HFOs IN THE PFAS RESTRICTION PROPOSAL

Honeywell

CONTEXT & AGENDA

Honeywell:

Supports reasonable, well-informed and coherent regulatory approaches contributing to uses of substances that are safer, better performing and key enablers of global climate & net zero ambitions.

Believes our products can be used safely and responsibly through:

A science-based approach considering all available physical, chemical, toxicological and environmental information

A coherent and integrated regulatory framework

A substance specific approach which avoids blanket bans with negative, unintended effects

Outcome of the F-Gas Regulation and leakage to PFAS

A discussion on the PFAS REACH restriction proposal – to share perspective/views

<u>We will cover</u>

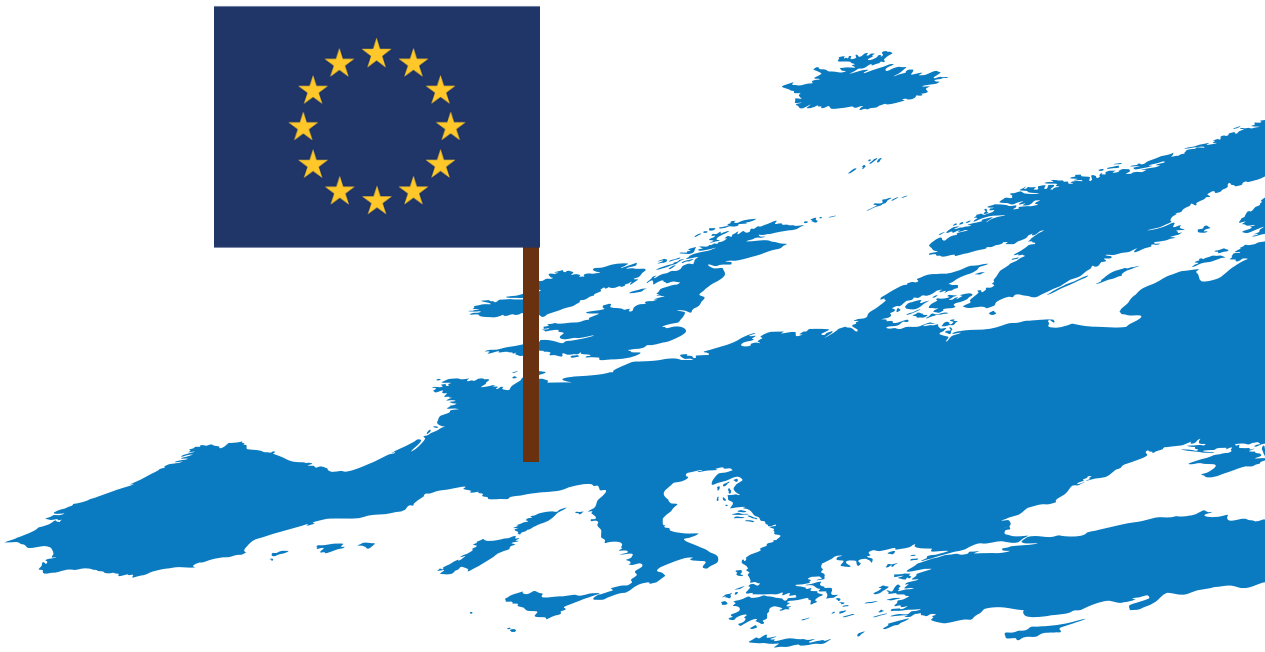
- The general approach on the restriction
- Approach specific to Fluorocarbon gases

Honeywell

HONEYWELL IN EUROPE

18 European countries
~200 sites
~20,000 employees
50 manufacturing sites
150 engineering sites

~825 sites
~103,000 employees
Charlotte, NC headquarters
NASDAQ listed
Fortune 100



IMPACT FROM RESTRICTION PROPOSAL:
Performance Materials and Technologies / Advanced Materials:

- Refrigerant, propellants and blowing agents (fluorocarbon gases) = Low GWP Solstice
- Packaging Films (using PCTFE fluoropolymer) = Aclar – pharma packaging

All Honeywell businesses: Materials containing PFAS above specified limits shall no longer be manufactured, used, or placed on the market either individually, or as a component of another substance (as a constituent), a mixture, or an article.

HONEYWELL AT A GLANCE

Honeywell
invents and commercializes technologies that address some of the world's most critical challenges, including climate change.

