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

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Phasing-in for a Change: Natural Refrigerants

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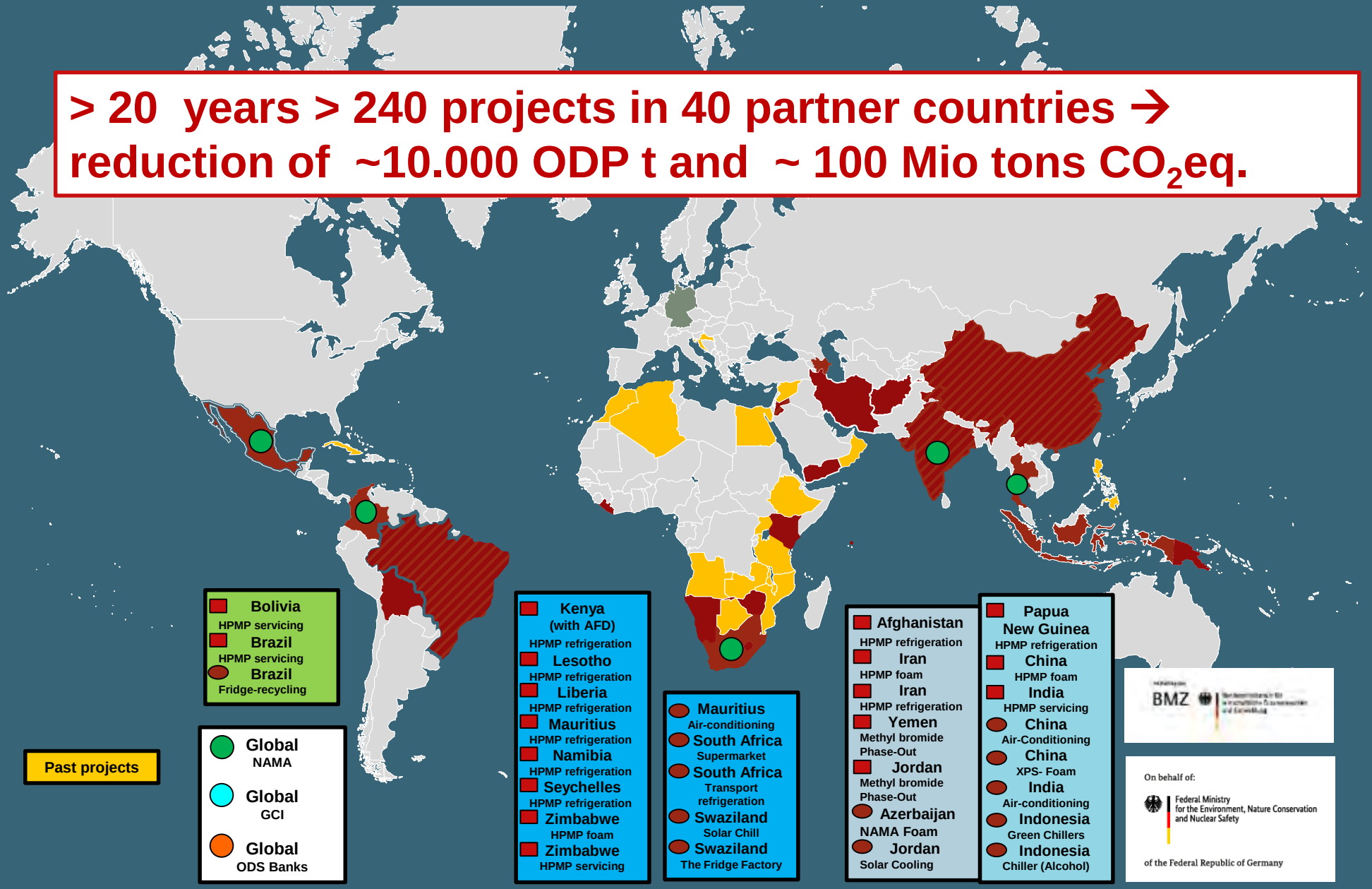
GIZ, Proklima

World Bank's International Conference on Sustainable Cooling
Washington DC, Nov 28-30, 2018

Proklima International

> 20 years > 240 projects in 40 partner countries → reduction of ~10.000 ODP t and ~ 100 Mio tons CO_2eq.



