Natural Refrigerants: The Solutions

Glossary

F-gases: CFCs, HCFCs and HFCs are all part of a family of gases known as F-gases or flourocarbons. The regulatory control of F-gases is split between the Montreal Protocol and the Kyoto Protocol.

CFCs: Chloroflourocarbons (and their close cousins HCFCs) are ozone layer depleting substances and are regulated by the Montreal Protocol. These are alsostrong greenhouse gases but were excluded from the Kyoto Protocol because they were already being regulated.

HFCs: Hydroflourocarbons are strong greenhouse gases and are regulated by the Kyoto Protocol. HFCs are not ozone-depleting and were developed as replacements for CFCs.

Kyoto Protocol: A 1997 international treaty to solve global warming by curtailing emissions of greenhouse gases.

Montreal Protocol: A 1987 international treaty to heal the ozone layer by controlling ozone depleting substances.

Natural Refrigerants: Common natural refrigerants include isobutane and other hydrocarbons, ammonia, water, air, and carbon dioxide.

GDP: Global Warming Potential is the relative power of a given pollutant to cause global warming over a given timescale, factoring its ability to trap the sun's heat and its atmospheric lifetime. GDPs are measured relative to carbon dioxide, which is given a GDP of 1.

ODP: Ozone Depleting Potential is a factor indicating a substance's relative ozone damaging power.

So what is the solution? What are the alternatives to CFCs, HCFCs and HFCs, the F-gases that are a growing and serious contributor to global warming?

The switch from CFCs and HCFCs to HFCs represents a classic example of industry replacing one harmful chemical with another while protecting the status quo and their market share. All these chemicals contribute to climate change, most with Global Warming Potential (GWP) thousands of times higher than CO2. By shifting to HCFCs and now HFCs since banning CFCs, we have continued to destroy the ozone layer with HCFCs and harm the climate with both alternatives, and will keep on doing so for the next several decades at least. It has also tarnished the legacy of the Montreal Protocol by creating an enormous and unnecessary problem for the climate. There were natural solutions available (some developed by Greenpeace) when HFCs were originally introduced. Greenpeace believes that these chemicals can and should be replaced with climate-friendly natural refrigerants. This is the only responsible course of action.

What is the history of natural refrigeration technology and Greenpeace's role in developing it?

In the early 1990s, Greenpeace set out to find climate-friendly alternative technologies, convinced that there was a way to avoid HFCs through innovation. The result is the creation of GreenFreeze, which uses hydrocarbons for both the blowing of the insulation foam and the refrigerant and are entirely free of ozone-depleting and global warming chemicals. Greenpeace then commissioned a reluctant manufacturer to build 10 prototypes of the most likely-to-work technology. Greenpeace open-sourced the technology and has received no financial remuneration or royalty for developing the product. Greenpeace then marketed, gathered orders, and pre-sold 70,000 refrigeration units (in three weeks) for an East German manufacturer in order to make the retooling of its factory worthwhile. Since March 15, 1993, when the first GreenFreeze refrigerator rolled off the assembly line, 300 million units have been sold in Europe, Russia, Asia and South America by leading brands including Whirlpool, Bosch, Panasonic, LG, Miele, Electrolux, and Siemens. Greenpeace's achievement was recognized by the United Nations Environment Program in 1997, when GreenFreeze received the prestigious UNEP Ozone Award.

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What is the current market situation of natural refrigeration technology?

GreenFreeze (hydrocarbon) technology has spread extensively throughout Europe, Japan, Russia and China. It is currently the refrigerant of choice in 300 million household refrigerators worldwide, but it is still illegal to sell or to purchase in the United States and Canada. Greenpeace is currently working to change this situation through a variety of avenues — policy changes, corporate engagement, and, as soon as a manufacturer is ready, market development.

What are natural refrigerants?

Natural refrigerants are naturally occurring, non-synthetic substances that can be used as cooling agents in refrigerators and air conditioners. These substances include hydrocarbons (propane, butane, and cyclopentane), CO2, ammonia, water and air. (Carbon dioxide….Huh? Yes, CO2. See the next question.) These are sometimes referred to as `the Gentle Five', each with a different area of application. Natural refrigerants are ozone layer- and climate-friendly substances. Other refrigeration and cooling techniques include thermo-acoustic and Stirling Cycle, evaporative cooling technologies. An analysis of the myriad of alternative technologies currently available is detailed in this recent Greenpeace report (PDF).

How is CO2, whose emissions are killing the earth, considered a good natural refrigerant?

The same goes for ammonia — isn't ammonia toxic?

