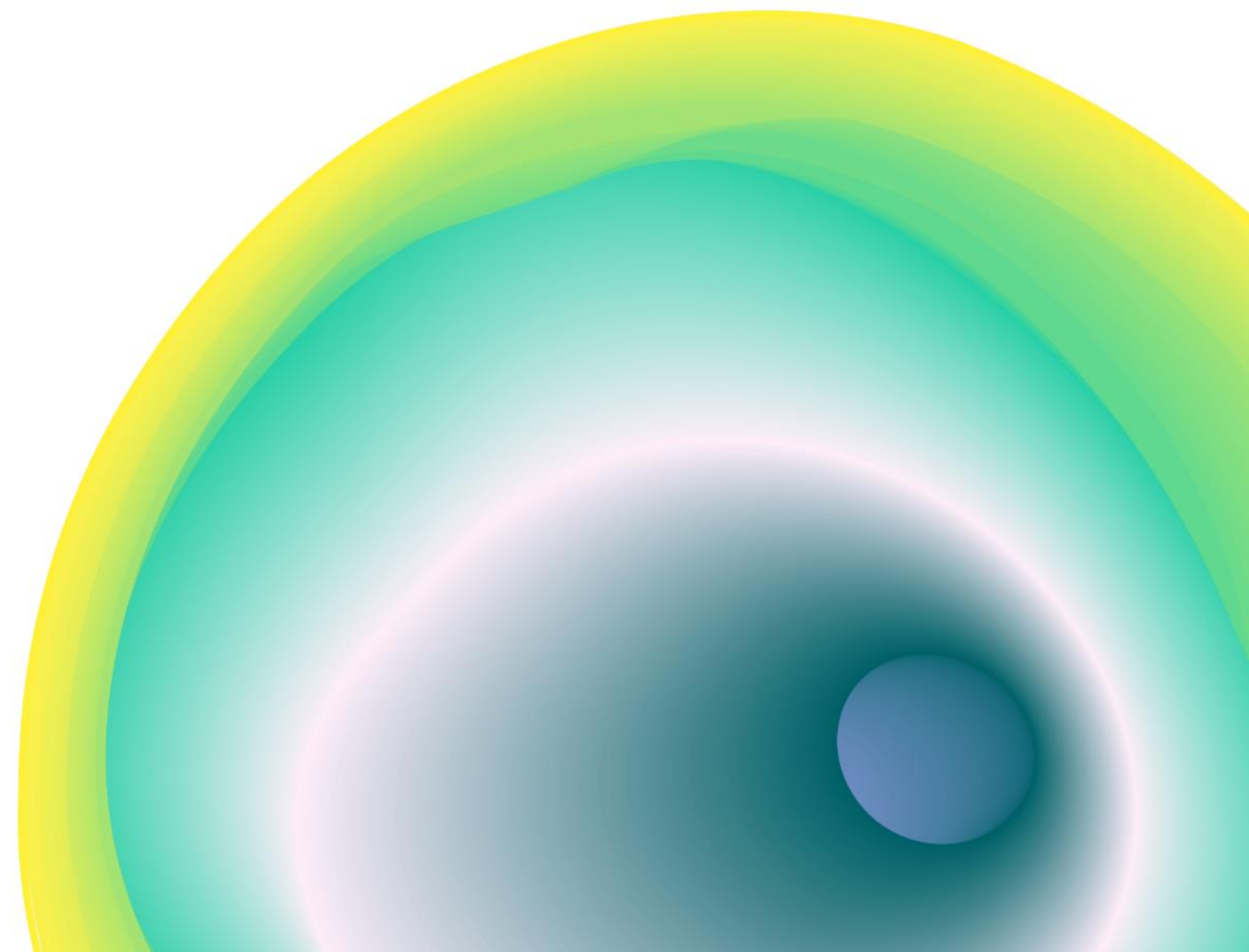


Persistence of PFAS and F-gases

Heating and cooling systems



Leapfrogging to Natural Refrigerants - avoiding GWP, PFAS and TFA

Philipp Denzinger, Project Manager, GIZ Proklima

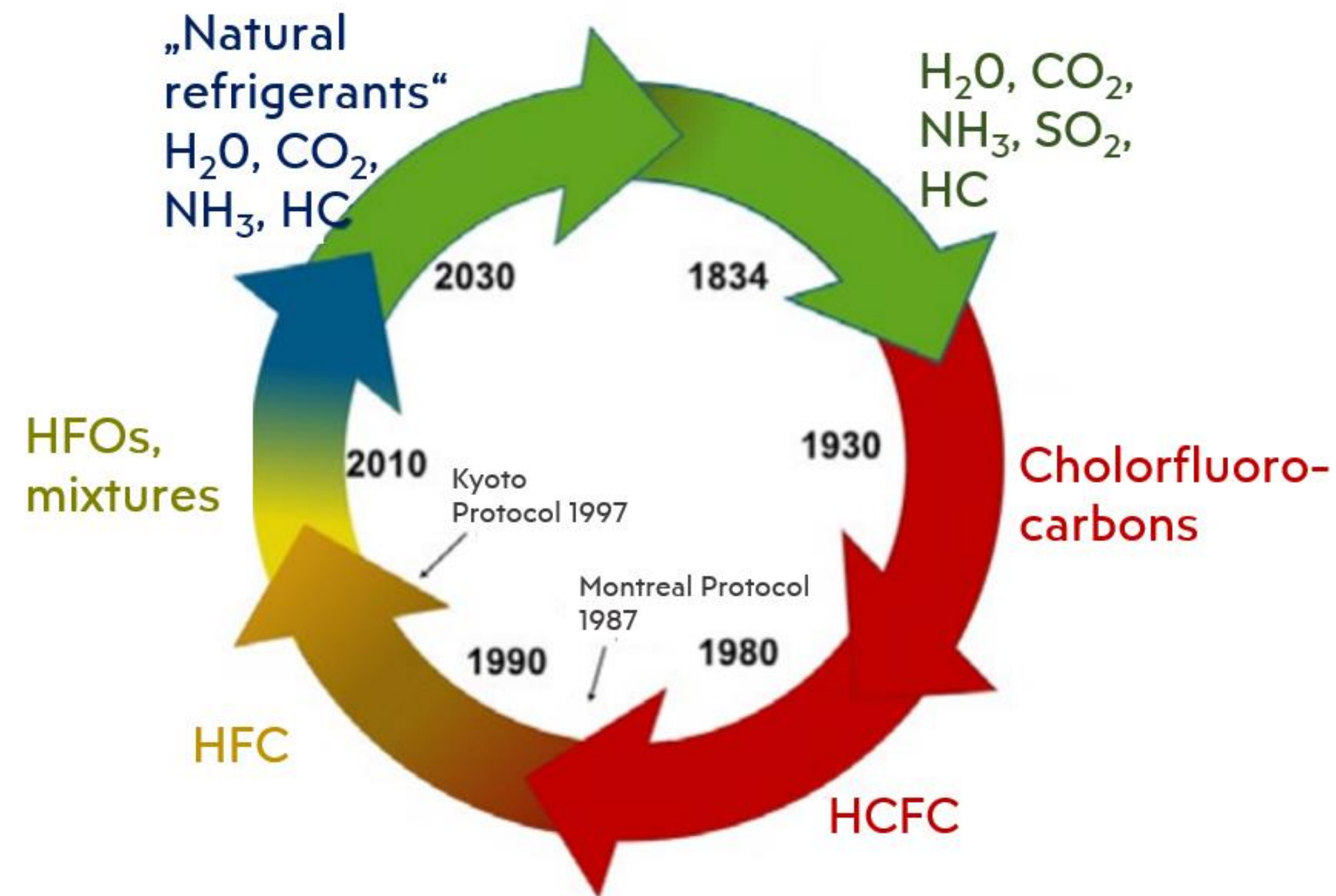
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Federal Ministry
for the Environment, Nature Conservation,
Nuclear Safety and Consumer Protection

IKI  INTERNATIONALE
KLIMASCHUTZ
INITIATIVE

Evolution of refrigerants



Ozone Depleting Substances (ODS): Artificially induced substances that deplete the ozone layer (-> the earth's protection against UV rays is reduced).