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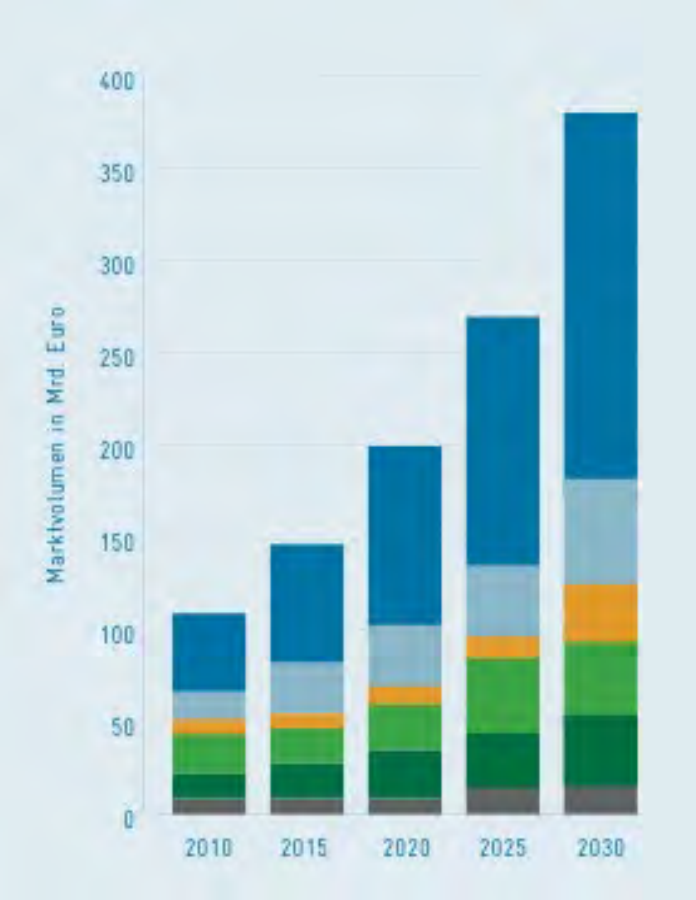
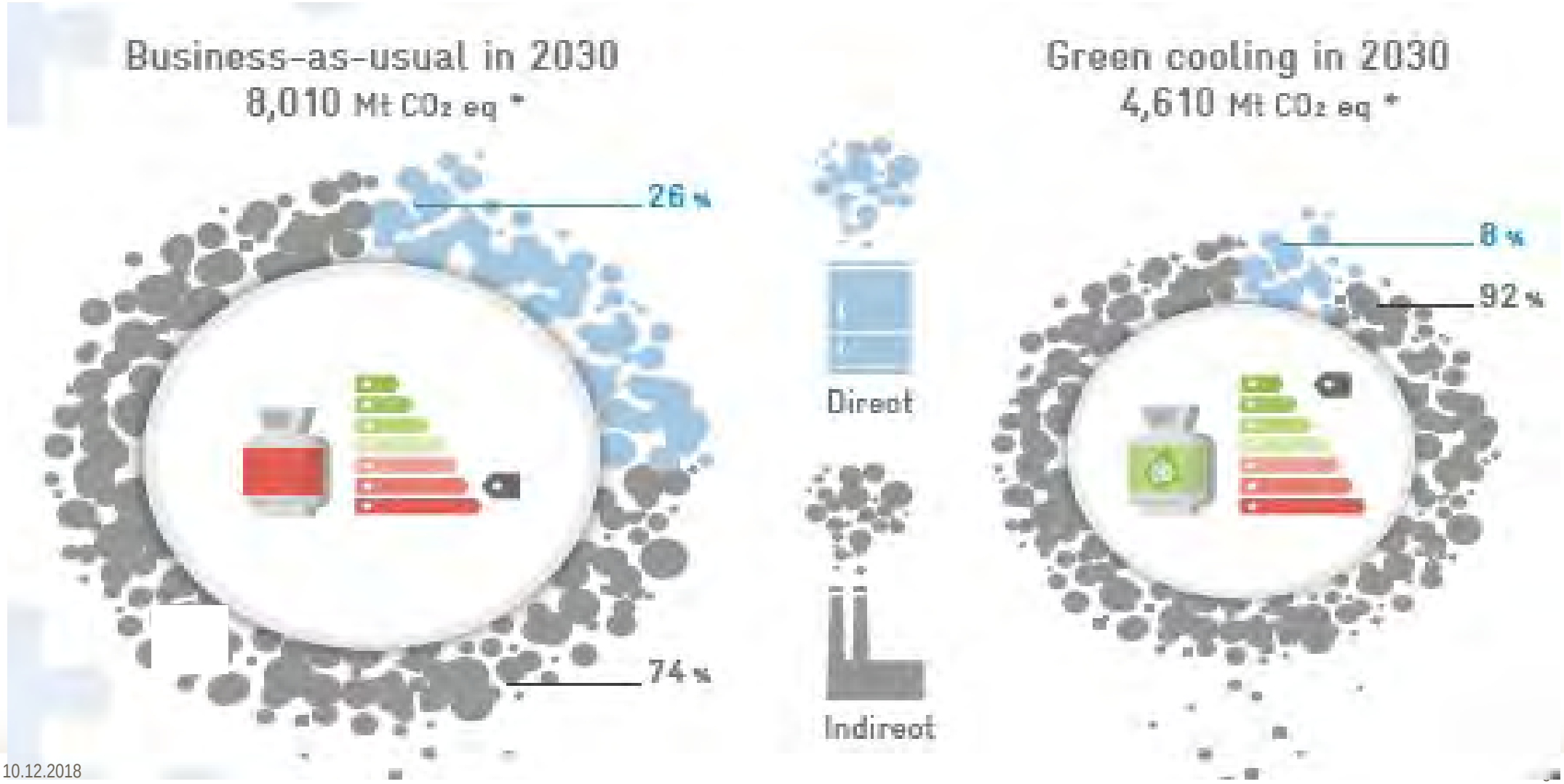
Relevance of the RAC Sector