It does seem strange that Greenpeace is arguing for the uptake of carbon dioxide in one area and pushing for its reduction in another. CO2 has a GWP of 1, and the F-gases currently popular on the market have a GWP in the thousands. Carbon dioxide has no ozone depletion potential (ODP=0) and negligible direct global warming potential when used as a refrigerant in closed cycles. To put it in perspective, while the average car emits 5 tons of

carbon dioxide per year, a CO2-charged refrigerator or vending machine would emit say 300 grams of CO2 after its 10-year lifetime. Ammonia has both no ozone depletion potential (ODP = 0) and no global warming potential (GWP=0). It is considered a natural refrigerant because although produced synthetically for refrigeration, it occurs in nature's material cycles. It is a hazardous substance, but is used widely and safely around the world in

large-scale industrial cooling systems such as food processing and building air conditioning.

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What is the Global Warming Potential (GWP) of F-gases and natural refrigerants?

Below is a table that compares the GWP of CFCs and HCFCs to natural (CO2 and hydrocarbon) technology.

Gas	Lifetime (years)	20 year	100 year	500 year
co2		1	1	1
CFC-11	45	6730	4750	1620
CFC-12	100	11,000	10,900	5,200
HCFC-141b	9.3	2250	725	220
HFC-134a	14	3830	1430	435
Cyclopentane	weeks	<3*	<3*	<3*
Isobutane	weeks	<3*	<3*	<3*
Propane	months	<3*	<3*	<3*

*Note that The 20 year GWP of the common HFC-134a is 3830, more than twice its 100 year GWP, meaning cutting emissions now eliminates an even larger near term threat. Natural refrigerants (in this case, hydrocarbons) are incomparably better for the environment than F-gases, from their low GWPs to their very short atmospheric lifetimes.

Are natural refrigerants cost competitive?

Natural refrigeration technologies also outperform from an economic standpoint. Many natural refrigerants are inexpensive, some less expensive than HFCs. In addition, natural refrigerants often boast the most energy efficient technologies, some up to 40% more energy efficient than HFCs. Depending on the type and size of the system, a company may indeed incur additional expenses upon installing a natural refrigerant system (always the case with a new system), but these costs are offset in the mid- to long-term by reduced costs. Operating costs are lower when using natural refrigerants because of lower leakage related costs, the low cost of maintenance, and most importantly low energy consumption. As governments begin to regulate F-gases more diligently, the inexpensive disposal of natural refrigerants at the end of a refrigerators' lifecycle will become a major financial incentive to switch to cleaner cooling systems.

Many governments and companies believe containment of HFCs will solve the problem. What is Greenpeace's opinion?

If governments and companies had set up a global network to deal with the recapture and safe destruction of all F-gases, they wouldn't be the huge climate problem they are today. Containment policies have been an absolute failure because containment is virtually unenforceable. Leakage rates tend to be much higher than industry claims. And even the data provided by industry points to a catastrophic failure in containment: a chemical industry

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website called Alternative Flourocarbons Environmental Acceptability Study (please link to: www.afeas.org) which compiles and presents F-gas data provided by companies, shows that 81% of the main F-gas currently in use today (HCFC 22) has already been released into the atmosphere. Fifty-nine percent of HFC 134a, the main HFC on the market today, has already been released into the atmosphere.

Containment policies are even more difficult to implement in developing countries because1 many developing countries lack well-trained personnel who can ensure that fluorine gases will be properly handled, and2 adequate disposal facilities are almost non-existent in most developing countries, although this latter point applies to most developed countries as well.

Greenpeace thinks that governments should therefore promote the use of natural refrigerants and endorse phase-out dates for HFCs in refrigeration and air-conditioning. These gases have to be eliminated—**not just 'contained'**

What is Refrigerants, Naturally!?

In 2004, The Coca-Cola Company, McDonalds, and Unilever with support from Greenpeace and UNEP (United Nations Environment Program) launched Refrigerants, Naturally! <hyperlink to www.refrigerantsnaturally.com> a multi-stakeholder initiative to develop HFC-free point-of-sale retail vending machines, display cases, beverage coolers, etc. . In doing so, Refrigerants, Naturally! became the first
corporate alliance with the explicit goal of replacing HFC technology in favor of natural refrigerants. These companies have, over the last years and together with their suppliers, developed and tested multiple innovative HFC-free refrigeration technologies.
In 2006, three more companies—Carlsberg, Ikea, and the PepsiCo Company—joined the initiative. The first major US rollouts of HFC-free refrigeration took place on September 29, 2008 when Ben & Jerry's/Unilever installed the first HFC-free ice cream freezers in the United States.

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i. For instance, ammonia is much less expensive than its HFC counterpart HFC-404A, and hydrocarbons have prices comparable to HFCs.

ii. For more information, please consult the 2004 report, HFC Containment Has Already Failed by chemist Eric Johnson.