



Efficiency gains and sustainable RAC sector transformation: Why? How?

Roundtable Discussion
“A Sustainable transformation of the Refrigeration
and Air-conditioning sector”
with a specific focus on improving energy
efficiency”

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GIZ, SV Proklima

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Sustainable RAC sector transformation

What do we mean by this:

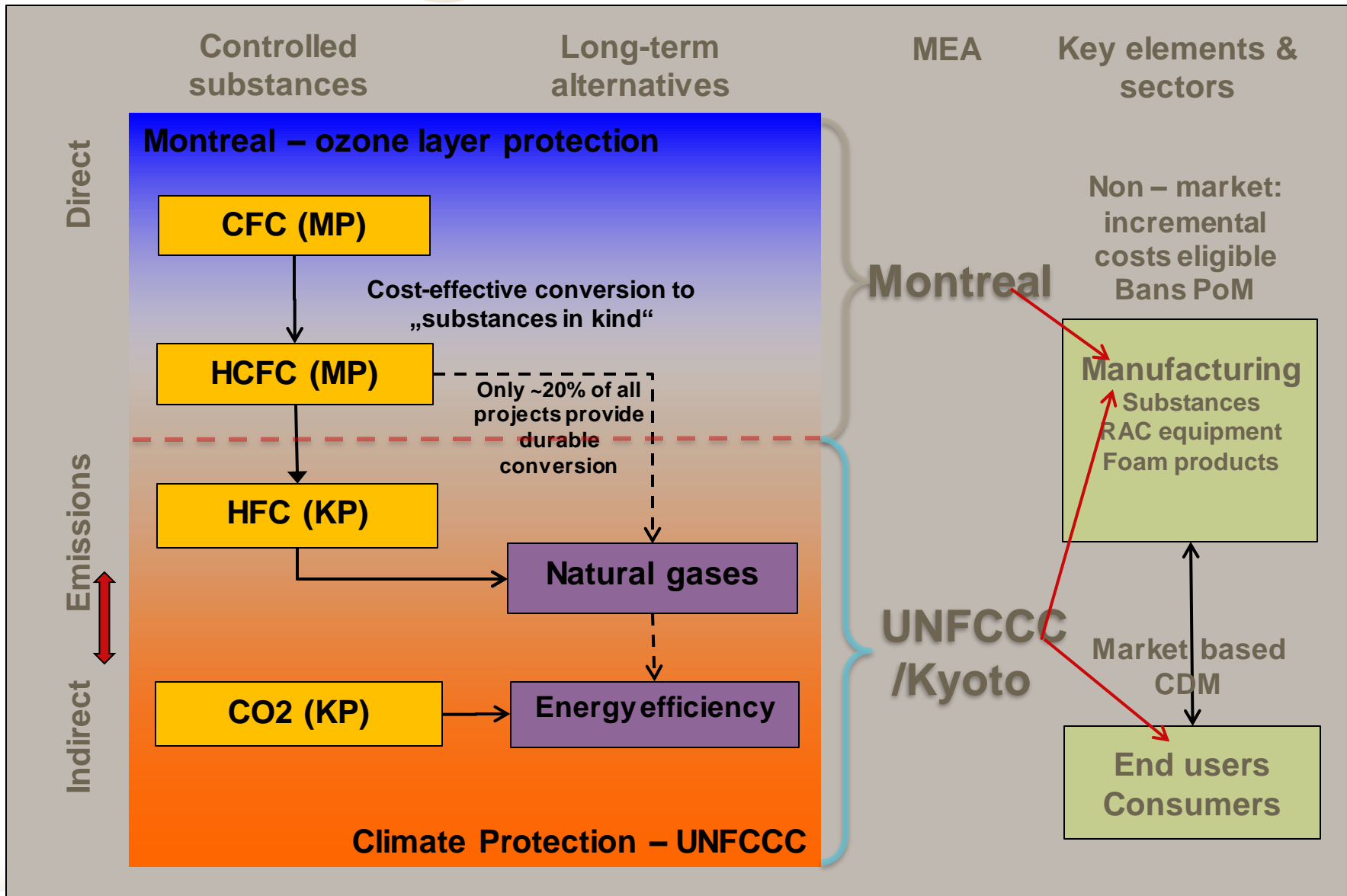
- Sector Transformation/conversion – so far happened in MP in unsustainable manner; 1st conversion, 2nd conversion, 3rd conversion,.....
- Sustainable sector transformation
- Development hardly considers growth



Sustainable....