Aerospace Technologies (AT) 	**Used in virtually every commercial and defence aircraft platform worldwide, Honeywell aerospace products will continue to lead the future of air travel, including driving advanced air mobility and greater sustainability with the electrification of aircraft.**
Industrial Automation (IA) 	**Honeywell enables process industry operations, creates world-class sensor technologies, automates supply chains, makes warehouses smarter, and improves worker safety.**
Building Automation (BA) 	**Honeywell's hardware, software, sensors, and analytics helps customers convert buildings into integrated, safe, and more sustainable assets. Our solutions and services used in more than 10 million buildings worldwide**
Energy and Sustainability Solutions (ESS) 	**With a decades-long focus on sustainability, Honeywell enables the energy evolution, improves resiliency and efficiency, reduces emissions, and facilitates the circular economy. Honeywell's expertise in this area will continue helping solve the world's toughest challenges.**

HFO SOLUTIONS

DISTRICT HEATING

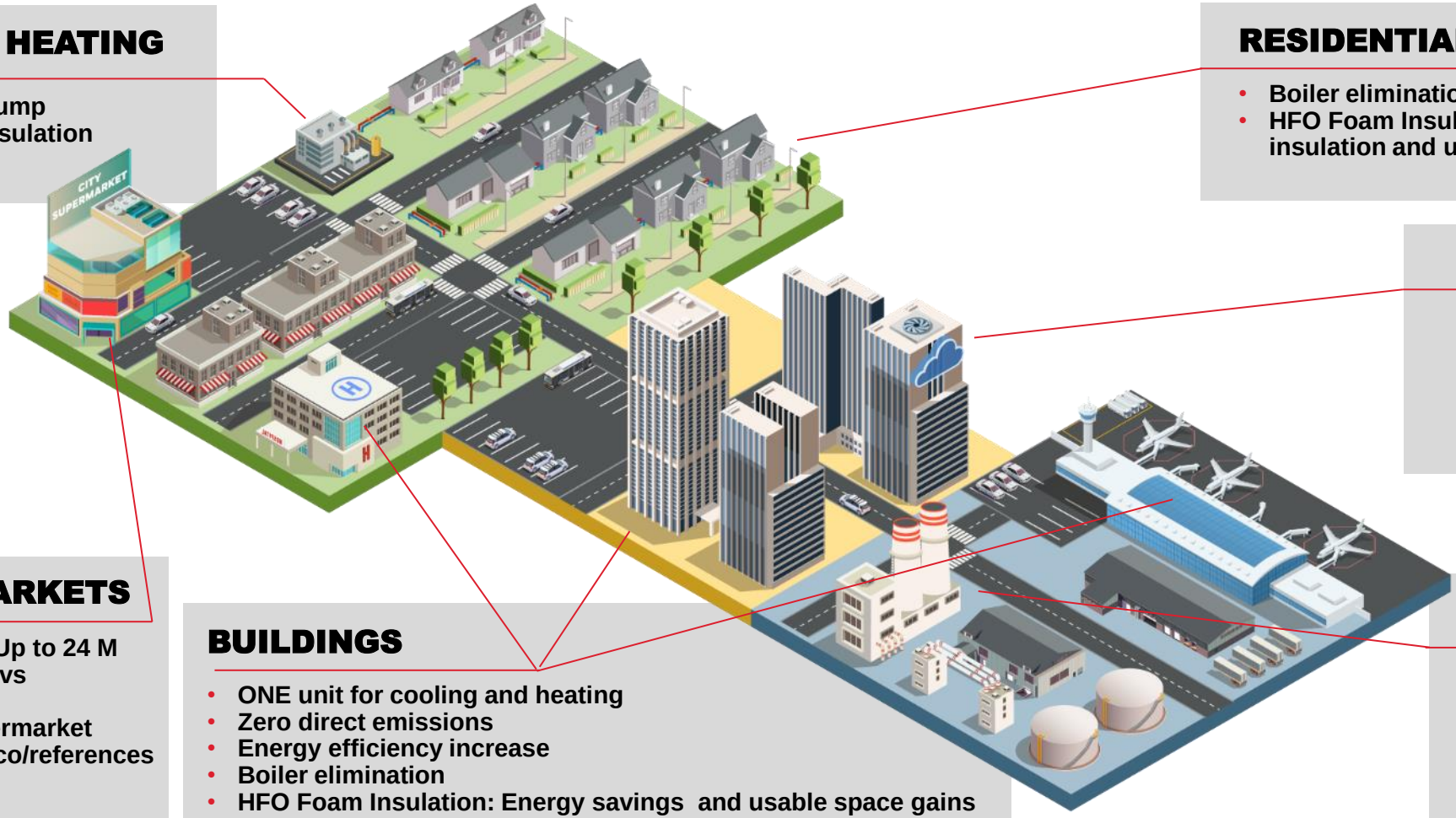
- HFO Heat pump
- HFO pipe insulation

RESIDENTIAL

- Boiler elimination: HFC/HFO Heat pumps
- HFO Foam Insulation: Best in class insulation and usable space gains

DATA CENTERS

- Cooling HFO Chiller (GWP < 1)
- Net zero data center with HFO Heat pump
- Air traffic control



SUPERMARKETS

- HFO cooling Up to 24 M tCO_2e saving vs alternatives
- Net zero supermarket
- Source: hwll.co/references

BUILDINGS

- ONE unit for cooling and heating
- Zero direct emissions
- Energy efficiency increase
- Boiler elimination
- HFO Foam Insulation: Energy savings and usable space gains
- Clean Heat: HFO Heat pump
- Cooling: HFO Chiller (GWP < 1)

INDUSTRIAL

- HFO Chiller displacing ammonia chiller in apple storage: up to 25% energy savings
- HFO Foam Insulation
- Clean Heat: HFO Heat pump
- Cooling: HFO Chiller (GWP < 1)

HFOs ARE DESIGNED TO…

Tackle climate change and play a critical role in the energy transition

HFOs have low global warming potential (<1) and are an important technology in the fight against climate change.

