環境省
Ministry of the Environment

Setting the Scene for the Refrigerant Circular Economy at a Crossroads

Current Challenges, Strategic Directions, and Key Questions

November 3, 2026

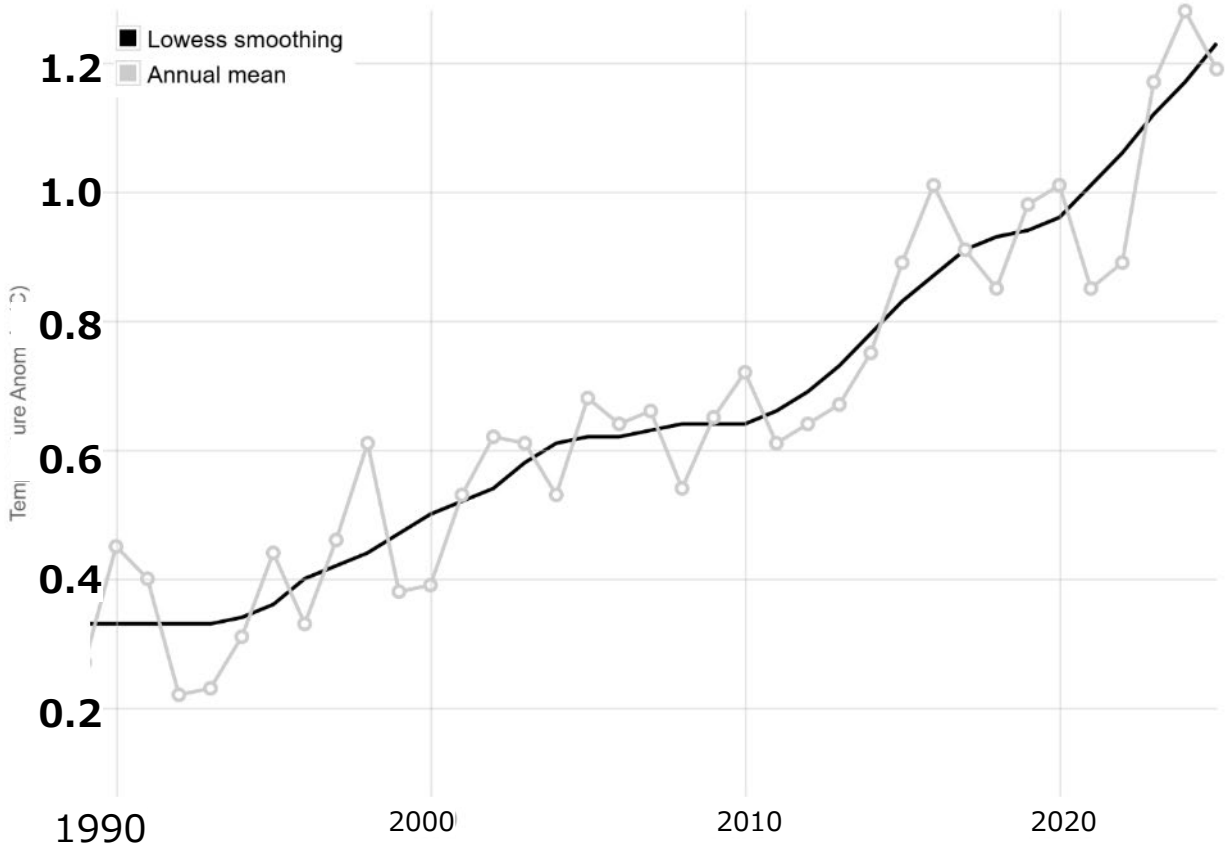
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Office of Fluorocarbons Control Policy,
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Climate Change and Heat-Related Mortality