No ozone depletion potential (ODP) but high global warming potential (GWP)



Natural substances with low environmental impact, i.e. no ODP and low GWP

- **Natural refrigerants** were the first refrigerants to be used in cooling and heating systems.
- **CFCs, HCFCs, HFCs, and HFOs** have shown to have ozone, climate, multiple environmental and health effects (**ODP, GWP, PFAS** and **TFA**).
- **Natural refrigerants** do not have harmful impact to ozone layer, climate, environment, health and are very efficient.

Ozone, Climate and environmental impact of the refrigerants

Type	Substance	Type	ODP ¹	GWP 20yrs ²	GWP 100yrs ²	Contain PFAS ³	TFA ⁴
Synthetic	R-12	CFC	0,82	12700	12500	No	No
Synthetic	R-22	HCFC	0,04	5690	1960	No	No
Synthetic	R-141b	HCFC	0,11	2710	860	No	No
Synthetic	R-32	HFC	0	2690	771	No	No
Synthetic	R-134a	HFC	0	4140	1530	Yes	Up to 20%
Synthetic	R-404A	HFC	0	7208	4728	Yes	Up to 20%
Synthetic	R-407A	HFC	0	4890	2262	Yes	Up to 20%
Synthetic	R-410A	HFC	0	4714	2256	Yes	No
Synthetic	R-507A	HFC	0	7290	4775		Up to 10%
Synthetic	R-245fa	HFC	0	3170	962	Yes	Up to 10%
Synthetic	R-365mfc	HFC	0	2920	914	Yes	Up to 10%
Synthetic	R-1234yf	HFO	0	1.81	0.501	Yes	100%
Synthetic	R-1234ze(E)	HFO	0	4.94	1.37	Yes	Up to 10%
Synthetic	R-1233zd(E)	HFO	0	14	3.88	Yes	2%
Synthetic	R-513A	HFO-HFC	0	1822	673	Yes	Up to 60%
Natural	R-290	HC (propane)	0	0.072	0.02	No	No
Natural	R-744	CO ₂	0	1	1	No	No
Natural	R-600a	HC (isobutane)	0	<1	<1 ⁵	No	No
Natural	R-717	HN ₃ (ammonia)	0	0	0	No	No
Natural	C ₅ H ₁₀	HC (cyclopentane)	0	0	11	No	No
Natural	R-601	HC (pentane)	0	<1 ⁵	<1 ⁵	No	No
Natural	R-601a	HC (isopentane)	0	<1 ⁵	<1 ⁵	No	No

¹ WMO's Scientific Assessment of Ozone Depletion, 2010.

² IPCC 6th Assessment Report, 2021.

³ ECHA, Annex XV Restriction Report

⁴ Behringer, D. et al. Persistent degradation products of halogenated refrigerants and blowing agents in the environment, Final Report, 2021.

⁵ UNEP, Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, 2022 Assessment Report.

