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Driving the change for the
FUTURE
of HVAC & Pumping machines

Future Refrigerants: situation in the EU

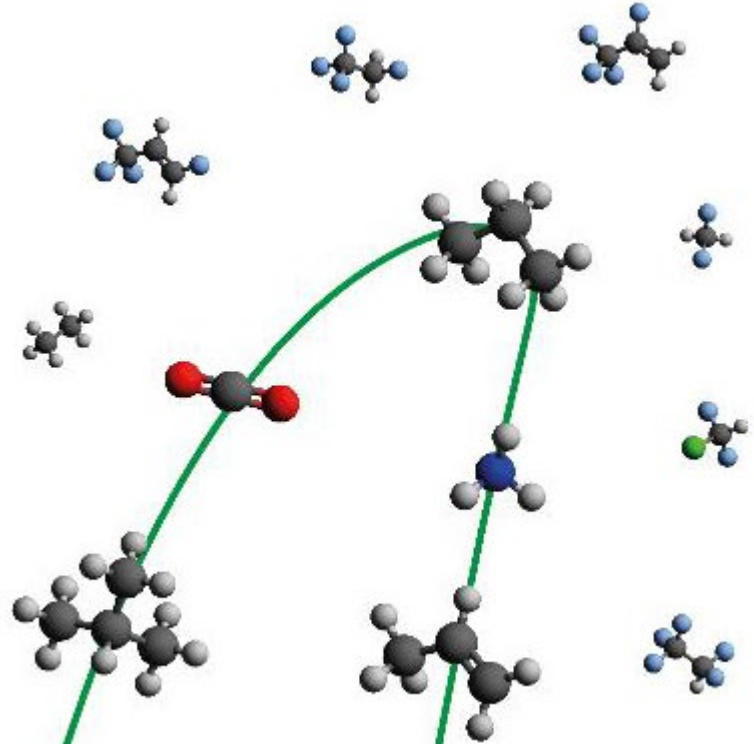
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Content

- Look for long term available refrigerants
- EU F-Gas Regulation
- PFAS restriction under REACH
- Regulations outside the EU
→ Present situation in US
- What can be the path?



Long term available refrigerants

Horizon of 12 to 15 years and more

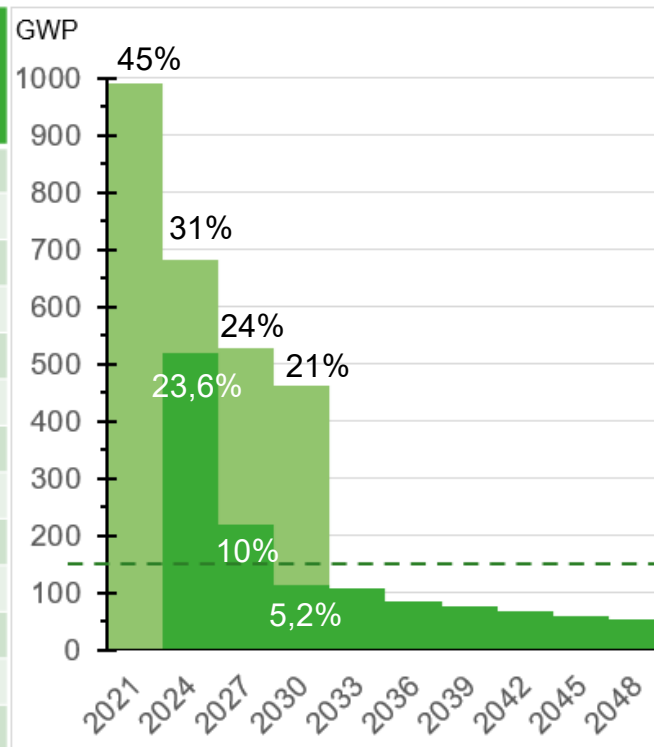
- Refrigerants that shall be available in large amounts for widely used applications will have to fit into a sustainable economic system and have an environmental impact as low as possible
 - ODP = 0, GWP as low as possible (GWP<10)
 - High energy efficiency
 - Very low to no amount of breakdown products harmful to environment
 - Very low production effort and production waste generation (see  Refrigerant Report)
- So, what is left?
 - Naturally appearing substances, so called natural refrigerants
 - R744 (carbon dioxide), R290, R1270, R600a etc.(hydrocarbons), R717 (ammonia), R718 (water), R729 (air), ...
 - Maybe a few other low GWP refrigerants (HFOs, ...)