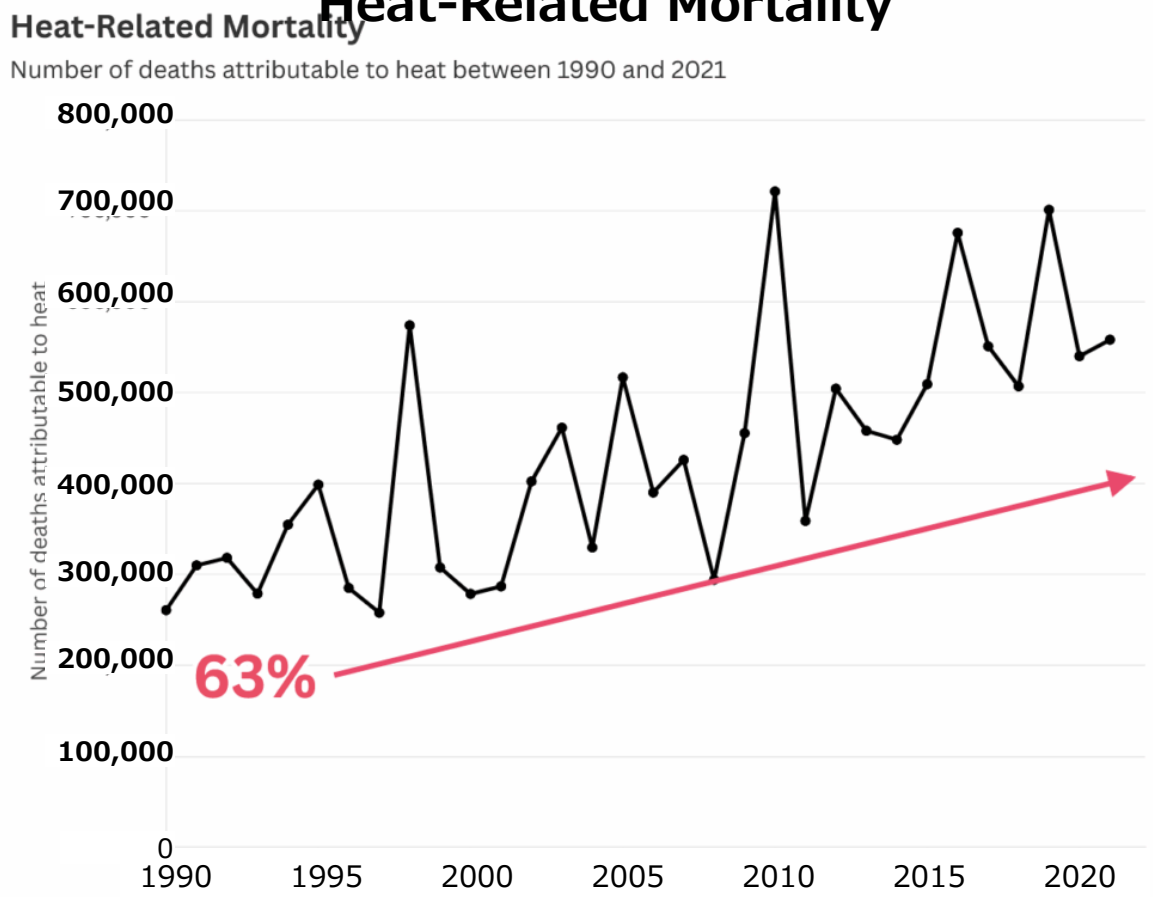
- As global temperatures continue to rise, the risks of heatwaves and heat-related health impacts are increasing.
- **Air conditioning systems play an increasingly important role in adapting to climate change.**

Global Temperature



Source) Global Temperature - Earth Indicator (NASA)
https://science.nasa.gov/earth/explore/earth-indicators/global-temperature/