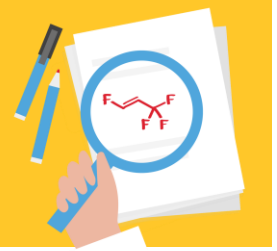
Their continued use is critical to achieve decarbonization goals.

- Support drive to urgent large-scale adoption of energy-efficient technologies such as heat pumps and electric vehicles - to ensure energy independence and decarbonize.
- HFOs provide lower energy consumption than alternatives in many systems. This ultimately leads to lower overall emissions.
- In commercial refrigeration, industrial refrigeration and chillers, the implementation of HFOs shows a 15-29 % improvement in energy efficiency compared to ammonia, propane, and CO2

For use in many critical applications across multiple industries worldwide

They will play a critical role in the roll-out of important transformational technologies

- Heat pumps in residential single home, multi-family habitation, commercial buildings, schools and hospitals
- Affordable EV roll out — helping to decarbonize
- Net zero emissions Data Centre
- District heating networks in densely urbanised areas
- Industrial processes decarbonisation via heat pumps
- Home and Building renovation



HFOs ARE DESIGNED TO…

Be safe, with no health and environmental impact

They are safe to use and install in their (approved) application

They are non-Persistent, Bioaccumulative or Toxic (PBT)

HFO decomposition to TFA - "de minimis" impact

Offer the most flexible and effective solutions compared to available alternatives

A critical technology enabling important industries to operate such as: The Food Chain Home and Building construction and renovation Mobility and transport infrastructure (EVs) | Healthcare and patient care

Offer superior environmental and energy performance versus available alternatives

- Superior environmental and energy performance versus available alternatives
- Better safety record and superior installation and servicing support

Provide solutions in markets where there are no or no suitable alternatives, including:

- Mobile Air Conditioning (MAC)
- Meter Dose Inhalers (MDI)
- Technical Aerosols
- Refrigerated trucks insulation
- Spray foam insulation in renovation and new builds
- Commercial building cooling and synergies with heating decarbonization
- District heating in densely urbanized areas

OVERVIEW:
F-GAS REGULATION OUTCOME

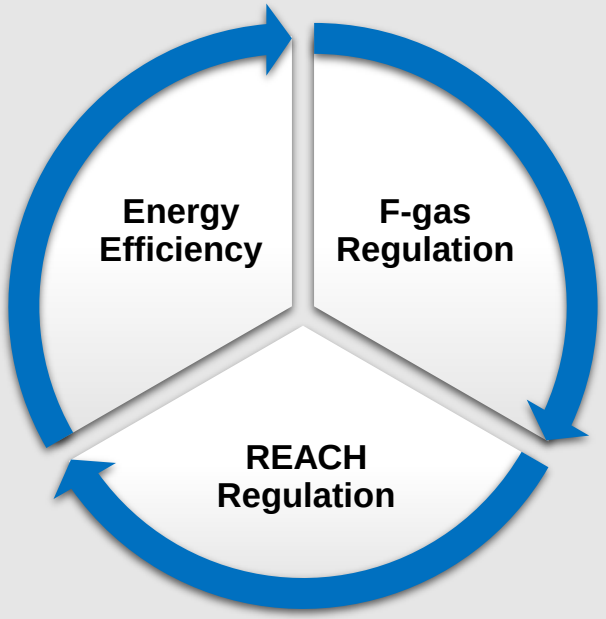
- The F-Gas Regulation covers the placing on the market and export of F-gases and equipment containing F-gases.
- **On 11 March 2024, the new F-Gas Regulation will enter into force** (current version No. 517/2014).
- At its core is containment (the prevention of emissions of all F-gases, including HFOs, from existing equipment) by requiring checks, proper servicing and recovery of the gases at the end of the equipment's life. The Regulation also sets specific targets to reduce the use of hydrofluorocarbons (HFCs) across Europe and to thereby contribute to decarbonization.
- **Due to a push from the European Parliament, the revised law introduces several full bans on placing products and equipment containing all F-gases (not only HFCs, but also HFOs)** on the market, including domestic refrigerators and freezer (from 2026), technical aerosols (from 2030), small chillers (from 2032), small heat pumps (self-contained from 2032, splits from 2035), and foams (from 2033).
- The Regulation contains several reviews, including a full assessment by 1 January 2030 of the impacts and effects of the regulation, and whether cost-effective, technically feasible and sufficiently available alternatives exist to replace F-gases.
- The first review will already have to take place by 1 July 2027, in order to assess the extension of scope to mobile air conditioning.