Revision of EU F-gas regulation

Proposal of April, 2022

- Main tool: stricter phase-down
 - 2024 – 23.6 %
 - 2030 – 5.2 %
 - 2048 – 2.4 %
- Result of model calculation:
Presumably in 2027, latest in 2030
all available HFCs will be needed
for service of existing units
- European Parliament proposes
F-gas phase out for AC, R and
HP until 2050
- Secondary tools: application bans
 - Still discussed in EU dialogues
next dialogue: October 5th

year	% 517/ 2014	Avg GWP 517/ 2014	% Rev. prop.	Avg GWP prop.
2015	100	2200		
2016	93	2046		
2018	63	1386		
2021	45	990		
2024	31	682	23,6	519
2027	24	528	10	220
2030	21	462	5,2	114
2033			4,8	106
2036			3,8	84
2039			3,5	77
2042			3,1	68
2045			2,7	59
2048			2,4	53



Selected bans for refrigeration, AC and HPs

In revision Commission proposal of April 2022

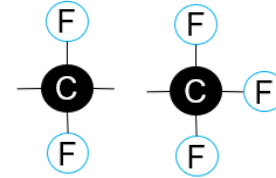
Year	Application	Ban mat + GWP
2024	Commercial refrigerators and freezers	FGG >150
2024	Stationary refrigeration equipment, excl. product storage temperatures <-50°C	FGG >2500
2025	Any self-contained refrigeration equipment	FGG >150
2025	Plug in room air conditioners and heat pumps	FGG >150
2025	Single split AC and HP up to 3 kg charge	FGG >750
2027	Split systems <=12 kW AC + HP, except when required to meet safety standards	FGG >150
2027	Split systems >12 kW AC + HP, except when required to meet safety standards	FGG >750
2030	Service with recycled material	FGG >2500
From validity	Recovered refrigerant without recycling or reclaim	

FGG: fluorinated greenhouse gases

PFAS under REACH– What is it about?

Restriction on PFAS (per- and polyfluorinated alkyl compounds)

- 2021-07-15: RoI - Registration of Intend under REACH Regulation
 - Defines compounds with at least one CF_2 -group or CF_3 -endgroup as potentially dangerous for health or environment
 - Approx. 4000 to 15000 substances
- 2023-04 publication of complete report (PFAS Dossier)
 - Detailed assessments per substance/small substance group
- 2023-05 until 2023-09: Possibility for statements of stakeholders
 - response input by individual companies and associations
- 2023-09 ECHA committees on impact on environment, economy and society
- 2025-... coming possibly into force: control measures, bans, restrictions ...



Outside PFAS
definition:
R32, R152a, ...