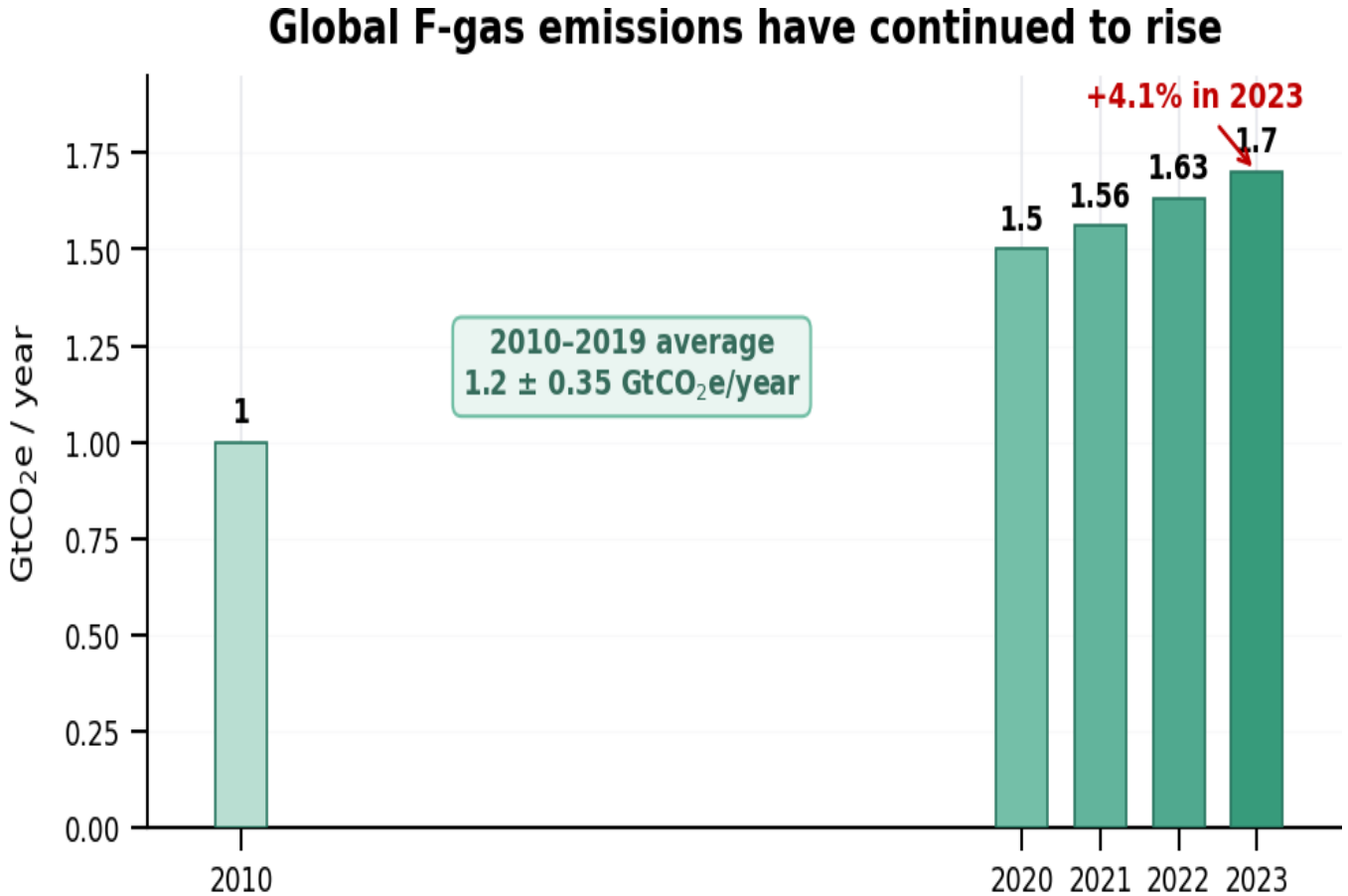
Heat-Related Mortality



Source) Lancet Countdown
https://lancetcountdown.org/explore-our-data/

Rising Global F-gas Emissions Require Urgent Action

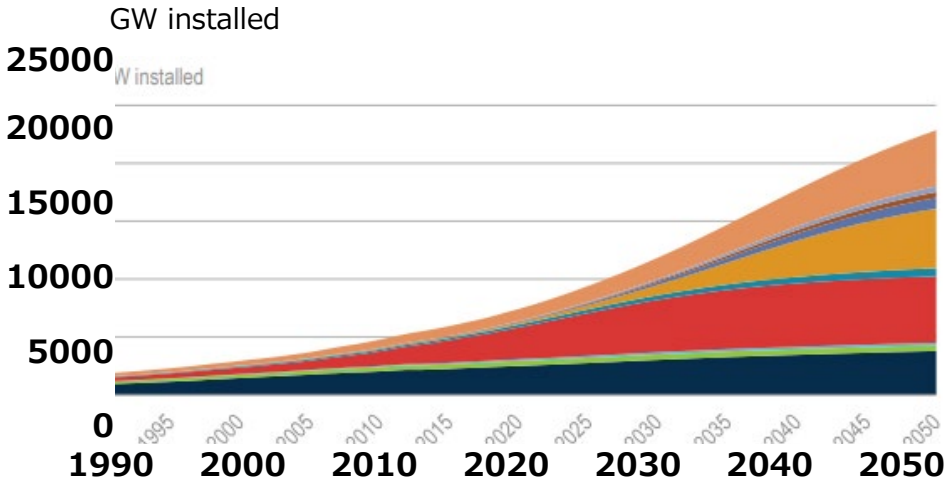
- **Global F-gas emissions have continued to rise,** reaching approximately 1.7 $GtCO_2e$ in 2023, an increase of 4.1% from the previous year.
- **This upward trend must be reversed.** Substantial reductions in F-gas emissions are essential to achieve the goals of the **Paris Agreement and carbon neutrality.**