OVERLAP BETWEEN F-GASES & PFAS

U-PFAS REACH Restriction:
Proposal to restrict the use of PFAS including F-gases and equipment using fluoropolymers

Energy Efficiency-first Principle:
"*taking utmost account of cost-efficient energy efficiency measures in shaping energy policy and making relevant investment decisions.*"

So-called "natural refrigerants" cannot always guarantee the same level of:
- **safety**
- **energy efficiency**
- **affordability**

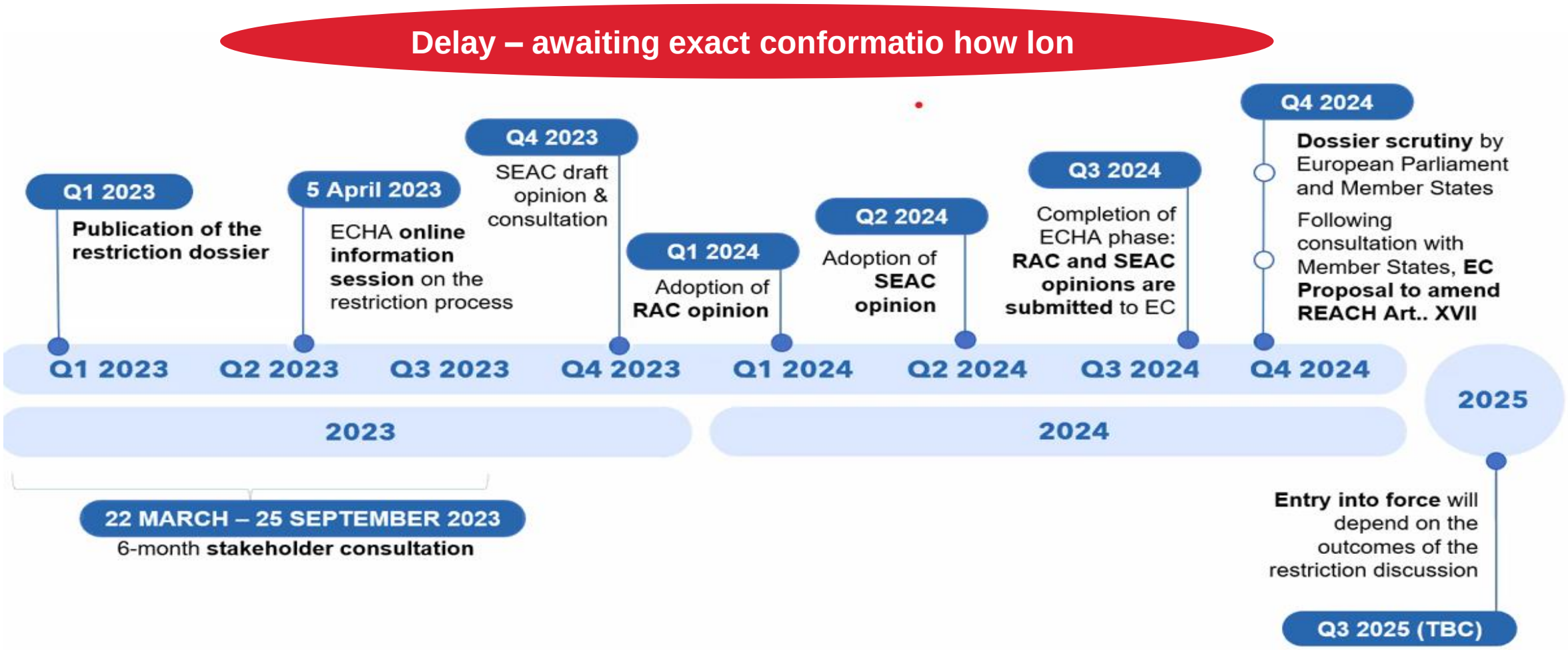


2024 F-gas Regulation:
Further pushes the HFC Phase Down and transitions towards HFOs and non-fluorinated alternatives

The first two F-gas Regulations (2006/2014) are considered to be very successful.

REACH Regulation:
HFOs, like any other chemical substance, are registered and comply with the requirements of the REACH regulation to ensure their safe use and minimize potential adverse impacts on health and the environment.

PFAS RESTRICTION TIMELINE



Expectation is that timeline will be 12 –18 months delayed

CONCERNS WITH THE GENERAL APPROACH

Unclear scope

does not specify the identity of PFAS substances in sufficient detail

Flaws in baseline assessment of hazard and risks

Insufficient information

- for an independent assessment of hazard,
- on specific uses PFAS and resulting emissions/exposure

Does not properly assess alternatives

No proper evaluation of effectiveness, enforceability, practicality and monitorability

(of the proposal or other options)