- Durable
- Without negative impact on future generations
- Balanced approach of economic, environmental and social considerations
- Consideration of changing frame conditions (e.g. growth)
- Participative decision-making process
- Iterative journey towards sustainability

Regulations of MEA (MP & UNFCCC)

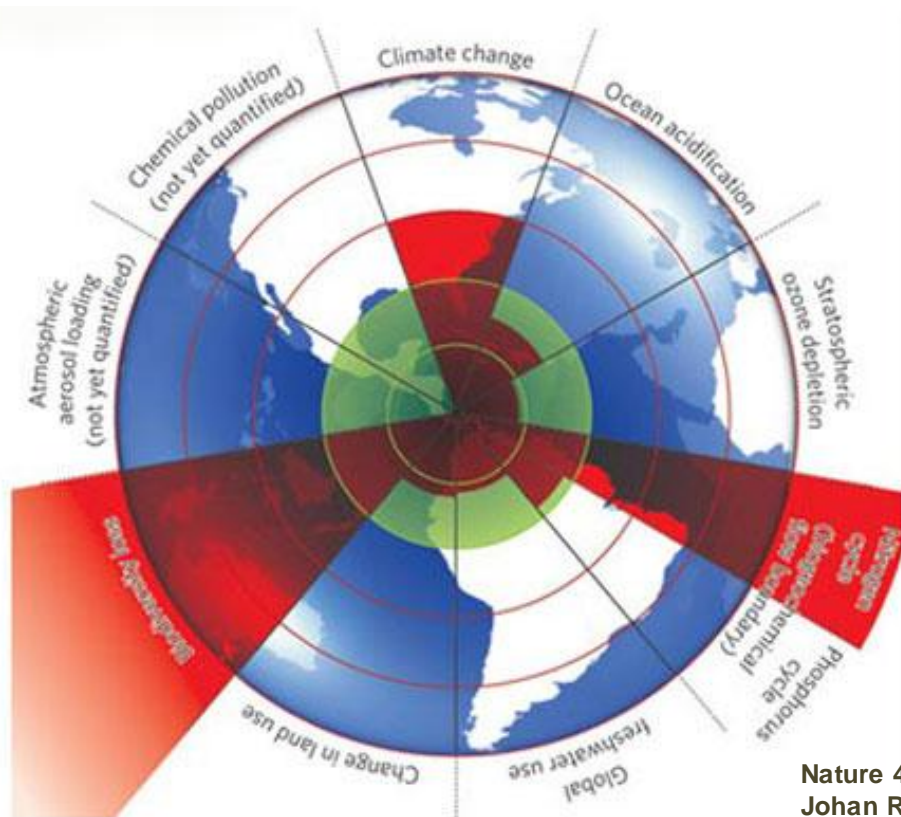




Paul Crutzen, Nobel price winner for discovering ozone depletion:

Mankind has become the dominating geological force in the earth system

Three out of nine interlinked planetary boundaries already overstepped



Refrigerants impact on:

- Ozone Depletion
- Climate Change
- Chemical Pollution (persistent wastes)
- Biogeochemical access (fluor)
- Biodiversity (food chains)

MP applied precautionary approach in 1982-1987 when ozone depletion was still not scientifically proven



ODS management and related policies

- ❑ ODS Management/F-Gas Management: HCFC Phase-out Management Plan (HPMP)
 - ❑ Production and Consumption of HCFCs
 - ❑ Sector plans to comply with multilateral obligations
 - ❑ Substantial co-financing by country and private sector
- ❑ Climate change
- ❑ Energy-efficiency
- ❑ Energy supply / demand side management
- ❑ Eco-design
- ❑ Management of natural resources
- ❑ (Wider) environmental management (air quality, water quality, waste,...)

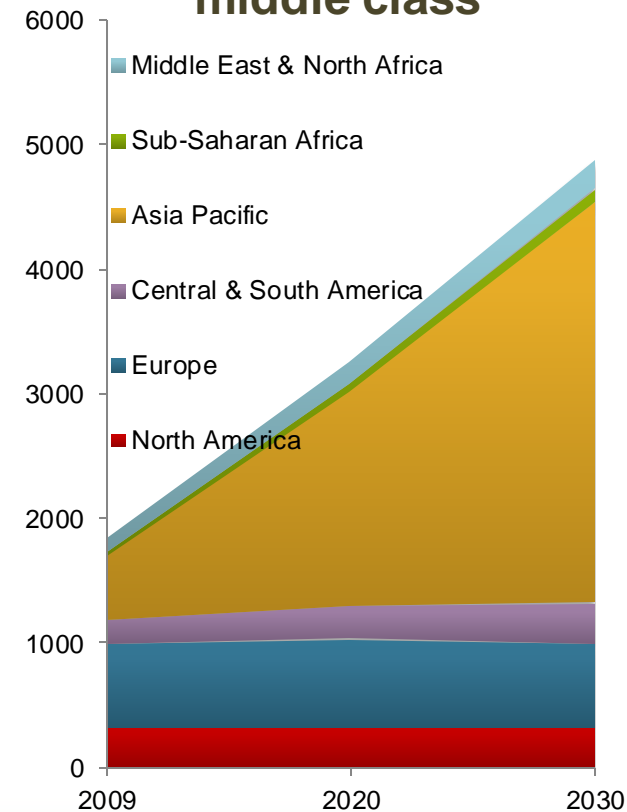


Is it possible to scale up existing growth patterns?