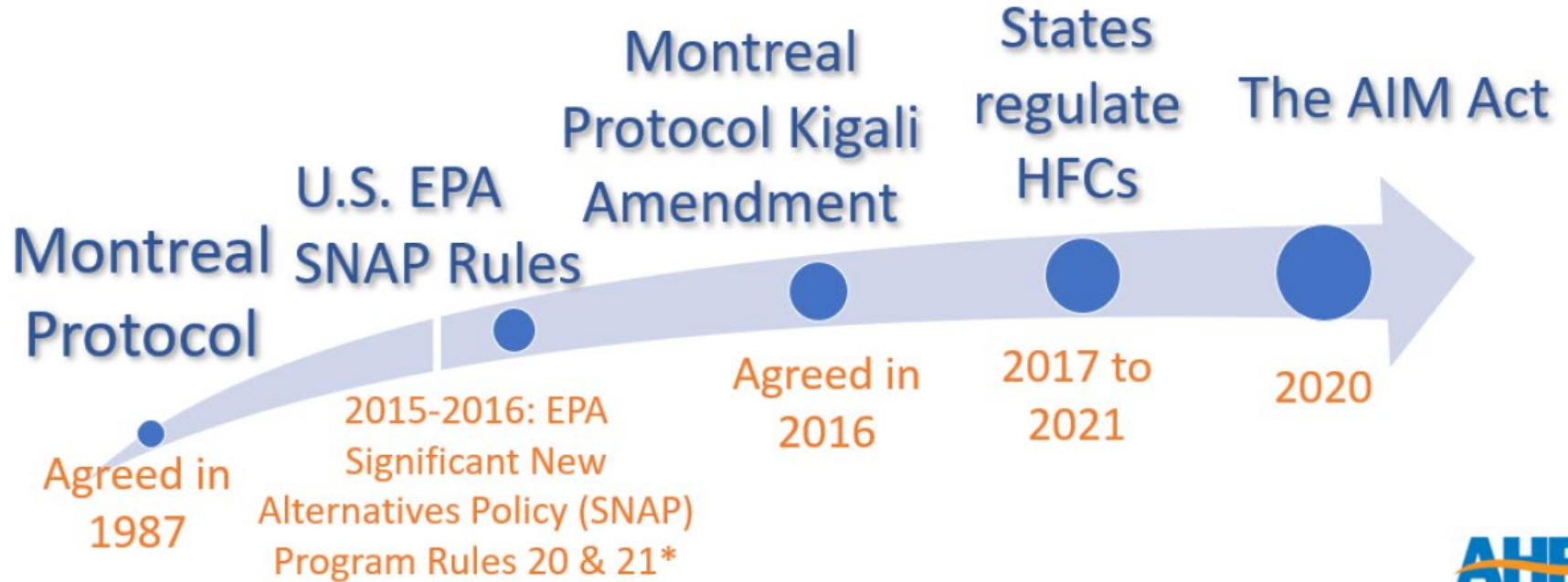
Examples for PFAS containing products

- Fluorinated gases, like refrigerants
- Low friction and emergency lubrication coating in bearings
- Fluoropolymers for gaskets, vibration damper, bearing bushes
- Electrical insulation for high temperature
- Additives in motor oil, hydraulics oil
- Non-stick coating in cookware, one-way food packaging
- Breathing membranes in outdoor wear
- Textile production, impregnation for outdoor wear, personal protective equipment, ...
- Dirt, oil, water repelling coating
- Low friction coating für fibres/threads, easy ironing prep
- Leather surface protection
- Cosmetics additives