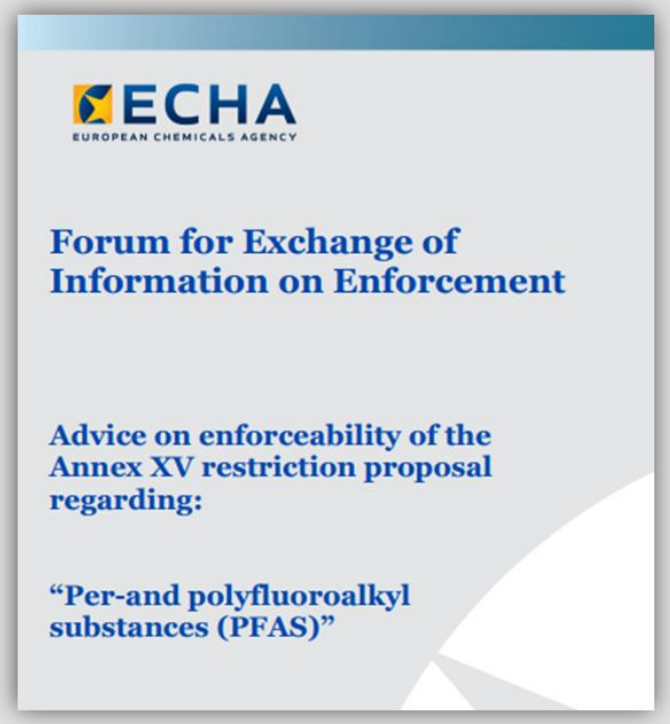
We consider failings on Methodology, Legal Principles and Scientific Rigor

ECHA - FORUM ON ENFORCEMENT OPINION

Opinion from November 2023

Main issues identified related to enforcement:

- Overall scope of the restriction:
  - Definition of PFAS (considered to be far too broad)
  - No reference to a list of substances or CAS numbers
  - Unclear what it applies to (e.g. substances, mixtures and articles)
- Overlap with existing legislation (including F-Gas Regulation)
- Unclear derogations
- Significant underestimation of enforcement costs
- Detailed guidance will be required



On F-gases specifically, the Forum points out that sampling them to determine whether they are PFAS or not is challenging, requiring specialized equipment and personnel

The Forum considers that the proposal in its current form will be challenging to enforce.

FLUOROCARBON GASES (HFC/HFO)

USE

Fluorocarbon gases used in refrigerants, industrial solvents, blowing agents and aerosol propellants (medical & technical)

A SUSTAINABLE CHOICE

- Full choice of needed to achieve the EU Net Zero Goals / Energy Efficiency
- Low-GWP HFOs engineered to deliver unique climate and energy efficiency benefits

RISK / HAZARD WELL UNDERSTOOD

Fluorocarbon gases are used largely in closed systems and are not persistent, not bioaccumulative, nor toxic

ASK

- Fluorocarbon gases should be out of scope of the future restriction given unique characteristics and their uses
- **Fluorocarbon gases are already regulated and phased-down under the F-gas Regulation and MAC Directive. Double regulation should be avoided**

UNINTENDED CONSEQUENCES

1. Jeopardize energy efficiency and decarbonisation
2. Obsolescence of existing systems
3. Safety constrains of alternatives and their performance
4. Expected socioeconomic cost is disproportionate to risk
5. End of high-performing systems in key sectors
6. EU competitiveness and jobs

HFC, and low-GWP HFO's in particular, critical to Climate Change & Energy Efficiency

HFC/HFO - BREAKDOWN PRODUCT - TFA

- **Trifluoroacetic acid (TFA) is formed in the atmospheric degradation processes for some HFCs and HFOs fluorinated gases**. (HFO-1234yf - 100%, 1234ze, 1233zd - ≤ 2%).
- **This results in small increases in overall TFA concentrations by comparison with pre-existing TFA levels.** These concentrations remain below scientifically established DNEL/PNEC levels and/or food intake or water quality standards for TFA.
- **Under TFA's REACH registration** this substance does not fulfil the criteria for a Persistent, Bio-accumulative and Toxic (PBT) or very Persistent and very Bio-accumulative (vPvB) substance. Nor does it raise equivalent levels of concern as a PBT or vPvB.

New studies

- **An environmental fate and distribution modelling of TFA** in the freshwater aquatic environment conducted based on the assumption of constant and ongoing HFO emissions.
  - **Within a short timeframe (months) a steady-state concentration of TFA is reached in rivers**, with no further increase over time.
- **NAM ToxProfiler** human cells assay (C2-C10 PFAS) demonstrates **NO toxicological activity or potency for PFAS with carbon chain length < C4**

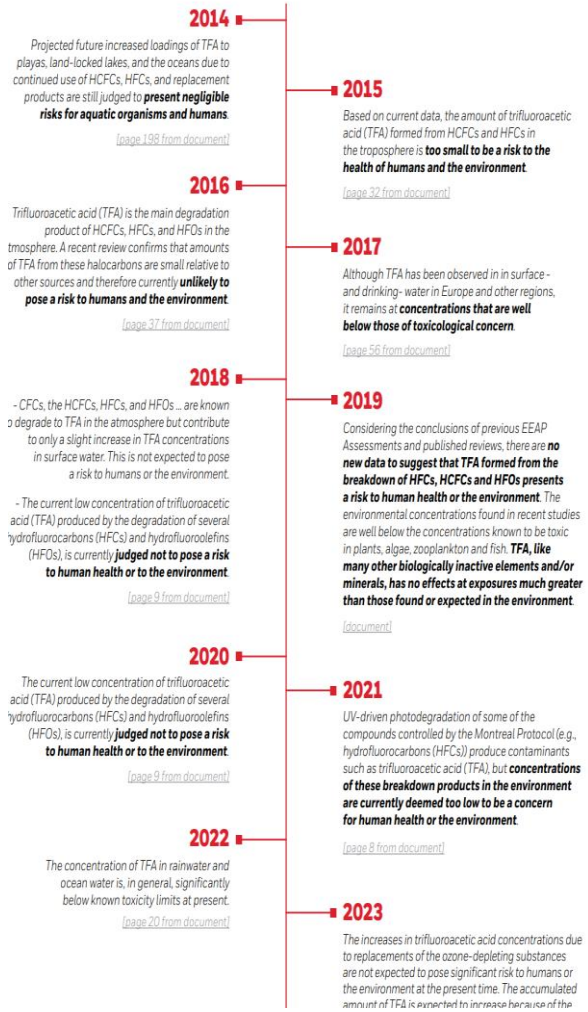
In line with the provisions of Articles 68 and 69 REACH: **fluorinated gases as well as TFA must be excluded from the scope of the proposed restriction of PFAS.**