- > 9 bio people in 2050, GDP triple until 2030
- 80% of consumers are in DC and emerging economies, OECD share drops from 55 to 20% (2030)
- Refrigeration & A/C market today ~200 bio. US\$, AC demand growth by factor 14 until 2050, ca. 7% per year (IEA)
- Pressing time constraint to avoid tipping points
- Need to secure valuable planetary resources for future generations
- Developing countries are in the process to replace HCFCs; HFCs are not sustainable

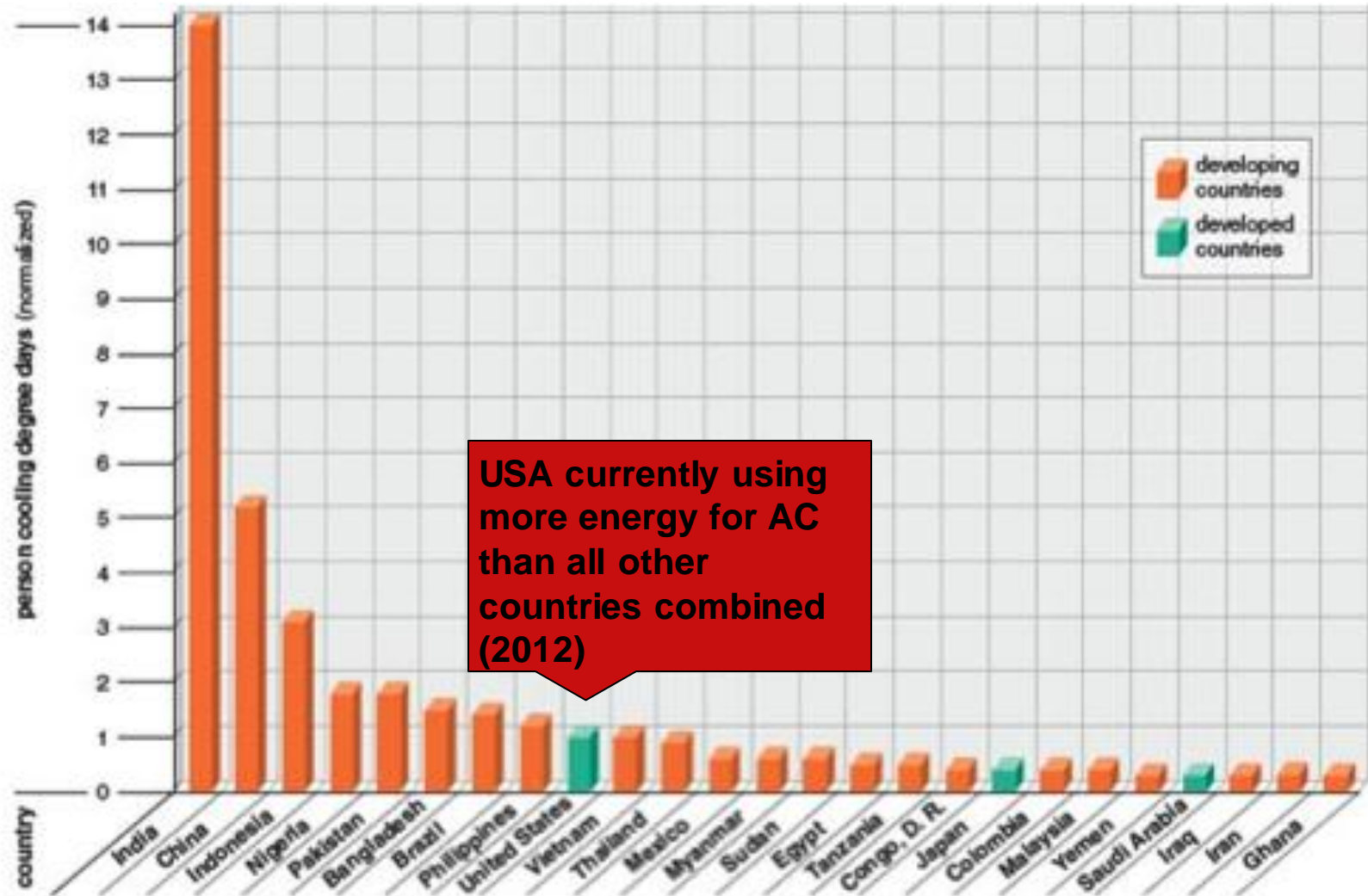
→ **Choosing sustainable alternatives is essential to reach the common goals**

Development of world's middle class





Potential AC demand [~2100]





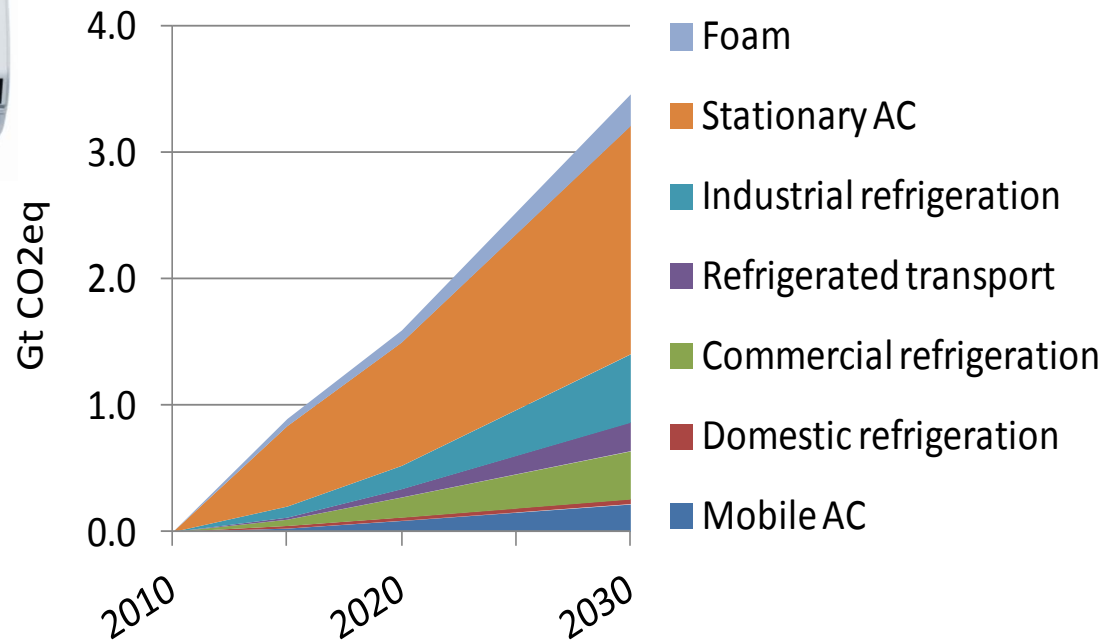
Mitigation of direct emissions (global): Stationary AC has most significant potential



