Climate-friendly alternatives to HFCs

ec.europa.eu/clima/eu-action/fluorinated-greenhouse-gases/climate-friendly-alternatives-hfcs_en

Stationary air conditioning

Stationary air conditioning (AC) is designed to control the thermal comfort of living and working rooms. The stationary AC sector can be broken down into several sub-categories:

- Moveable room AC:
  Devices that are hermetically sealed and can be moved between rooms by the user. Mostly used in private households.
- Single split AC:
  System that consists of one outdoor and one indoor unit linked by refrigerant piping, needing installation at the site of storage. Predominantly used in private households.
- Multi split AC/VRF:
  System that consists of one outdoor unit and multiple indoor units. Further developed systems enable a variable refrigerant flow (VRF) towards every indoor unit. Used in commercial facilities.
- Chiller:
  System in which the refrigerant cools down a liquid (normally water) that is then circulated to cool air in commercial or industrial facilities.
- Heat pump:
  System that is able to provide heating or cooling by transferring heat from or to an external reservoir (such as the ground, water or outside air). Used both in private households and commercial facilities.

In room air conditioning systems, hydrocarbons are safely used as alternative refrigerants in several countries such as India and China, but they are not yet common in the EU.

In chillers, hydrocarbons and ammonia are safe and energy-efficient alternatives to HFCs, both under moderate and high ambient temperature conditions. Heat pumps are also used with hydrocarbons, additionally CO_2 is available on the market.

Moveable room AC

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

Single split

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFCs	R32	675	-	A2L	R407A, R410A

Multi split/Variable refrigerant flow (VRF)

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane)	3	-	A3	R407A, R410A
HFOs	R1234yf R1234ze	R407A, R410A R407A, R410A			
HFCs	R32	675	-	A2L	R407A, R410A

Chiller

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane) R717 (ammonia) R718(H_20) R744 (CO_2) R1270 (propene)	A3 2BL A1 A1 A3	R134a, R407A, R410A R134a, R407A, R410A R134a, R407A, R410A R134a, R407A, R410A R134a, R404A, R407A		
HFC-HFO blends	R32/125/1234yf R32/1234yf R32/1234yf/CO_2 R1234yf/134a	R410A R410A R404A R134a			

	Substance	GWP	Composition	Safety group	Replacement for
HFOs	R1233zd R1234ze	R134a, R410A R134a, R407A, R410A			
HFCs	R32	675	-	A2L	R134a, R407A, R410A

Heat pumps

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane) R718 (H_2O) R744 (CO_2)	R134a, R407A, R410A R134a, R407A, R410A R134a, R407A, R410A			
HFC-HFO blends	R32/1234yf R1234yf/134a	R410A R134a			
HFCs	R32	675	-	A2L	R134a, R407A, R410A

Commercial refrigeration

Commercial refrigeration applications include stand-alone equipment, condensing units and centralised systems.

Plug-in equipment used in small stores and supermarkets, such as vending machines relying on hydrocarbons, has become available in recent years throughout the world. CO_2-based systems have also been introduced.

In large refrigeration systems for supermarkets ('centralised systems'), CO_2 cascade systems are an alternative to commonly used HFC systems in many climates.

Hydrocarbons have also proven to be highly efficient alternatives in most applications under high ambient temperatures, except for larger condensing units.

Centralised systems

Substance	GWP	Composition	Safety group	Replacement for

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane) R717 (ammonia) R744 (CO_2)	R134a, R404A, R407A R134a, R404A, R407A R134a, R404A, R407A			
HFC-HFO blends	R32/125/1234yf/1234ze(E)/134a R32/125/1234yf/134a	R404A R404A			

Condensing units

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane) R744 (CO_2) R717 (ammonia)	R134a, R404A, R407A R134a, R404A, R407A R134a, R404A, R407A			
HFC-HFO blends	R448A R449A R452A* R454C R513A	1387 1397 2140 148 631	R32/125/1234yf/1234ze(E)/134a R32/125/1234yf/134a R32/125/1234yf R32/1234yf R1234yf/134a	R404A R404A R404A R404A R134a	

* For low temperature applications

Mobile air conditioning

The refrigerant R134a used in air conditioning of cars is prohibited in new cars as a consequence of the EU Directive 2006/40/EC on mobile air-conditioning systems ('MAC Directive').

The main substitute is the R1234yf, which is almost exclusively used. The only alternative to this is CO_2, which is currently used by some car manufacturers and expected to become more widespread in the future.

CO_2 is also expected to become available as an alternative in the future for duty vehicles, busses and trains.