HFC/HFO are not persistent; short-chain PFAS, incl. TFA, are non-issue

HFC/HFO - BREAKDOWN PRODUCT - TFA

UNEP Environmental Effects Assessment Panel (EEAP) provides regular comment on TFA. The latest report (April 2023) states:

- "based on projected future use of these precursors of TFA [incl. HFC/HFO], no harm is anticipated" and that TFA "is unlikely to cause adverse effects out to 2100"
- "TFA has biological properties that differ significantly from the longer chain polyfluoroalkyl substances (PFAS) and inclusion of TFA in this larger group of chemicals for regulation would be inconsistent with the risk assessment of TFA"
- "all PFAS should not be grouped together, persistence alone is not sufficient for grouping PFAS for the purposes of assessing human health risk, and that the definition of appropriate subgroups can only be defined on a case-by-case manner"
- "it is inappropriate to assume equal toxicity/potency across the diverse class of PFAS"



2014

Projected future increased loadings of TFA to playas, land-locked lakes, and the oceans due to continued use of HCFCs, HFCs, and replacement products are still judged to **present negligible risks for aquatic organisms and humans**.

[page 198 from document]

2015

Based on current data, the amount of trifluoroacetic acid (TFA) formed from HCFCs and HFCs in the troposphere is **too small to be a risk to the health of humans and the environment**.

[page 32 from document]

2016

Trifluoroacetic acid (TFA) is the main degradation product of HCFCs, HFCs, and HFOs in the tmosphere. A recent review confirms that amounts of TFA from these halocarbons are small relative to other sources and therefore currently **unlikely to pose a risk to humans and the environment**.

[page 37 from document]

2017

Although TFA has been observed in in surface - and drinking- water in Europe and other regions, it remains at **concentrations that are well below those of toxicological concern**.

[page 56 from document]

2018

- CFCs, the HCFCs, HFCs, and HFOs ... are known o degrade to TFA in the atmosphere but contribute to only a slight increase in TFA concentrations in surface water. This is not expected to pose a risk to humans or the environment.

- The current low concentration of trifluoroacetic acid (TFA) produced by the degradation of several ydrofluorocarbons (HFCs) and hydrofluoroolefins (HFOs), is currently **judged not to pose a risk to human health or to the environment**.

[page 9 from document]

2019

Considering the conclusions of previous EEAP Assessments and published reviews, there are **no new data to suggest that TFA formed from the breakdown of HFCs, HCFCs and HFOs presents a risk to human health or the environment**. The environmental concentrations found in recent studies are well below the concentrations known to be toxic in plants, algae, zooplankton and fish. **TFA, like many other biologically inactive elements and/or minerals, has no effects at exposures much greater than those found or expected in the environment**.

[document]

2020

The current low concentration of trifluoroacetic acid (TFA) produced by the degradation of several ydrofluorocarbons (HFCs) and hydrofluoroolefins (HFOs), is currently **judged not to pose a risk to human health or to the environment**.

[page 9 from document]

2021

UV-driven photodegradation of some of the compounds controlled by the Montreal Protocol (e.g., hydrofluorocarbons (HFCs)) produce contaminants such as trifluoroacetic acid (TFA), but **concentrations of these breakdown products in the environment are currently deemed too low to be a concern for human health or the environment**.

[page 8 from document]

2022

The concentration of TFA in rainwater and ocean water is, in general, significantly below known toxicity limits at present.

[page 20 from document]

2023

The increases in trifluoroacetic acid concentrations due to replacements of the ozone-depleting substances are not expected to pose significant risk to humans or the environment at the present time. The accumulated amount of TFA is expected to increase because of the

HFO ALTERNATIVES OVERVIEW – NO ONE SOLUTION

Ammonia, CO2, and hydrocarbons are not universally viable substitutes because of their hazard and exposure characteristics.