Leapfrogging to Natural Refrigerants – avoiding GWP, PFAS & TFA



Contain PFAS	No	Most	All	No
TFA	No	Most	All	No

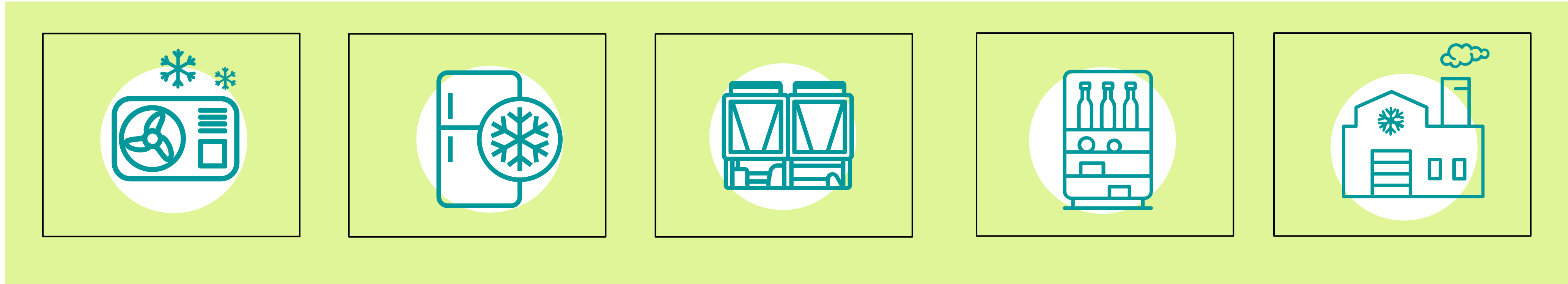
Road map to Green Cooling – How to leapfrog?

- Set clear GWP caps/limits and timelines in HFC legislation & phase outs of F-gases for some sub-sectors
- Create tax incentives for natural refrigerants/tax disincentives for F-gases
- Set up supply chains and subsidy schemes
- Equip training centers with tools and equipment that use naturals
- Adopt international safety standards
- Set up obligatory Qualification Certification and Reporting (QCR) and incl. naturals into curricula
- Conduct trainings, trainings, trainings, ...
- Set ambiguous MEPS, labels, testing, certification
- Introduce ecolabels (see e.g. German Blue Angel for ACs)
- Include natural refrigerants and EE into green public procurement programmes
- Set up extended Producer Responsibility (EPR) Schemes
- Include obligatory recovery and collection of F-Gases into the HFC legislation



Best Practice Examples

Climate-friendly solutions exist for (almost) all applications!



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Air Conditioners

Refrigerators

Chillers

**Commercial
refrigeration**

**Industrial
refrigeration**



HC



HC



**CO2,
NH3,
HC**



**CO2,
NH3,
HC**



**NH3,
HC**

HC: Hydrocarbons (e.g Isobutane, Propane) CO2: Carbon dioxide NH3: Ammonia

EXAMPLE of R290 split ACs available in Europe



World Environment Day

Think green, go green. Making sustainable choice to protect biodiversity with Midea R290 green products.