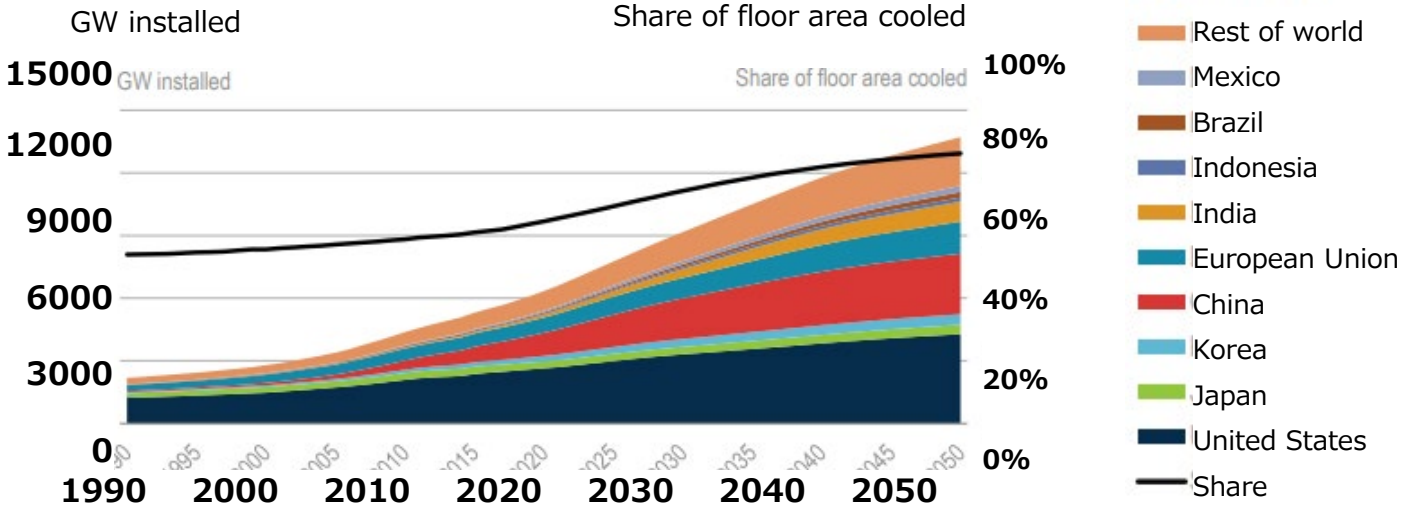
Projected increase of demand for global air-conditioning capacity

- **Demand for air conditioners is growing** due to global warming, economic growth, and urbanization.
- Global air-conditioning capacity is projected to increase from 6,200 GW to 23,000 GW for residential applications and from 5,500 GW to 14,000 GW for commercial applications between 2016 and 2050.