- The number of **air-conditioning** systems worldwide is expected to rise from 660 million to more than 1.5 billion by 2030.
- The stock of **refrigerators** in emerging and developing countries is expected to double to around 2 billion by 2030.

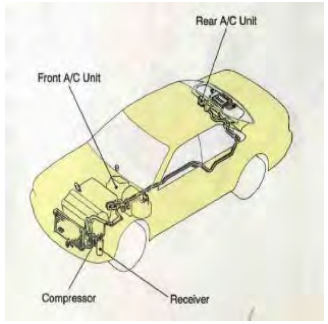
Green Cooling and Climate Protection



Ozone and Climate Impact of Refrigerants

Substance	Ozone Depletion Potential (ODP) (R11=1)	Atmospheric lifetime (yrs)	Global Warming Potential (GWP) 100yrs CO2eq
CFC-12	1	100	10,900
HFC-404a	0	14 – 52	3922
HFC 410a	0	5 – 29	2,088
HCFC-22	0.055	12	1,810
HFC-407c	0	5 – 29	1,800
HFC-134a	0	14	1,430
HFC-32	0	4.9	675
HC-290	0	0.04	3
HC-600a	0	0.02	3
HC-1270	0	0.0001	2
Ammonia (NH3)	0	0.25	0
CO2	0	30-95	1