Fluorocarbon transitions in the US

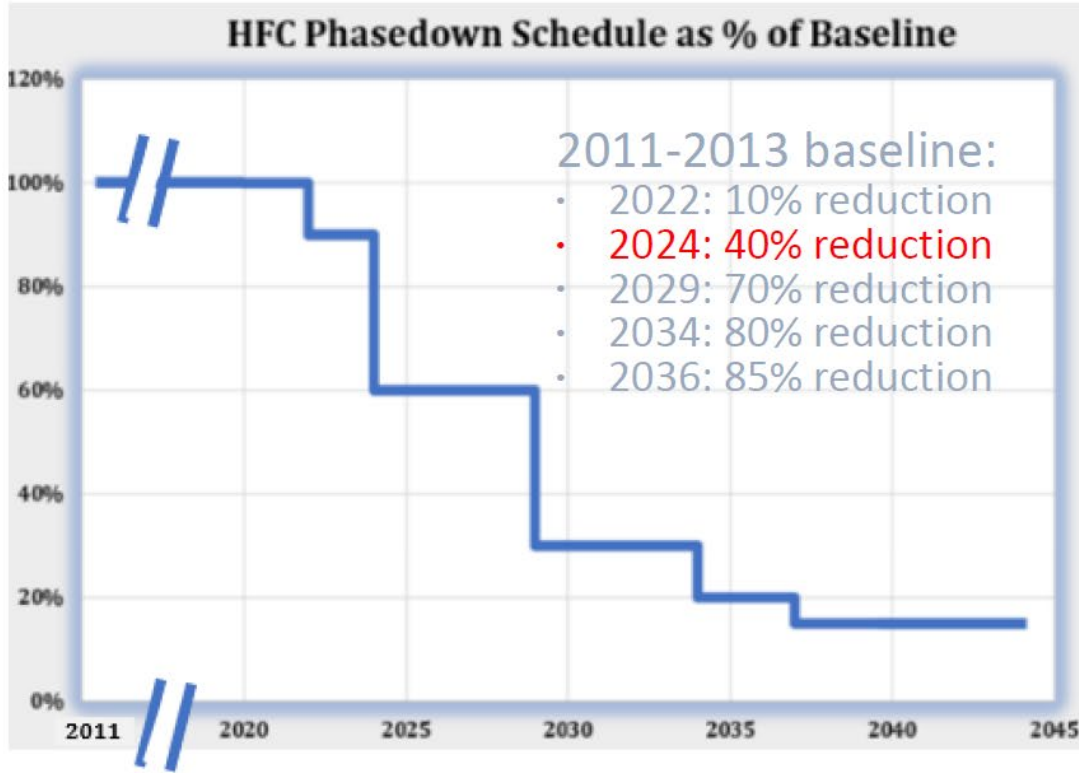
The American Innovation and Manufacturing Act (AIM)



*SNAP rules 20 & 21 were remanded back to EPA by DC Circuit Court (2017/2018)



AIM Act – HFC phase-down in US



- Mandates phase-down of HFC supply
 - Environmental Protection Agency (EPA) regulation Oct 1, 2021
- Authorizes sector transitions
- Refrigerant management, including recovery and reclaim



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Application bans base on GWP thresholds in the US

Refrigeration Equipment (Proposed Compliance Date 1/1/25)		GWP	
Industrial Process Refrigeration	Systems with refrigerant charge capacities of 200 pounds or greater	150	
	Systems with refrigerant charge capacities less than 200 pounds	300	
	High temperature side of cascade systems	300	
	Chillers	700	
Retail Food Refrigeration	Stand-alone units	150	
	Refrigerated food processing and dispensing equipment	150	
	Supermarket systems with refrigerant charge capacities of 200 pounds or greater	150	
	Supermarket systems with refrigerant charge capacities less than 200 pounds charge	300	
	Supermarket systems, high temperature side of cascade system	300	
	Remote condensing units with refrigerant charge capacities of 200 pounds or greater	150	
	Remote condensing units with refrigerant charge capacities less than 200 pounds	300	
	Remote condensing units, high temperature side of cascade system	300	
Vending machines	150		
Cold Storage Warehouse	Systems with refrigerant charge capacities of 200 pounds or greater	150	
	Systems with refrigerant charge capacities less than 200 pounds	300	
	High temperature side of cascade system	300	
	Ice rinks	150	
	Automatic commercial ice machines – selfcontained with refrigerant charge capacities of 500 grams or lower (Note: Does not align with petition)	150	
	Transport refrigeration – intermodal containers	700	
	Residential refrigeration	150	
Comfort Cooling		GWP	Date
Chillers – comfort cooling		700	1/1/2025
Residential and light commercial air conditioning and heat pump systems		700	1/1/2025
Residential dehumidifiers		700	1/1/2025
Residential and light commercial air conditioning – variable refrigerant flow systems		700	1/1/2026

