-90%.[34] The only realistic way to prevent all emissions of high-GWP refrigerants is to stop using them in appliances.

While leakage rates vary from system to system and design improvements can reduce these rates, because of their lower GWP, the climate impact of natural refrigerant leakage is lower. Also, due to the safety characteristics of some natural refrigerants, systems containing them are often held to higher standards of leak proofing.

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