Window AC



Split AC (Indoor)





Scaling up depends on sustainable systems and behaviour

Strategies:

- **Decarbonisation of energy supply**
- **Reduce, reuse, recycle materials**
- **Use of renewable materials**
- **Establish environmental safe systems & behaviours**
- **Accelerate innovation cycles**
- **Eliminate use of environmentally critical substances**



→ Choosing natural alternatives is a precautionary approach for transformation, in terms of resource efficiency and overall environmental protection



Energy Efficiency – Rebound effects and Uncertainties in the replacement of Appliances

- Mexican Households that replace their refrigerators with energy-efficient models decrease their energy consumption considerably less than was predicted by the Worldbank : -132kWh vs -481kWh

Even larger decreases were predicted for air-conditioners, who ended up increasing their electricity consumption: -1250kWh vs. +80 kWh *

- In Japan, a survey on actual energy consumption of top runner refrigerators of Jyukankyo Institute (2006) monitored over 100 refrigerators and found that the ave. annual electricity consumption was 65 % larger than the Japan Industrial Standards rating of the units.

* The economics of Household Energy Efficiency , Davis et al 2012



Halocarbons

1 ODP ~ 0,07 Flammability (HF)

~ 8000 ~1600 GWP ~1800 ~ <10

CFC
(FCKW)

HCFC
(HFCKW)

HFC
(HFKW)

HFO
(unsaturated HFC)

1 Depletion of Resources (Fluor) x ~ 2 - ?

1 Persistent Waste (TFA) x ~ 2 -5 ?

1 Price x ~ 30 ?



Transformation from HFCs to sustainable refrigerants & blowing agents

IPR Sensitivity	HFC/HFOs	NRs
Raw material production	Red	Green
Manufacturing process	Yellow	Green
Manufacturing equipments	Yellow	Green
Products / components*	Yellow	Yellow

* Mainly with components such as heat exchangers etc.

Less IPR issues, more local production potentials!



Moving from environmental harmful to environmentally benign substances has a cost

→ new complexities for the application

Natural refrigerants offer the best options for developing countries, in particular also for high-ambient temperatures.

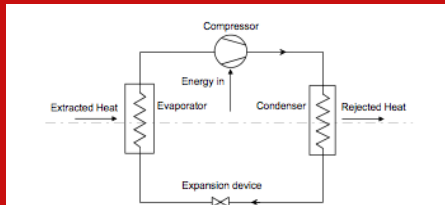
Safety requirements (flammability, toxicity, high pressure) to be addressed.

	CFC/ HCFC	HFC	HFC/ HFO	NH3	CO2	HC
Ozone Depletion	Red	Green	Green	Green	Green	Green
High GWP	Red	Red	Green	Green	Green	Green
Persistent wastes	Red	Red	Red	Green	Green	Green
Depletable Resources	Red	Red	Red	Green	Green	Green
Recycling	Red	Red	Red	Green	Green	Green
Safety issues	Green	Green/Red	Red	Red	Green	Red
Energy efficiency	Green	Green	Green	Green	Green/Red	Green
Costs	Green	Green	Red	Red	Red	Green
IPR	Red	Red	Red	Green	Green	Green

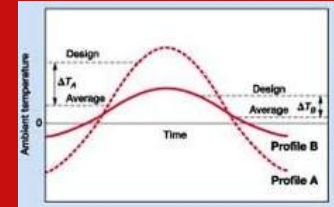


Reducing RAC Energy Use

Improve the Refrigeration Cycle



Optimize Transient Effects



Behavioural Changes



Reduce Parasitic Losses

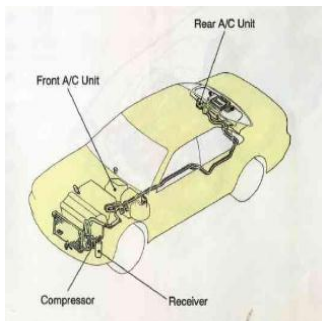


Servicing/Training





There are climate-friendly, sustainable alternatives for (nearly) all applications!