What can be the future path? → present insights

- Existing systems: convert to refrigerants with lowest possible GWP
 - F-gases will be allowed for service and repair → but won't be available for new units
 - even for service the available amounts might be limited
- New systems:
 - where ever possible
 - use natural refrigerants like carbon dioxide (R744), hydrocarbons (R290, R1270, R600a...) ammonia (R717)...
 - where not possible
 - use A2L refrigerants with GWP as low as possible (recommended: GWP < 10, at least < 150)
 - A2L and A3 have same pressure equipment categories
 - development of safety standards might later allow A3 refrigerants like R290 (propane) instead of A2L
 - reduction of refrigerant charge per unit
 - improvement of system tightness

Example: Possible low GWP substitutes for R404A

Refrigerant	Components	ODP	GWP			Safety Class	Boil. Temp.	Dew Temp.	Temp.-Glide	crit. Temp.	crit. Press.
			AR4	AR5	AR6						
						°C	°C	K	°C	bar	
R290	propane	0	3	3	0,02	A3	-42,1	-42,1	0	97	42,5
R1270	propylene / propene	0	2	2		A3	-47,6	-47,6	0	91	45,6
R717	ammonia	0	0	0		B2L	-33,4	-33,4	0	132	113
R744	carbon dioxide	0	1	1	1	A1	-78,3	-78,3	0	31	73,8
R443A	R1270/ 290/ 600a	0	4	4		A3	-45,2	-42,1	3,1	96,0	44,9
R454C	R32/ 1234yf	0	148	146	166	A2L	-45,6	-37,8	7,8	86	43,2
R455A	R32/ 1234yf/ 744	0	148	146	166	A2L	-52,0	-39,2	12,8	86	46,5
R457A	R32/ 1234yf/ 152a	0	139	139		A2L	-42,6	-35,5	7,1	90	43,1
R457C	R32/ 1234yf/ 152a	0	72	72	82	A2L	-37,3	-32,1	5,2	94,1	39,6
R459B	R32/ 1234yf/ 1234ze(E)	0	144	143		A2L	-45,0	-36,7	8,3	87	43,6
R465A	R32/ 1234yf/ 290	0	145	143	162	A2	-51,7	-40,0	11,7	82	43,4

Example: Possible low GWP substitutes for R410A

Refrigerant	Components	ODP		GWP		Safety Class	Boil. Temp.	Dew Temp.	Temp.-Glide	crit. Temp.	crit. Press.
			AR4	AR5	AR6		°C	°C	K	°C	bar
R468B	R32/ 1234yf/ 1132a	0			101	A2L	-52,4	-36,8	15,6	85	42,5

Further information, available refrigerants, ...

For example: Digital BITZER Refrigerant Report (bitzer-refrigerantreport.com)

- Available online
- Tables for specific replacement tasks
 - Containing more than 130 refrigerants
 - Tables with filters
- Additional background information
 - EU F-Gas Regulation
 - REACH PFAS process
 - Montreal Protocol, Kigali Amendment
 - ...
- Many links to more information



A screenshot of the Bitzer Refrigerant Report website. The top right features the Bitzer logo in a green diamond shape. Below it, the text 'Home' is visible. The main content area is titled 'A-500, A-501 Refrigerant Report Online Edition'. The page is decorated with several 3D ball-and-stick molecular models of various refrigerant molecules. On the left side of the screenshot, a navigation menu lists several topics: 'Home', 'What are refrigerants?', 'What is new in the Refrigerant Report?' (with sub-items: 'Choosing the refrigerant', 'Refrigerant selection tables', 'Methods for comparison of refrigerants', 'What's new on refrigerants?'), 'Long-term available refrigerants', 'Regulations and other legal provisions', 'Emissions', 'Reports of the IPCC', and 'Refrigerant Report 21'. At the bottom right of the screenshot, the Schneider Electric logo and the slogan 'Life Is On' are displayed.

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Thank you!