Picture: Midea



Midea R290 Product Line

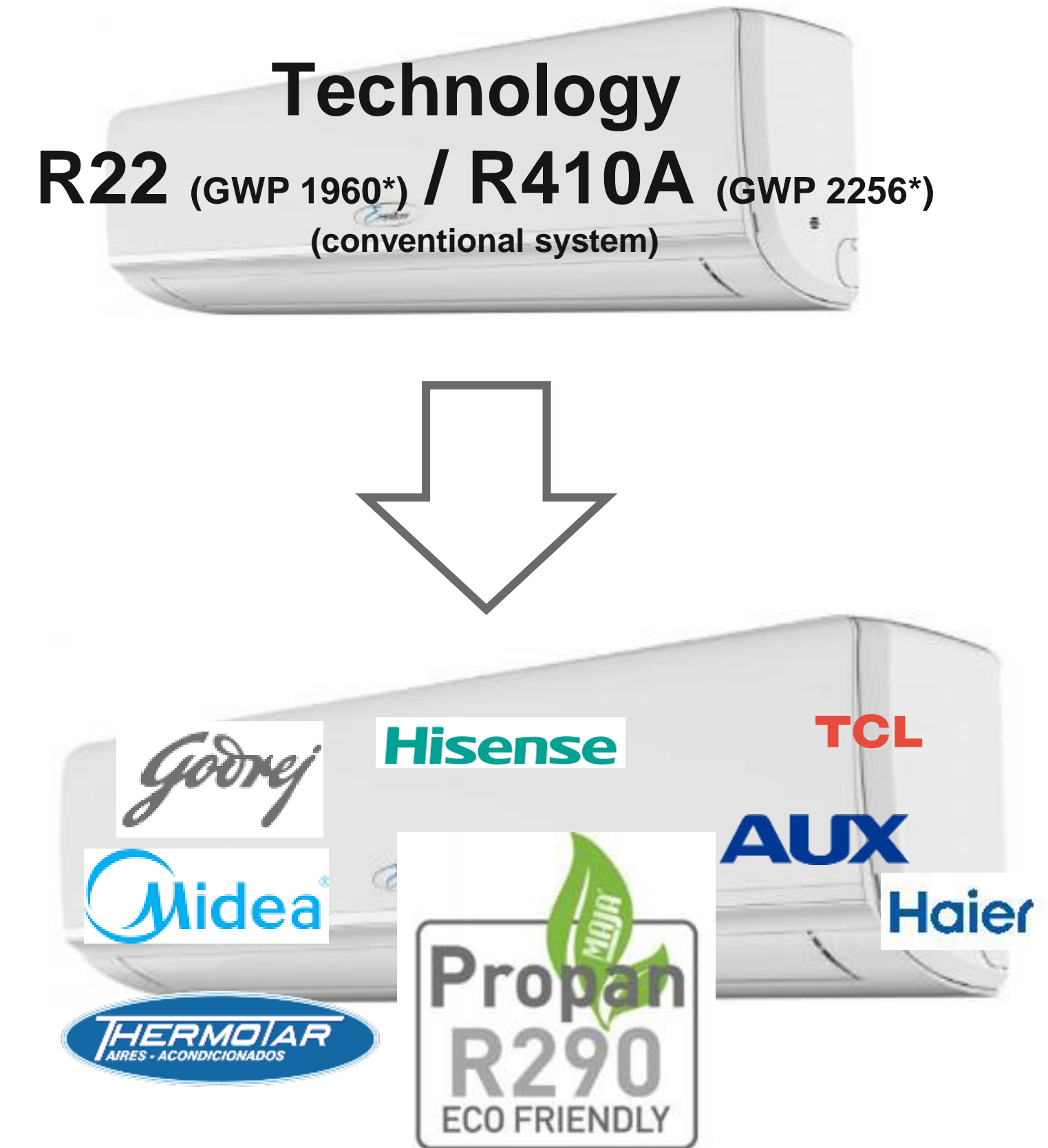
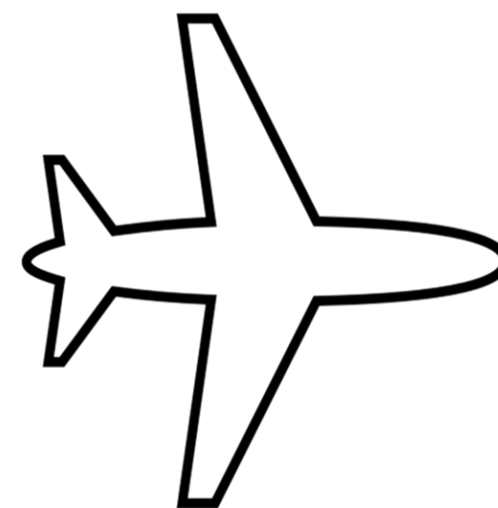
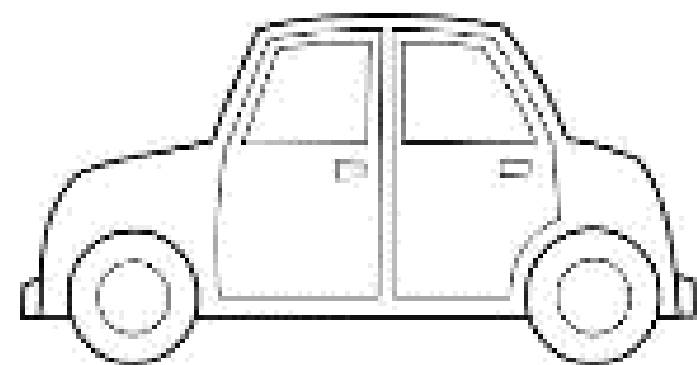
Exchange of conventional ACs by Green ACs (highly energy efficiency and natural refrigerant R290)