Mobile AC

**Domestic
Ref.**

**Comm.
Ref.**

**Industr.
Ref.**

AC

Foams



**CO₂,
(HC)**

HC

**CO₂,
NH₃, HC**

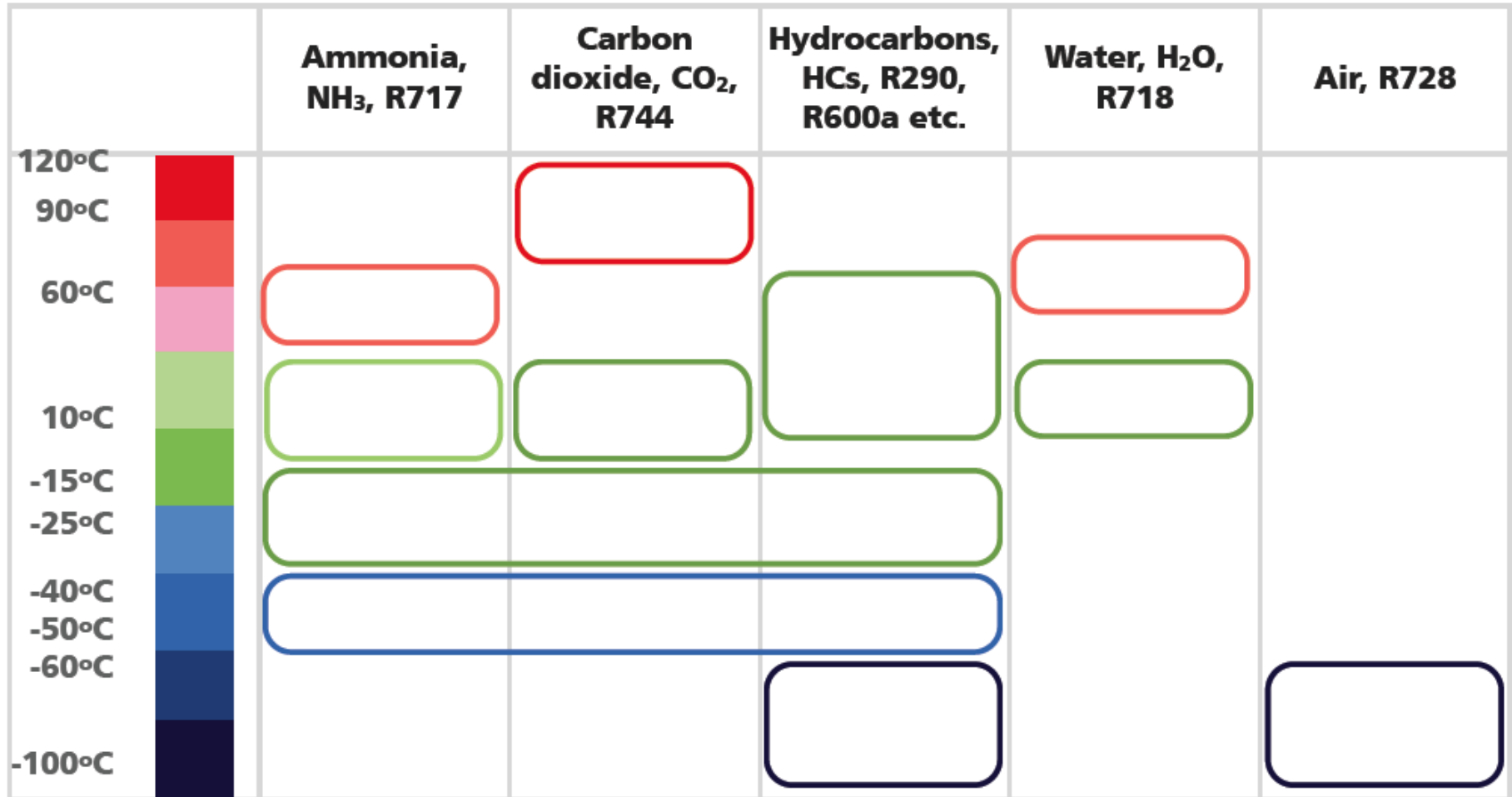
NH₃, HC

HC, NH₃

**CO₂,
HC**



Potentials of Natural Refrigerants RHPAC Applications

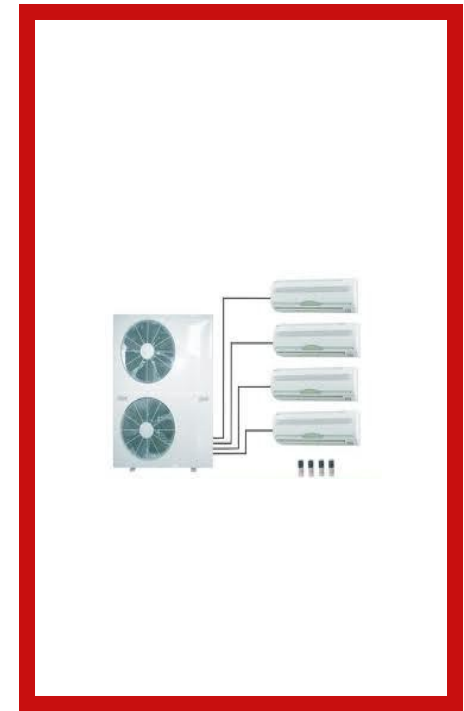


