

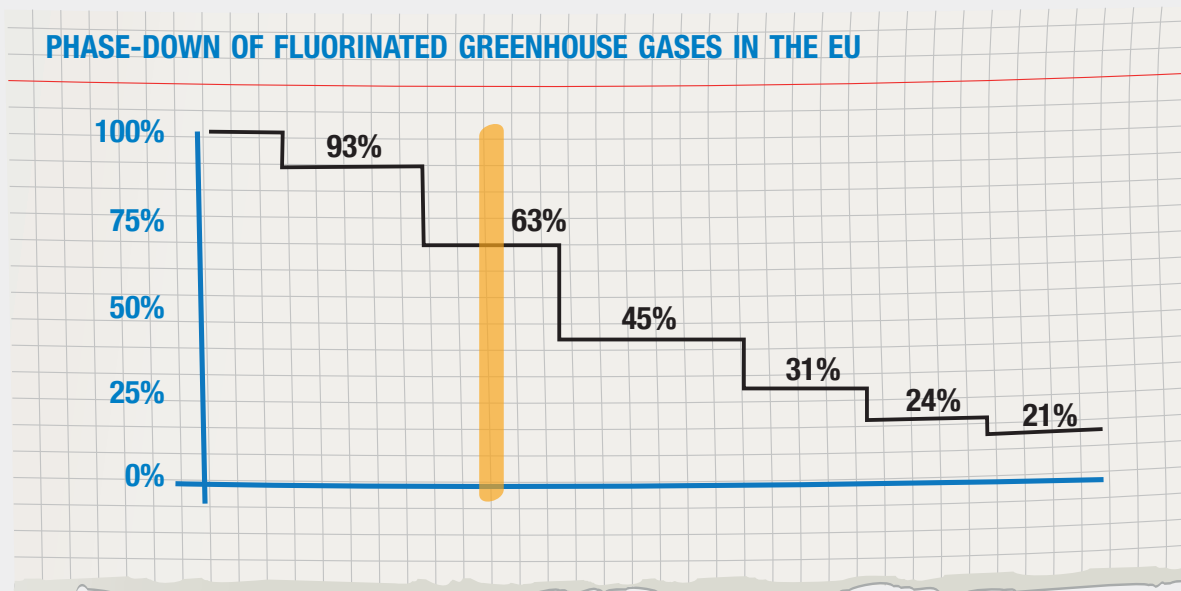
F-Gas Regulation EU 517/2014



The F-Gas Regulation EU 517/2014 aims to reduce emissions of fluorinated greenhouse gases and thus limit global warming. It is binding law throughout Europe. It prohibits the circulation of certain greenhouse gases and refrigeration units and also provides a quota system for shortages in the supply of commercially available refrigerants. In so doing, it encourages the use of environmentally-friendly technologies, the recycling of gases and leak-tightness measures. The law stipulates a gradual reduction in supply until 2030.

OBJECTIVE

Implementation will be phased (known as “phase down”). Based on the yearly average from 2009 to 2012 representing 100%, the law stipulates a reduction in the average CO₂ amount to 21% by 2030.



Maximum amounts in percent and the relevant quotas for the circulation of partly fluorinated hydrocarbons

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The change is based on the substance-specific global warming potential (GWP) of a refrigerant and its considered mass (also referred to as filling quantity in refrigeration units) in metric tons. This product is referred to as CO₂ equivalent and is calculated as follows:

$$\text{CO}_2 \text{ equivalent} = \text{GWP [-]} \times \text{mass (filling quantity) [kg]} / 1,000 \text{ [kg/t]}$$

It can be assumed that the higher the GWP of a refrigerant, the more quickly it will become unavailable. Below is a list of the GWP of refrigerants typically used in modern refrigerant dryers:

Refrigerant	GWP	BOGE	Series
R 404 A	3922	N/A	
R 452 A	2140	N/A	
R 407 A	2107	N/A	
R 410 A	2088	N/A	
R 407 F	1825	N/A	
R 407 C	1774	x	DS 120...DS 1800
R 134 A	1430	x	DS 4-2...DS 100-2

IMPLEMENTATION PERIODS

The reduction will take place in three relevant phases up until 2025:

First phase:

By 2020: switch from all refrigerants with a GWP > 2500

Second phase:

By 2022: GWP value > 750

Third phase:

By 2025: GWP value > 150

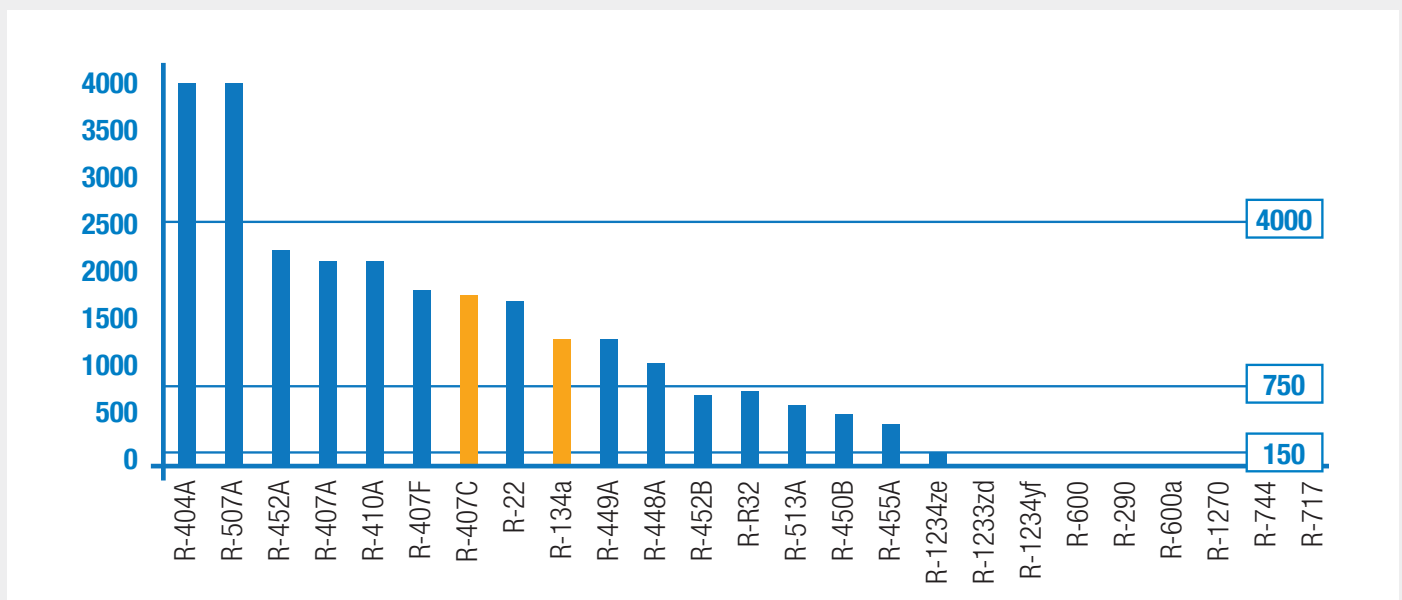
Federal German Ministry for Environment, Nature Conservation and Nuclear Safety (BMU)

Circulation

Product or equipment	Key feature	Deadline
Domestic refrigerators and freezers	F-gas with GWP 150	1.1.2015
Fire extinguishers	with HFKW23	1.1.2017
Technical aerosols	GWP 150 (exception for safety requirements)	1.1.2018
Commercial refrigerators and freezers	GWP 2500 GWP 150	1.1.2020 1.1.2025
Stationary refrigeration equipment	GWP 2500 (exception for product refrigeration below -50°C)	1.1.2020
Mobile room air conditioners	GWP 150	1.1.2020
Foams	XPS Other	1.1.2020 1.1.2023
Central refrigeration units with a refrigeration capacity from 40 kW	GWP 150 in secondary circuit GWP 1500 in primary circuit	1.1.2023
Mono-split air conditioners	Less than 3 kg filling quantity / F-gas with GWP 750 or more	1.1.2025

WHO IS AFFECTED?