Over lifetime (10 yrs.) per AC:

- Reduced energy consumption, on average by **5,000 kWh**
- Significant cost reduction for consumers and government
- Reduced emissions on average of **5-10 t CO₂eq***

Equivalent to emissions of:

- Approx. 2-4 return travels **Nairobi - Frankfurt /**
 - Approx. **15 - 30,000 km**



*Source: IPCC 6th Assessment Report ***depending on grid emission factor, running hours, etc.**

GWP 0.02 *
(1 kg = 0.02 kg CO₂eq)

Example: Installation of R-290 Chillers for Industry and Businesses in Indonesia

	HFC Chiller (R-22)	Green Chiller (R-290)	Difference (%)
Unit Price (USD)	37,822 USD	55,886 USD	32%
Energy Efficiency Ratio (EER)	2.7	3.6	+ 25%
Energy Consumption (kWh/year)	783,442	572,238	- 37%
Annual Energy Cost (USD)	61,584	44,982	- 37%
Lifecycle Cost, LCC (USD)	434,686	348,372	- 25%
Direct Emissions (tCO2eq)	451	0.34	
Indirect Emissions (tCO2eq)	12,367	9,033	
Total Emissions (tCO2eq)	12,819	9,034	- 42%
Global Warming Potential (GWP)	1810	3	
Ozone Depletion Potential (ODP)	0.055	0	
Internal Rate of Return (IRR) %	21 %		
Payback Period (years)	1.04 %		



Photo: MEMR 2022



Photo: GIZ 2018

Example: Supported 2 Pick n Pay supermarkets in switching to CO2 cooling systems in South Africa (currently over 350 CO2 supermarkets in South Africa)



**Green Cooling in
supermarkets
([Download](#))**



**Non-state action
towards climate-
friendly and energy-
efficient cooling
([Download](#))**

Example: Solar Powered Solutions using R290

Automated Autotark System

Refrigerant
A PV-Solar Plant Ice Machine is using propane R290 refrigeration. R290 capable of high performing, excellent thermodynamic performance and very low global warming potential.

PERTAMINA

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

ILK Dresden
Institut für Luft- und Kältetechnik
gemeinnützige Gesellschaft mbH

2023

Picture:



Environmentally and climate-friendly solar-powered walk-in cold rooms
[\(Download\)](#)



PV-powered Air Conditioning in Buildings
[\(Download\)](#)

Examples: Solutions for Transport Refrigeration using Natural Refrigerants

PBX



- Natural refrigerant R290 propane
- Outstanding efficiency
- Zero planned maintenance
- Reduces carbon footprint of the fleet by 93%
- Up to 25% energy efficiency increase.
- 75% less installation efforts



Pictures: PBX

ECOOLTEC



- Natural refrigerants (R1270 propylene and R744 carbon dioxide),
- Low charge components
- Full hermetic system
- Electrically driven
- High efficiency and capacity
- Not affected by engine exhaust air
- Efficiency benefits vs DX systems
- Multi-temp capability
- Low noise and vibration level

Pictures: ECOOLTEC

Qualification, Certification, Registration (QRC) – Find out more on our website



Event Recording | OEWG44 side event: The qualification programmes "Cool Training" and "Fit for Green Cooling"

07/2022 | PUBLICATION - VIDEO

Well-trained refrigeration and air conditioning (RAC) technicians are indispensable for a future-friendly transformation of the cooling sector. The side event presented the concepts and recent developments of GIZ Proklima's qualification programmes.



Fit for Green Cooling

Fit for Green Cooling: QCR of RAC Technicians (Video)

Cool Training

Event Recording – OEWG44



Green Cooling Network

- aims to promote green cooling technologies
- connects key players in the RAC sector such as gov't institutions, international organizations, and the private sector
- provides information, advice and collaboration opportunities to its members
- members are all committed to green cooling

Join the Green Cooling Network today!

www.green-cooling-initiative.org/network



Contact information



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ATMO
Network

**Thank you
for listening.**

