



INSTITUT INTERNATIONAL DU FROID  
INTERNATIONAL INSTITUTE OF REFRIGERATION

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48<sup>th</sup> Informatory note  
on Refrigeration  
Technologies

## Low-GWP Refrigerants : Status and Outlook

# SUMMARY FOR POLICYMAKERS

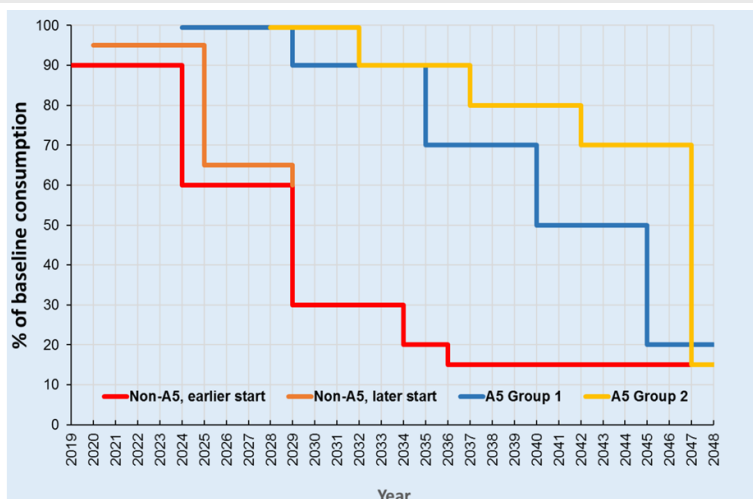
At the outset of mechanical refrigeration, the selection of refrigerants was based on satisfying two main requirements: **performance** and **material compatibility**. With growing market penetration of refrigeration equipment and occurring accidents, safety became an essential selection requirement encompassing flammability and toxicity. The advent of regulations controlling ozone depletion substances (Montreal Protocol) and high-Global Warming Potential (GWP) refrigerants (Kyoto Protocol and Kigali Amendment) added **environment protection** to the list of main requirements. Refrigerant **cost** has always played a role in refrigerant selection but is typically considered after the first four criteria have been already applied.

**The IIR Informatory Note “Low-GWP Refrigerants Status and Outlook” discusses refrigerant requirements and available options for eight refrigeration applications.** It also presents performance simulation results obtained using an advanced simulation model with the latest refrigerant properties.

The availability of low-GWP refrigerants varies between applications. For centrifugal chillers, domestic refrigeration, and automotive air conditioning, equipment using refrigerants with GWP < 10 is already on the market. For other applications, in particular for those currently using high-pressure refrigerants, R-410A and R-404A, the choices

Figure 1

Kigali Amendment phase-down schedule for the two groups of non-Article 5 parties and the two groups of Article 5 parties





are limited, which results in the industry opting for interim (medium-GWP) solutions buying some time for the development of new low-GWP refrigerants or technologies that will enable ultra-low GWP solutions. For non-article 5 countries, this planning strategy corresponds to the reduction steps imposed by the Kigali Amendment (Figure 1), where medium-GWP refrigerants will satisfy the 2024-2025 phase-down and much lower-GWP refrigerants will be required to comply with the additional reduction impending in 2029.

Overall, the existing trade-off between GWP and flammability implies that a significant share of future equipment will use flammable refrigerants. Natural refrigerants are already in use in several applications such as small air conditioners, domestic and commercial refrigeration, large commercial and industrial applications, and the future holds their increased market share in other suitable applications. The use of cooling/refrigeration equipment based on alternative (non-vapor compression) technologies may increase in niche applications.

**The IIR recommendations regarding the selection of refrigerants, the research to be carried out and the training of personnel are as follows:**

*Selection of new fluids with full consideration of all their merits*

- The holistic approach should be used such as Life Cycle Climate Performance (LCCP) considering all GHG emissions or preferably the Life Cycle Analysis (LCA), which considers the whole equipment over lifetime.
- The availability and accessibility for the global population should be considered. Any new technology should not only be available at a commercial scale but also accessible for all countries.

**The IIR is ready to provide its expertise to participate in the implementation of these actions in each country.**

**Research needs**

- High-pressure low-GWP fluids with a normal boiling point similar to those of R-410A and R-404A are most needed. Research of new refrigerant chemistries should continue to find such fluids to replace R-410A and R-404A. This will help achieve high efficiency levels and minimize the cost of equipment compared to systems using low-pressure alternatives.
- Research should continue to facilitate the use of existing medium-pressure low-GWP fluids in current R-410A and R-404A applications. More research should be done to identify alternative cycles or technologies that can produce high-efficiency/low-cost equipment using these fluids.
- A large amount of research has been done in Asia, US, and Europe on flammability fundamentals, which help in development of safety standard. Still, the work on risk assessments should continue to ensure their global applicability.

*Training of personnel to handle flammable refrigerants*

- Training of personnel should include not only system installation and service technicians but also all personnel along the distribution chain.
- Safety standards for flammable refrigerants are still under development. They are becoming rather complex, making interpretation cumbersome for the end user. Refrigeration equipment manuals provided by the manufacturers or independent authors should clearly explain the specification and installation requirements when using flammable refrigerants without minimizing the required precautions.