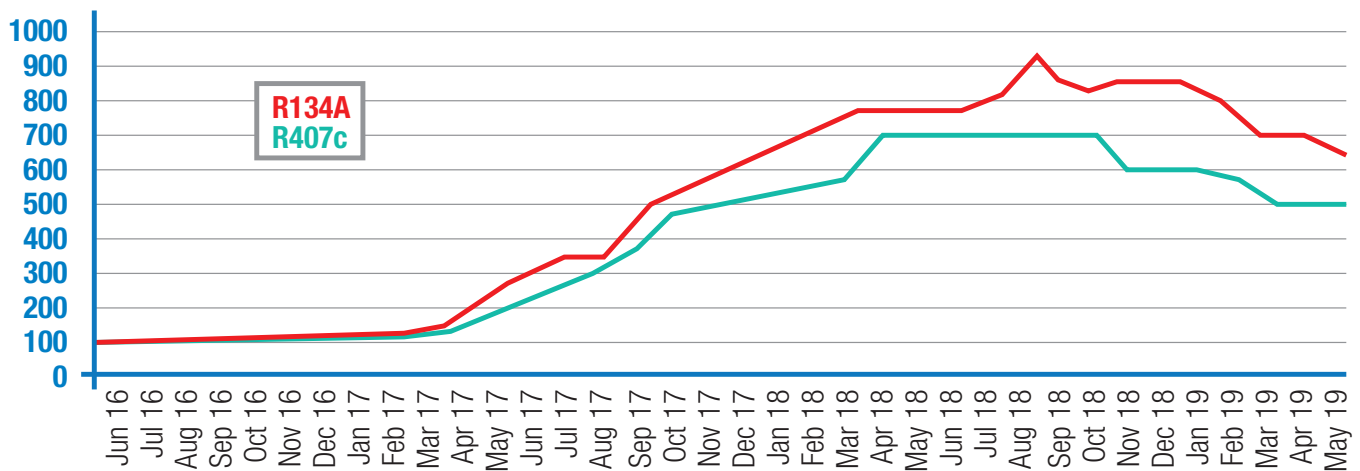
BOGE refrigerant dryers fall into the “stationary refrigeration equipment” category and must not contain any F-gas with a GWP greater than 2500 as of 1 January 2020. BOGE currently uses refrigerants R407C and R134A, which are significantly below the GWP of 2500 and therefore not directly affected by the switch. As an indirect consequence, however, it is likely that the refrigerants used will become more expensive because of the shortages. This would affect BOGE. This trend cannot, however, be confirmed based on the past four years.



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PRICE HISTORY IN EUROS/KG
 RAW MATERIAL: REFRIGERANT GASES



PRICE HISTORY OF REFRIGERANTS R134A AND R407A OVER THE PAST FOUR YEARS

Manufacturers of refrigerant compressed air dryers are already preparing for a possible switch from R134A and R407A. At present, refrigerant R513A is emerging as a quickly feasible, short-term interim solution.

- A direct switch from R134A to R513A would be possible without a compromise in performance with the current DS 4-2...DS 100-2 series and could happen immediately.
- A switch from R407A to R513A would involve a redesign of the current DS 120...DS 1800 series, which will be available soon on request.

As a manufacturer of stationary refrigeration equipment, BOGE does not recommend a direct switch at present, as there is currently no security of supply for R513A, in spite of significantly higher procurement costs.