Residential AC cooling capacity



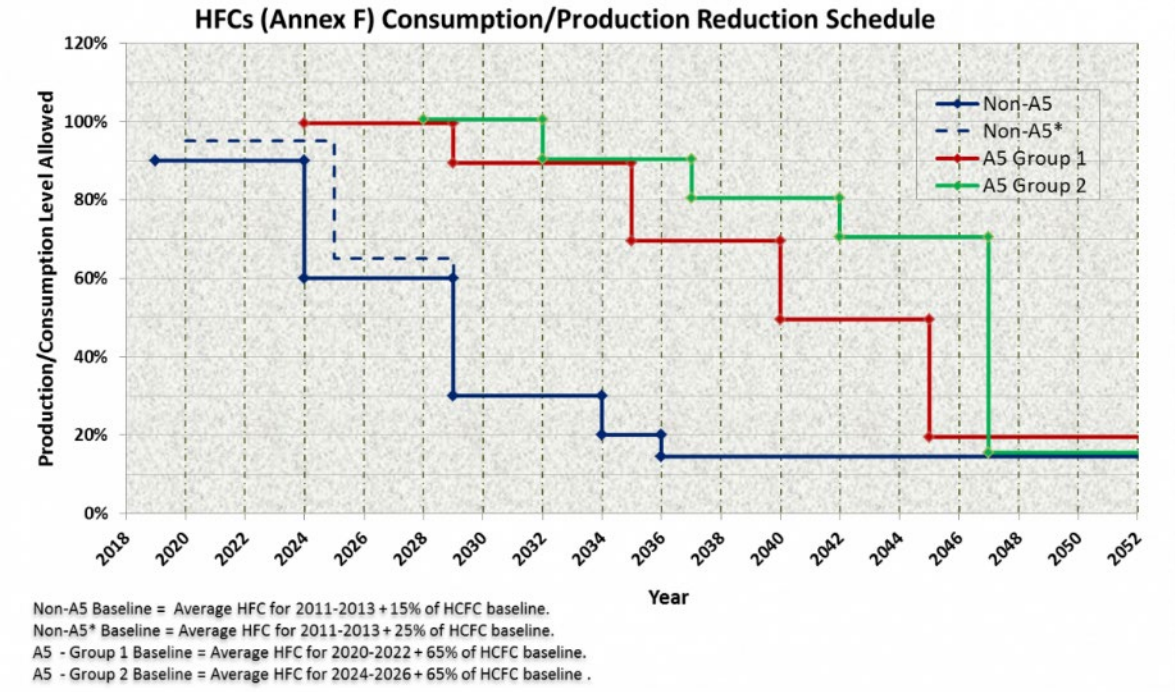
Commercial AC cooling capacity



The Future of Cooling,IEA,2018 : https://iea.blob.core.windows.net/assets/0bb45525-277f-4c9c-8d0c-9c0cb5e7d525/The_Future_of_Cooling.pdf

Phase down of the production and consumption of HFCs under the Montreal Protocol

- In 1987, the **Montreal Protocol on Substances that Deplete the Ozone Layer** was adopted under the **Vienna Convention for the Protection of the Ozone Layer** to regulate the production, consumption, and trade of ozone-depleting substances (ODS).
- **The Kigali Amendment adopted in 2016 requires all Parties to progressively phase down HFC consumption according to their respective schedules.**
  *HFC does not deplete the ozone layer but have a high global warming potential.
- The Protocol also includes mechanisms to support compliance and implementation, such as trade controls and financial assistance for developing countries through the Multilateral Fund (MLF).