RHPAC = Refrigeration, Heat Pumps, Air- Conditioning

Source: adapted from Mayekawa, 2012

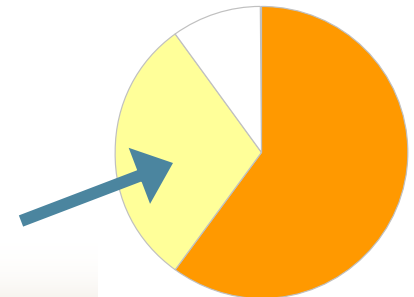


Suitability of Natural Refrigerants

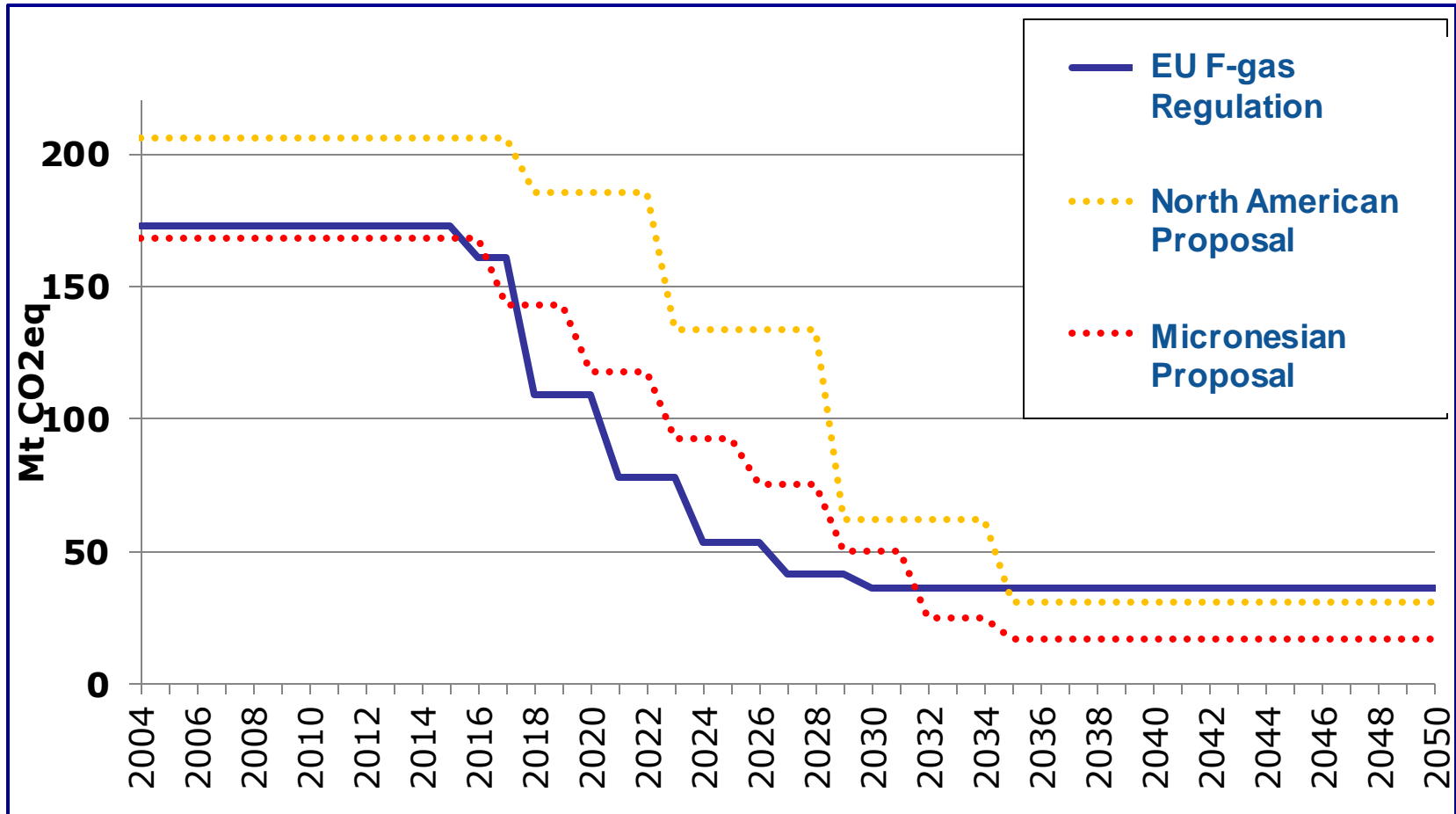


Requires: improvements to safety standards; charge reduction; safety mechanisms integration; further R&D

