Reduction in the Usage of F-Gases in the European Union Over the Last Decade

Analysis of regulatory impact and market transformation

Andrzej Grzebielec · Katarzyna Katana
Warsaw University of Technology – Institute of Heat Engineering

Context: EU Climate Ambitions & F-Gas Problem

🌍 2050 Climate Neutrality

The EU has committed to achieving climate neutrality by 2050, requiring deep cuts across all greenhouse gas sectors.

🌡️ F-Gases

Fluorinated gases have GWPs ranging from hundreds to tens of thousands, which is a major contributor to the global warming effect.

❄️ HVACR as Key Source

Refrigeration, air conditioning, and heat pumps are major users of F-gases.

📉 78% Drop in Decade

EU consumption of HFCs fell by ~78% over the last ten years, demonstrating the impact of regulatory action.

EU F-Gas Regulatory Timeline

2006

Directive 2006/40/EC

Targeted mobile air-conditioning systems; set emissions standards for F-gases during servicing and end-of-life.

2006

Regulation (EC) No 842/2006

First comprehensive EU F-gas regulation: containment, recovery, reporting, and training requirements.

2014

Regulation (EU) No 517/2014

Introduced HFC phase-down schedules, enhanced reporting obligations, and stricter enforcement mechanisms.

2024

Regulation (EU) 2024/573

Replaces all previous F-gas legislation; strengthened phase-down, covers production, import, export, use, recovery, and destruction.

How the Phase-Down Works

01

Quota System

Each company placing HFCs on the EU market is allocated a quota expressed in CO_2-equivalent tonnes.

02

Declining Caps

The total allowable quantity is reduced each year according to a fixed schedule, creating a shrinking market for high-GWP gases.

03

GWP Weighting

Gases are counted by their CO_2-equivalent impact: high-GWP gases count disproportionately against quotas.

04

Enforcement & Reporting

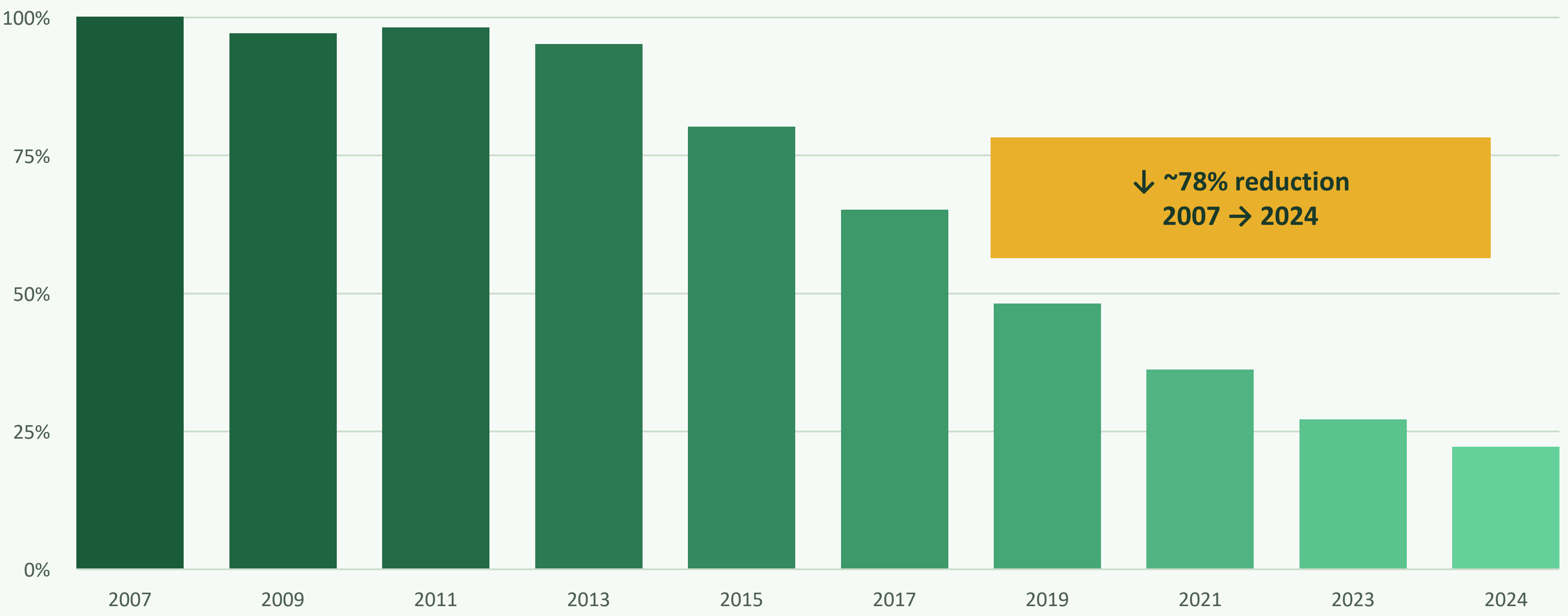
Companies must report production, import/export volumes and destruction. Non-compliance triggers penalties.