Ammonia, CO2 and hydrocarbons environmental watch points:

- **Derivatives from fossil fuel processing**
- **Lower performance in warm climates**
- **Impact on air quality**
- **Dangerous waste**

Ammonia, CO2 and hydrocarbons safety concerns:

- **Flammability**
- **Toxicity**
- **Anesthetic / asphyxiating effects**
- **High operating pressure**
- **Air pollution**

Specifically for MAC: CO2 has significantly higher equipment, use / servicing costs and reliability, comfort concerns

A wide ban of fluorocarbon gases would mean that many large vehicles, infrastructure projects and appliances could not be reequipped (lifetime 15-40 years)

QUESTIONS

Honeywell

BACK UP SLIDES

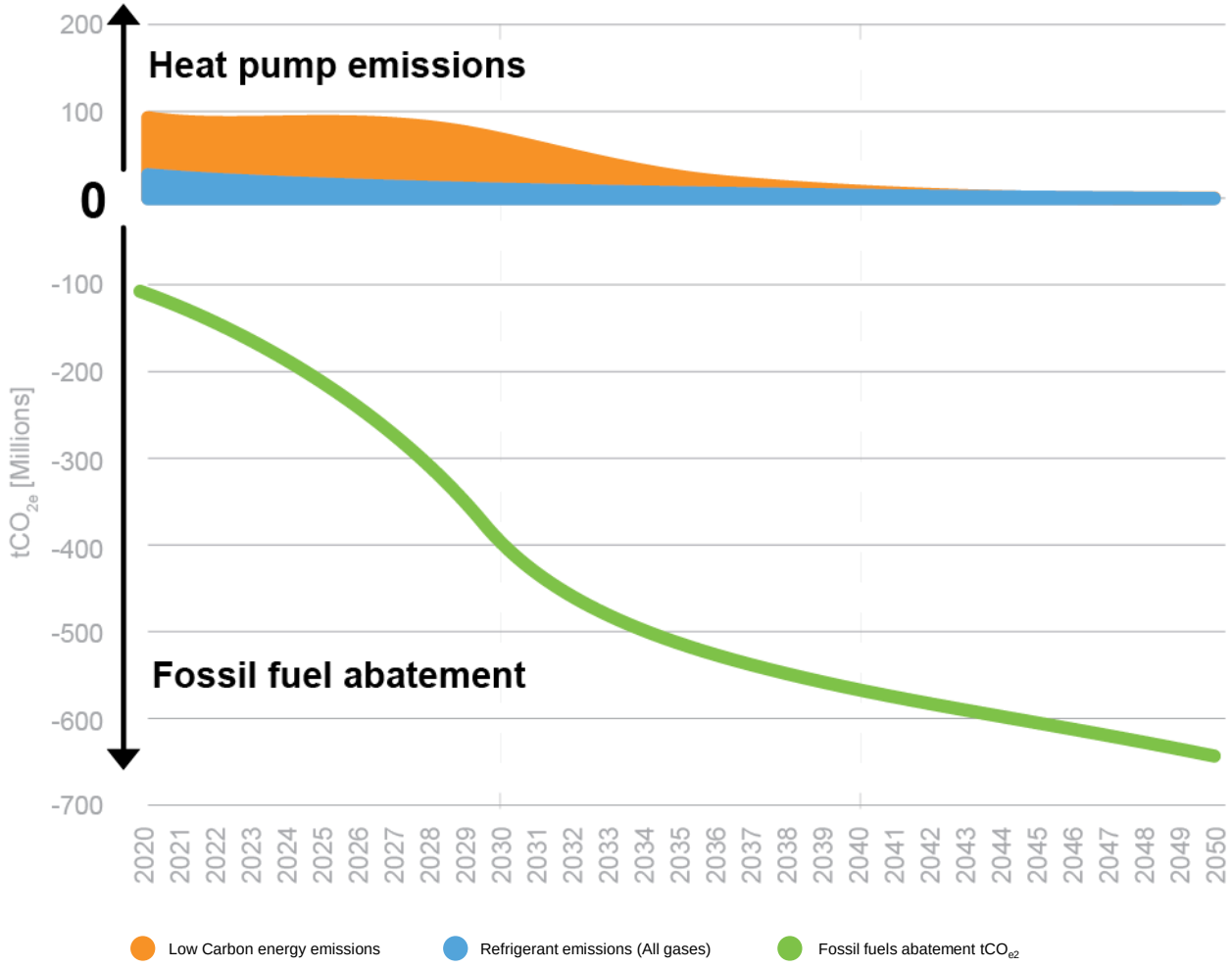
THE HEATING DECARBONISATION PRIZE IS MASSIVE
MAXIMISING HEAT PUMP ROLL-OUT IS CRITICAL

Refrigerant and energy-related emissions from heat pump stock is negligible compared to fossil-fuel emissions avoided.