Closing the gap



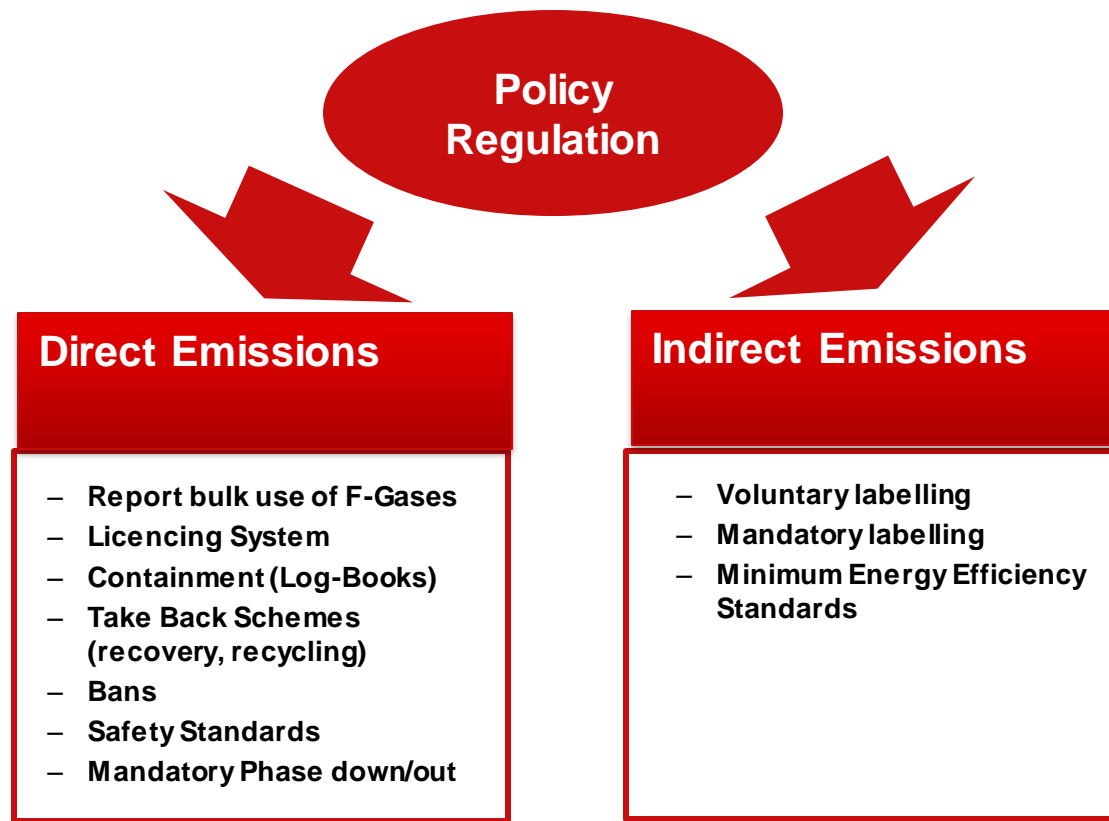
Control



→ For the period 2018-2030, the EU HFC phase-down (= legislation in force) meets all international phase-down proposals (under Montreal Protocol)











Addressing Direct and Indirect Emissions through Policies and Regulation



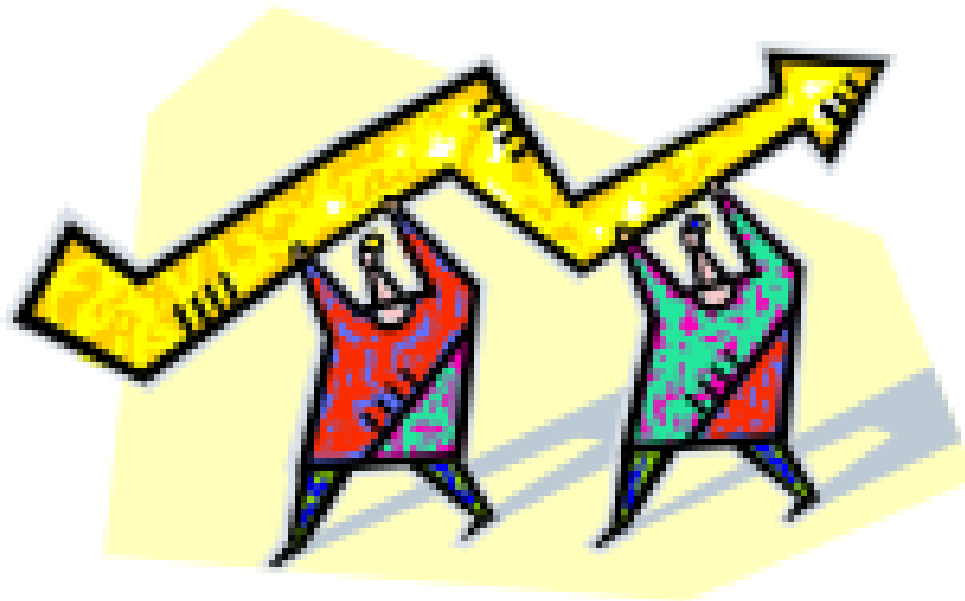


Technology Demonstration / Case Studies

<p>Production + R&D</p>	<p>Split AC India & China</p>			<ul style="list-style-type: none"> • Key Subsector • Low GWP natural refrigerant • Improved energy-efficiency • Local servicing capacity
<p>Production + R&D</p>	<p>HC/ Solar Refrigeration Swaziland</p>			<ul style="list-style-type: none"> • Production + capacity building in Africa • Natural refrigerants • Renewable energy (solar)
<p>Use</p>	<p>Supermarkets South Africa</p>			<ul style="list-style-type: none"> • Transform end-user sector • Low GWP natural refrigerant • Improved energy efficiency • Local engineering & servicing capacity
<p>Post-Use</p>	<p>Refrigeration Recycling Brazil</p>			<ul style="list-style-type: none"> • Sustainable end-of-life treatment • Collection of old appliances • Recovery and destruction (CFC, HCFC) • Local network/take-back system



Upscaling to sectoral approach



For...
RAC manufacturers,
End- users
(supermarkets,
hotels, cold
stores,...)