Key Measures under the Montreal Protocol

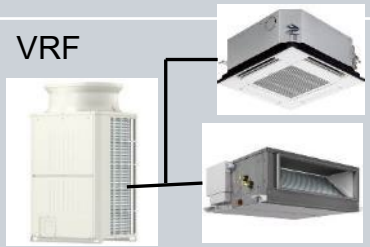
1. Controls on the Production and Consumption of ODS
Parties are required to comply with limits on the production and consumption (production + imports − exports) of ozone-depleting substances, including CFCs and HCFCs, and to implement their gradual phase-out and eventual elimination.

2. Trade Controls on Controlled Substances
Parties are required to take the necessary measures to regulate the import and export of controlled substances and related products with non-Parties.

3. Reporting and Compliance
Parties are required to regularly report data on production, consumption, and other relevant activities, and to comply with the Protocol's control schedules and obligations.

New refrigerant development

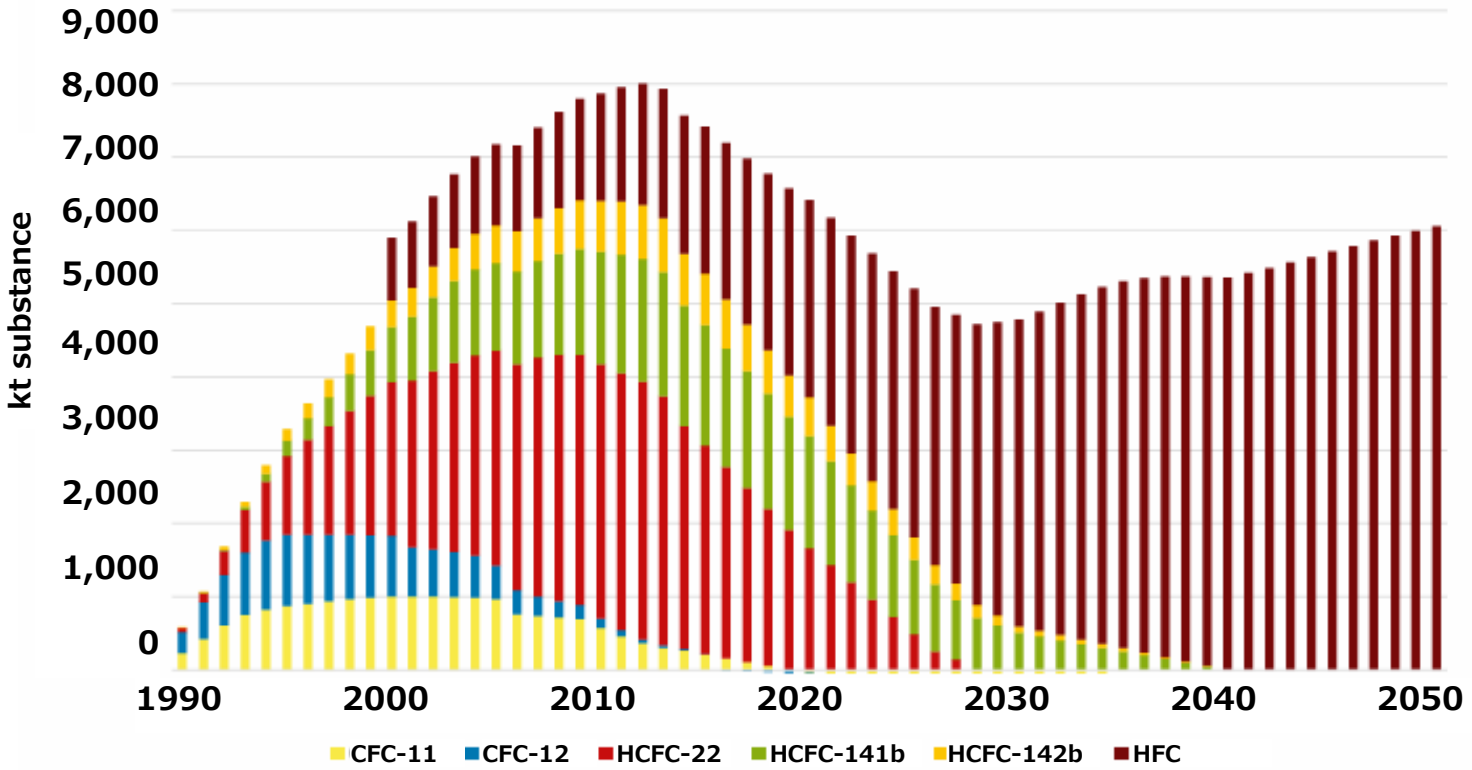
- For several air-conditioning applications, particularly medium- and large-scale systems, commercially viable non-fluorocarbon alternatives remain limited due to safety, energy-efficiency and technical constraints.
- To ensure a stable refrigerant supply, a highly practical option is to recover and reclaim the existing banks of HFC refrigerants and promote their circular reuse.