Slowing heat pump roll-out will significantly increase GHG emissions

EPEE ASSUMPTIONS

- Rapidly growing heat pump stock (RePower EU)
- Range of different lower GWP refrigerants used



For more ambitious emission reductions, Look beyond the FGAS regulation

HONEYWELL'S 15 ECHA SUBMISSIONS

GENERAL SUBMISSIONS

1. General Legal Comment
2. Trifluoroacetic acid (TFA)

DS USER SUBMISSIONS

1. SPS- electrochemical sensors
2. SPS- gas detectors
3. AERO- fluoropolymers in aerospace and defence applications
4. HBT- fluoropolymers in commercial building controllers and security devices/ applications

APPLICATION SUBMISSIONS

1. PCTFE in medical packaging
2. Mobile Air conditioning and TMS
3. Meter dosed inhalers (pMDIs)
4. Refrigeration /HVAC
5. Foams
6. Heating (heat pumps/ district heating)
7. Technical aerosols

THIRD PARTY COMMISSIONED STUDIES

1. Ramboll – proves safe, steady state concentration of TFA, over time in the Rhine basin
2. Toxys - short-chain polyfluorinated comp ounds such as TFA do no exhibit toxicological activity and differ from the longer-chain polyfluoroalkyl substances (PFAS).

Most submission are available here: **https://advancedmaterials.honeywell.com/be/en/honeywell-echa-reach-submissions**

HAPPY TO SHARE FULL SUBMISSIONS AND/OR SUMMARIES IF OF INTEREST

FLUOROPOLYMER (PCTFE)

Used as a non-contact layer in prescription and over-the-counter (OTC) pharmaceutical packaging, as well as medical device packaging applications

PCTFE is imported as a finished film for the above applications and is marketed under the trademark Aclar©.

Indispensable for delivery and preservation of safe pharmaceuticals

No risk to human health or the environment at any point during its life cycle- classified as a polymer of low concern

Already comprehensively regulated – EMA, WHO, European Pharmacopoeia…..

If banned,risk of a interruption of supply to thousands of medicines affecting the lives of patients across the EU

No viable alternatives

SHOULD BE OUT OF SCOPE DUE TO UNIQUE FUNCTIONALITIES AND LOW RISK PROFILE

PCTFE ALTERNATIVES OVERVIEW – NO ONE SOLUTION

There are no alternatives for PCTFE based medicines/pharmaceutical packaging due to superior characteristics (stability, inertness, moisture barrier, transparent, volume & weight)

Other materials will inevitably deteriorate and impact the stability of pharmaceuticals, increase packaging sizes, and exhibiting dangerous features, e.g., PVC/PVDC15 polymers.

PCTFE also improves patient/drug adherence due to the transparency and clarity of blister packaging.

RESPONSE TO THE PROPOSAL – PCTFE

Grouping PCTFE with all other PFAS for reach read-across and restriction processes purposes is scientifically unjustified

Emissions over full life cycle already managed for PCTFE

Emissions of PCTFE are not an unacceptable risk

Regulation on top of existing legislative framework is excessive for PCTFE

The costs for society and the impact of the restriction on the EU green deal outweigh the alleged risks.

PCTFE SHOULD MADE SUBJECT TO AN UNLIMITED DEROGATION, SIMILAR TO THOSE GRANTED TO ACTIVE SUBSTANCES IN BIOCIDAL, PLANT PROTECTION, OR MEDICINAL PRODUCTS ALREADY INCLUDED IN THE PROPOSAL.

WHAT IS IN THE PROPOSAL

Expected

1. Definition as per OECD
2. Very Persistent prime criteria
3. Grouping
4. General ban unless specific derogations (18-moths transition period upon Entry into Force)
5. Covers manufacture, use or placing on the market (import) as substances on their own
6. Derogations
7. End user sector impact extensive (heating & cooling, textiles, shipping, aviation, construction, food processing, medical articles/packaging)

Other

1. Covers “theoretical” substances and PFAS as a constituent (intentionally added) in a mixture, or in an article
2. Concentrations thresholds: 25 ppb (individual substances), 250 ppb (sum), 50 ppm (e.g., fluoropolymers)
3. 40+ derogations – based on unclear reasoning and evidence
4. 5- or 12-years derogations for specific uses/applications and 3 time-unlimited derogations for exceptional cases
5. Potential derogation for reconsideration

DEROGATIONS PROPOSED

Relevant proposed Derogations:

- **refrigerants in low temperature refrigeration below -50°C - 6.5 years**
- **refrigerants in laboratory test and measurement equipment - 13.5 years**
- **refrigerants in refrigerated centrifuges - 13.5 years**
- **maintenance and refilling of existing HVACR equipment put on the market before [18 months after EiF] and for which no drop-in alternative exist - 13.5 years**
- **refrigerants in HVACR-equipment in buildings where national safety standards and building codes prohibit the use of alternatives – time unlimited**
- **refrigerants in mobile air conditioning-systems (MAC) in combustion engine vehicles with mechanical compressors - 6.5 years**
- **refrigerants in transport refrigeration other than in marine applications - 6.5 years**

Potential Derogations for reconsideration after public consultation:

- **foam blowing agents in expanded foam sprayed on site for building insulation - 6.5 years**
- **refrigerants and for mobile air conditioning in vehicles in military applications - 13.5 years**
- **PCTFE-based packaging for medicinal preparations, medical devices and medical molecular diagnostics - 13.5 years**

BASED ON UNCLEAR REASONING AND EVIDENCE & CONTRARY TO FGR