NAMA*)




MtCO₂eq

*) Nationally appropriate Mitigation Action (NAMA)



Guidance

Proklima International




PROKLIMA

Guidelines for the safe use of hydrocarbon refrigerants

A handbook for engineers, technicians, trainers and policy-makers - For a climate-friendly cooling

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of **BMZ** Federal Ministry for Economic Cooperation and Development




Operation of split air conditioning systems with hydrocarbon refrigerant
A conversion guide for technicians, trainers and engineers

Good Practices in Refrigeration

Natural Foam Blowing Agents
Sustainable Green- and Climate-Friendly Alternatives to HFCs

Production conversion of domestic refrigerators from halogenated to hydrocarbon refrigerants
A Substrate

Natural Refrigerants
Sustainable Green- and Climate-Friendly Alternatives to HFCs



Cool Training Concept

- Training consists of 30 % theory and 70 % practical work
- Main subject is the application of natural refrigerants for commercial refrigeration systems
- Training includes excursions to innovative enterprises in the sector
- Regional replication and upscaling



green cooling initiative

For more information, please refer to the webpages of the Green Cooling Initiative and the Cool Training Alumni:

<http://www.green-cooling-initiative.org/>

<https://www.green-cooling-initiative.org/rac-alumni-network/>





COUNTRY DATA

The refrigeration and air conditioning sectors around the world

Our world map allows you to explore a wide variety of data: refrigeration and air conditioning appliances in use, unit sales, emissions and emission mitigation potentials in the cooling sectors both today and in the future.

[explore data >](#)

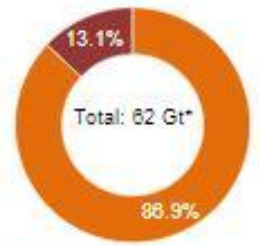


COOLING SECTORS

Global greenhouse gas emissions in 2030

Global greenhouse gas emissions and percentage contributed by the cooling sector (projections for 2030)

[switch to Table](#)



*in CO₂ eq



NETWORK

Our network and best practice examples

Do you want to contribute to making green cooling a worldwide success story? The Green Cooling Initiative is looking for network members and best practice examples.



TECHNOLOGY

Green cooling - markets and technologies



Natural refrigerants and high energy efficiency are



ABOUT

Green Cooling Initiative

Refrigeration and air conditioning are responsible for a significant share of the global greenhouse gas emissions. Especially in developing and emerging countries, the demand for cooling equipment is rising. Low levels of efficiency and high leakage rates of refrigerant gases with high global warming



Transforming to a knowledge-based economy

- Resolving complexities is a typical starting point of environmental sound technologies
- Safety & best practice is not refrigerant-specific, it is a general requirement when competently managing RAC systems
- Continued education and knowledge sharing is essential for transformation, e.g. engineers, technicians, mechanics require to update their knowledge and need to learn to think systems.



Lessons learned:

- **HC refrigerators:** just one example for global acceptance, incl. know-how & infrastructure, RefNat example in commercial refrigeration
- **Establishing qualification and controls for safe behaviour is essential for public safety when introducing sustainable alternatives**



2012 – 20 years Greenfreeze





Proklima worldwide

- ~ 19 years worldwide initiatives
- ~ 245 projects
- ~ 40 Partner countries
- ~ 8,100 ODP tons reduced
- ~ 100 Mio tons CO₂eq. reduced
- > 35.000 technicians trained

On behalf of

BMZ




Federal Ministry
for Economic Cooperation
and Development

On behalf of



Federal Ministry for the
Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany



*Integrated ozone and climate protection with focus on
natural refrigerants with low-GWP and energy-efficient
applications*

The image features the GIZ logo in a bold, red, lowercase sans-serif font. Above the logo is a stylized globe with red dashed lines connecting it to various points on a world map in the background. The map is light gray with red dots and numbers indicating office locations across all continents.

giz

- Deutsche **G**esellschaft für **I**nternationale **Z**usammenarbeit GmbH
- An international cooperation enterprise for sustainable development with worldwide operations
- Owned by the German Government
- Established in 1975
- In more than 130 countries
- With 67 own offices.
- ~18,000 employees



- Constructive approach needed to tackle HFC management – technicalities to be agreed along the way;
- Training has to be seen in the context of ongoing transformation of global economies; this takes time, better start as early as possible
- No “one size fits all” refrigerant in the future. Despite the “burning” issues of introducing new refrigerants, a sector by sector consideration to be considered; a culture of continued education and knowledge sharing in RAC sector is necessary
- Capacity building not restricted to servicing personnel, integration with value chain and public stakeholders essential;
- Public support insufficient, initiative and cooperation from private sector stakeholders required. Transnational technology cooperation specifically beneficial.



Thank you for your attention!

BMZ



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