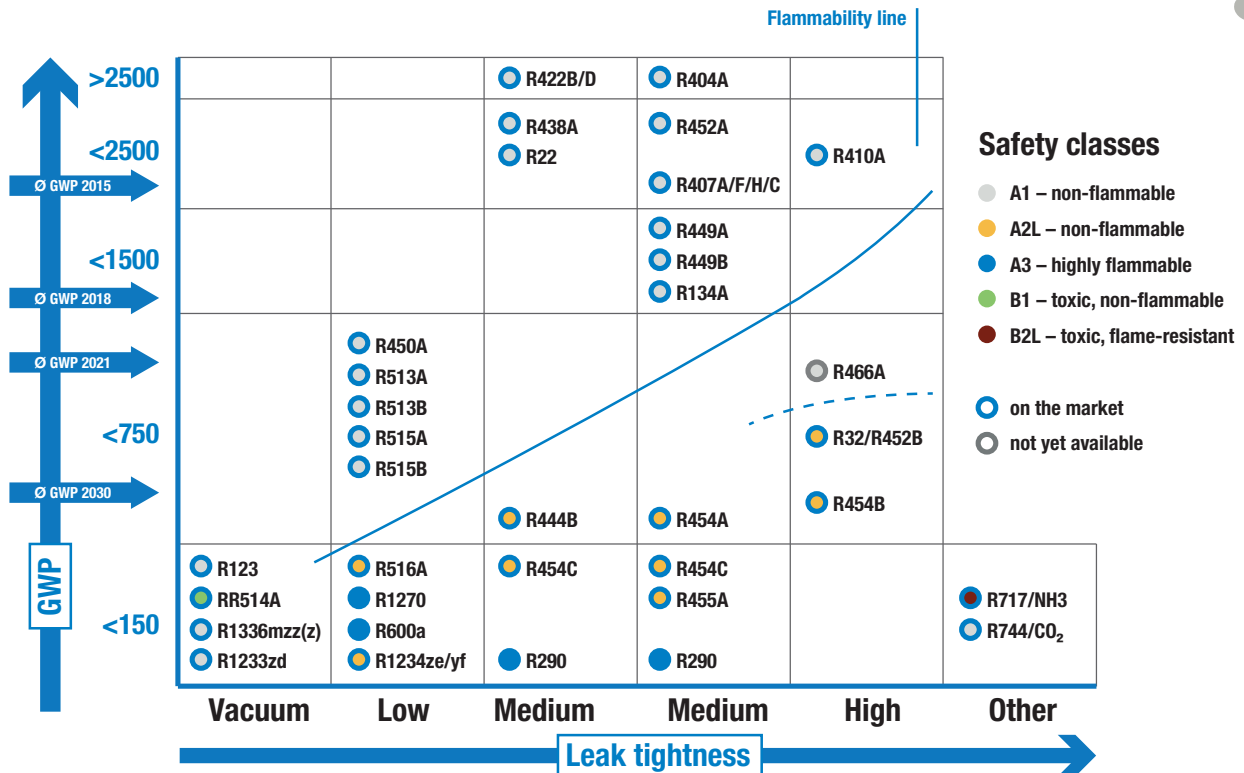
In addition, there are technical limitations which would result in reduced performance of the larger series. It would mean that dryers would have to be much bigger to maintain the current performance. The higher investment and service costs in the field mean that a switch at the current time would not be economically attractive.

Furthermore, it has been pointed out that refrigerant R513A is a mixture consisting of R-1234yf (56%) and R134A (44%). A potential analogous price rise cannot, therefore, be ruled out for R513A too. The current market trend with regard to a suitable future refrigerant is thus deemed highly uncertain and is the subject of controversial discussion. The chart below suggests that the market and manufacturers will become much broader and more complex in future. It seems the panacea refrigerant of the future has not been discovered yet.

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MAIN REFRIGERANT IN CIRCULATION THE MARKET IS CONSTANTLY CHANGING



CONCLUSION – WHAT DOES THIS MEAN FOR MANUFACTURERS OF COMPRESSED AIR REFRIGERANT DRYERS?

Phase 1

Replacement of all refrigerants with a GWP value > 2500 by 1/1/2020.

Refrigerants concerned: R404A, R507A

All manufacturers were obliged to have made this switch by the end of last year. BOGE was not affected.

Phase 2

Replacement of all refrigerants with a GWP value > 750 by 2022.

Refrigerants concerned: R134A, R407A

As a manufacturer of stationary refrigeration equipment, BOGE is not affected at the present time. Nevertheless, BOGE would be indirectly affected by a possible price rise.

If the price rise materialises, BOGE could, however, switch to alternative refrigerant R513A immediately without further ado.

Phase 3

Replacement of all refrigerants with a GWP value > 150 by 2025.

To conclude it is also important to mention that even switching to R513A (GWP = 631.4), for example, can only be considered a temporary solution, because even though the refrigerant seems technically promising in the short term, it cannot be considered adequate with regard to phase 3 (GWP > 150) in 2025. At present there is no known refrigerant technically suitable for refrigerants dryers with a GWP value below 150.

Conclusion

Given the lack of security of supply, the significantly higher investment and service costs, as well as the fact that refrigerant R513A can only be considered a temporary solution, BOGE does not recommend switching at the present time for economic reasons.