Mobile air conditioning for cars

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R744 (CO_2)	1	-	A1	R134a
HFOs	R1234yf	4	-	A2L	R134a

Mobile air conditioning for buses

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R744 (CO_2)	1	-	A1	R134a
HFC-HFO blends	R1234ze(E)/134a R1234yf/134a	R134a R134a			

Mobile air conditioning for trains

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R729 (air) R744 (CO_2)	R134a R134a			

Alternatives and safety groups

Most of the HFCs are used as refrigerants in refrigeration and air conditioning (RAC) equipment, but also as blowing agents, aerosol propellants and solvents.

In the following, alternatives to commonly used HFCs are listed for different sectors.

The alternatives include

- Natural refrigerants
- HFCs with lower GWP, such as R32
- Hydrofluoroolefins (HFOs)
- HFC-HFO blends.

Each substance is assigned to a safety group specified as follows:

	Lower toxicity	Higher toxicity
No flame propagation	A1	B1

	Lower toxicity	Higher toxicity
	A2	B2
Lower flammability	A2L*	B2L*
Higher flammability	A3	B3

* A2L and B2L are lower flammability refrigerants with a maximum burning velocity of ≤ 10 cm/s

Please click on the sector of your interest for further information.

Industrial refrigeration

In industrial refrigeration, such as large cooling facilities for food processing or process cooling in the chemical industry, ammonia systems have been used for many years.

Ammonia has been the most popular replacement option to R404A and its use is already widespread. In Europe, but also in other parts of the world such as North America, an increasing number of cascade systems with ammonia and CO_2 have been installed in the food and beverage industry.

Industrial refrigeration

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R290 (propane) R717 (ammonia) R744 (CO_2) R1270 (propene)	R134a, R404A, R407A R134a, R404A, R407A R134a, R404A, R407A R134a, R404A, R407A			
HFC-HFO blends	R32/125/1234yf/134a R1234ze(E)/134a R1234yf/134a	R404A R134a R134a			
HFOs	R1233zd R1234ze	4,5 7	-	R134a, R404A R134a, R404A	

Foam blowing

Polyurethane (PU) foam: Only few PU foam products are still manufactured with HFC blowing agents. The vast majority rely on hydrocarbons such as pentane or cyclo-pentane without loss in energy efficiency. HFCs are mainly limited to on-site application of PU spray foam. For this and some niche applications, unsaturated HFCs are already commercially available.

Extruded polystyrene (XPS): Major manufacturers of XPS insulation boards have already converted their production facilities to organic solvents or HFOs. The remaining users of HFCs are switching to HFOs. Energy efficiency of HFOs is considered to be better than that of HFCs.

Why use alternatives?

The climate impact of a substance is commonly expressed as the global warming potential (GWP). The lower the GWP, the more climate-friendly the substance.

HFCs have a very high GWP and are hence potent greenhouse gases. Most of the HFCs are used as refrigerants in refrigeration and air conditioning (RAC) equipment, but also as blowing agents, aerosol propellants and solvents.

To mitigate emissions of substances with a high GWP and comply with the F-Gas RegulationSearch for available translations of the preceding link*EN*•••, each sector needs to find solutions to quickly switch to low GWP refrigerants.

Transport refrigeration

Lately, R448A, R449A and R452A have become quite common to replace R404A in road transport refrigerated vehicles. R452A has a very high GWP of 2140 and hence will not be suitable for future use. For refrigerated containers, CO_2 can be used as a long-term alternative.

Refrigerated vehicles

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R744 (CO_2)	1	-	A1	R134a, R404A, R410A
HFC-HFO blends	R32/125/1234yf/1234ze(E)/134a R32/125/1234yf/134a R32/125/1234yf	R404A R404A R404A			

Refrigerated containers

	Substance	GWP	Composition	Safety group	Replacement for

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R744 (CO_2)	1	-	A1	R134a, R404A, R410A
HFC-HFO blends	R32/125/1234yf R1234yf/134a	R404a R134a			

Domestic refrigeration

In Europe, hydrocarbon refrigerants have replaced the use of HFCs since the mid-1990s.

Domestic refrigeration

	Substance	GWP	Composition	Safety group	Replacement for
Natural refrigerants	R600a (isobutane)	3	-	A3	R134a

Studies

A number of studiesSearch for available translations of the preceding link*EN*••• on the feasibility and availability of alternatives at sub-sectoral level have been carried out by various renown experts, including an extensive analysis carried out for the European Commission by the independent consultant Öko-Recherche in the context of developing Regulation (EU) No 517/2014.