		R290	CO2	R32, R454B, etc..	New HFO/HFC Blends
Small split AC (6kW≦) 	Safety	△ (A3)	△(high pressure)	○(A2L)	○(A2L)
	GWP	○ (<10)	○ (<10)	△(<750)	○ (1~150)
	Performance/Economics	○	x (low performance)	○	△~○
	challenges	**Safety Measures**	**impractical**	Medium GWP	**PFAS,Stability,Performance**
Medium/Large split AC(＞6kW) 	Safety	**×(Flammability)**	△(high pressure)	○	○(A2L)
	GWP	○ (<10)	○ (<10)	△(<750)	○ (1~150)
	Performance/Economics	△	x (low performance)	○	△~○
	challenges	**impractical**	**impractical**	Medium GWP	**PFAS,Stability,Performance**
VRF 	Safety	**×(Flammability)**	△(high pressure)	○	○(A2L)
	GWP	○ (<10)	○ (<10)	△(<750)	○ (1~150)
	Performance/Economics	×	x (low performance)	○	△~○
	Challenges	**impractical**	**impractical**	Medium GWP	**PFAS,Stability,Performance**

Source: JRAIA's side event presentation at OEWG45

Growing Fluorocarbon Banks and the Need for Emission Control

- While CFC and HCFC banks are projected to decline over time, **HFC banks are expected to continue increasing from 1,000 kt in 2010 to 6,000 kt by 2050.**
- As the Kigali Amendment does not directly address emissions, proper management of existing banks to minimize leakage during use and ensuring recovery at end-of-life remain critical to prevent future emissions and to recover potential resource.



GIZ 2018, Version 2.0: Global Roadmap on ODS bank management https://ozone.unep.org/system/files/documents/ODS%20HFC%20Banks.pdf

Three Constraints on Fluorocarbons

- Fluorocarbon policy must address three constraints at the same time: environmental, supply, and demand constraints.
- Rather than simply reducing refrigerant use, we must minimize emissions while securing the refrigerants society needs.

Environmental Constraint	**Substantial reductions in HFC emissions are required**	• HFCs have global warming potentials hundreds to thousands of times greater than that of CO_2. • **Substantial reductions in HFC emissions** are needed to achieve climate targets under Paris Agreement.
Supply Constraint	**Shrinking cap on virgin HFCs consumption**	• The **Kigali Amendment will progressively reduce the global supply of virgin HFCs**. • Many countries depend heavily on imported refrigerants and are **vulnerable to supply-chain disruptions and refrigerant prices** and availability may become increasingly uncertain.
Demand Constraint	**Growing Demand for HVAC/R**	• HVAC/R is essential for daily life and industry. • As global warming and extreme heat intensify, **demand for HVAC/R is expected to increase** to protect people from heat-related illness.

Fundamental Motivation for Discussion

While the transition to alternative refrigerants continues, large amounts of refrigerants remain in existing equipment.
As we mark ten years since the Kigali Amendment, the next major challenge is not only "what refrigerants we use," but also "how we manage the refrigerants already contained in existing equipment."

- **Our Next Challenge is What to Do with Existing Refrigerant Banks.**
- **If Left Unmanaged, Refrigerant Banks Will Become a Future Source of Emissions.**
- **Once Recovered, Refrigerants Can Both Reduce Emissions and Serve as a Resource that Reduces Demand for Virgin Refrigerants.**