05

Market Effect

Quota scarcity raises prices for HFCs, accelerating adoption of low-GWP and natural alternatives.

HFC Consumption in the EU: 2007–2024



Source: Öko-Institut / European Topic Centre on Climate Change Mitigation, 2025

Interpreting the Data: Market Distortions

2007

Reference Year

First full year after early EU regulations entered into force

Market relatively stable 2007–2013, then steep phase-down

- Pre-regulation stockpiling inflated early statistics, 2007 is a more reliable baseline than earlier years.
- Between 2007 and 2013 consumption was broadly stable as industry adapted to first-generation rules.
- From 2014 onwards, the HFC phase-down schedule drove rapid, sustained market contraction.
- ~78% decline over the decade reflects genuine substitution, not only reporting or quota adjustments.
- Parallel growth in low-GWP refrigerants (CO_2, NH_3, HCs) confirms real technology transition.

Rise of Alternative Technologies

CO_2

Carbon Dioxide (R744)

GWP = 1

Natural refrigerant used in commercial refrigeration, heat pumps, and mobile AC. Near-zero climate impact.

NH_3

Ammonia (R717)

GWP = 0

Thermodynamically excellent, widely used in industrial refrigeration. Zero direct climate impact.

HC

Hydrocarbons (R290/R600a)

GWP ≈ 0.02

Propane and isobutane increasingly used in household appliances and small commercial systems.

HFO

HFOs (e.g. R1234yf)

GWP < 10

Synthetic low-GWP drop-in replacements for HFCs; used in mobile AC and some industrial applications.

Regulation (EU) 2024/573 — Latest Framework

01

Entered into force: March 2024

Replaces Regulation (EU) 517/2014 - the most comprehensive update to EU F-gas rules to date.

02

Full lifecycle coverage

Rules cover production, import, export, use, recovery, reclamation, and destruction of F-gases.

03

Strengthened phase-down

Tighter HFC quota reduction schedule through 2050; aligns with Kigali Amendment targets.

04

Sectoral bans

New prohibitions on use of high-GWP F-gases in sectors where alternatives are technically feasible.

05

Split AC ban from 2025

New residential split AC ≤12 kW must not contain F-gases, forcing transition to natural refrigerants.

06

Enforcement & reporting

Strengthened obligations for companies, registries, and national authorities; linked to Kigali data.

EU Market Transformation: Key Findings

📊 78% HFC Reduction

Consumption fell from the 2007 baseline by ~78% through 2024, the strongest regulatory result globally.

🏭 Industry Adaptation

Manufacturers shifted R&D toward low-GWP and natural alternatives; supply chains restructured accordingly.

💰 Price Signal Effect

Rising HFC prices due to quota scarcity incentivised early adoption of alternatives well ahead of deadlines.

🌱 Technology Pull

Growing availability of low-GWP refrigerants reduced barriers to adoption, creating a positive feedback loop.

🏢 Sector Differentials

Transition pace varied: commercial refrigeration led adoption; mobile AC and industrial lagged initially.

🎯 2050 Outlook

If current trajectory holds, F-gas emissions will be near negligible supporting EU climate neutrality goal.

Conclusions

1. EU F-gas regulations have achieved a significant, measurable reduction in fluorinated gas emissions: ~78% since 2007.
2. The gradual tightening of rules, from the 2006 directive through Regulation 2024/573, created a predictable market signal that drove technological change.
3. Regulatory measures proved effective at influencing technology development and encouraging alternative low-GWP and natural refrigerants.
4. The phase-down quota system created economic incentives (rising HFC prices) that accelerated industry transition beyond legal minimums.
5. If current regulatory trajectory is maintained alongside technological progress, the EU is on track to achieve its 2050 climate neutrality goals in the HVACR sector.
6. F-gas regulation stands as a model for how targeted environmental policy can transform an industrial sector within a decade.