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

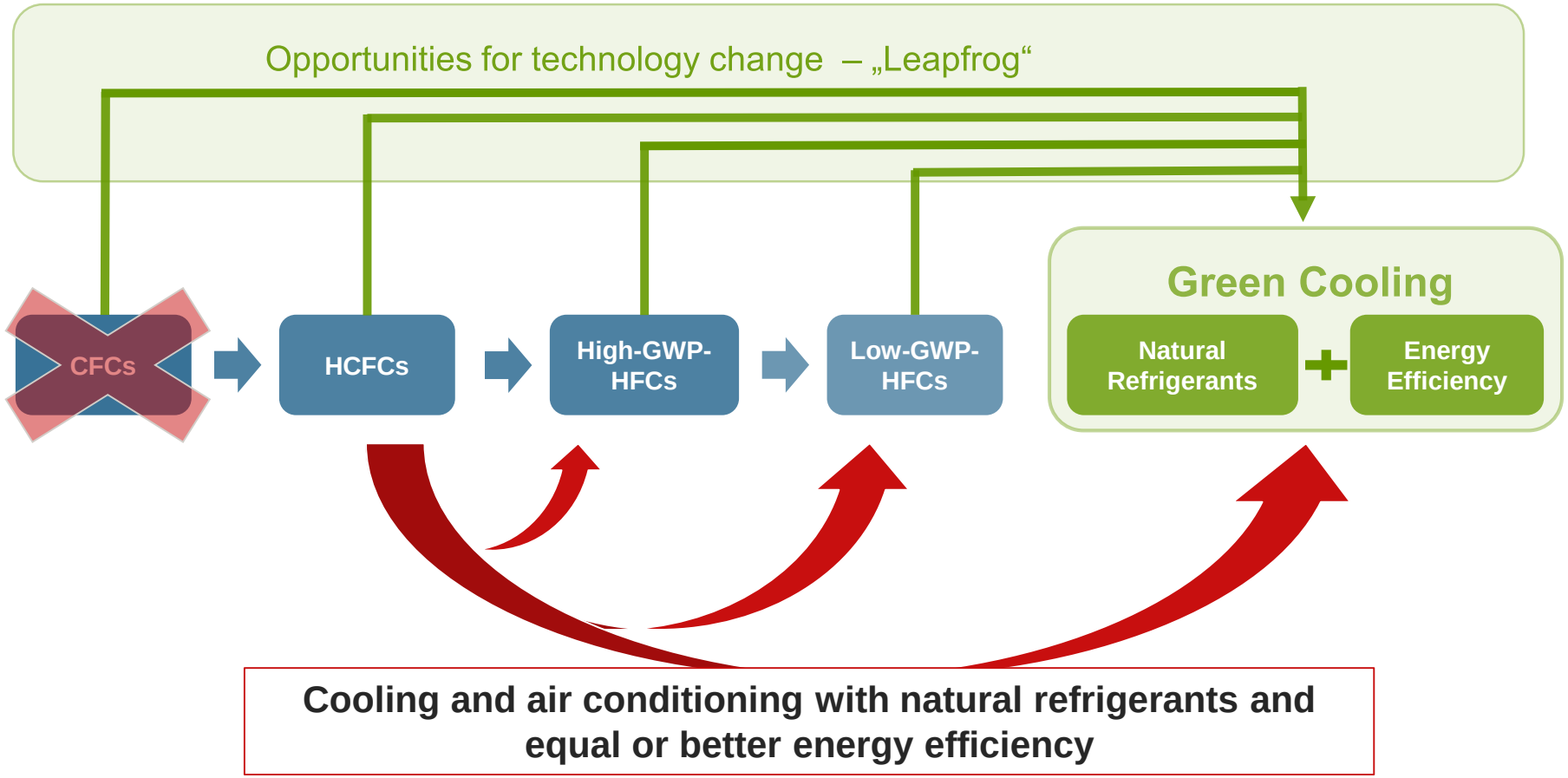






Mobile AC	Domestic Ref.	Comm. Ref.	Industr. Ref.	AC	Foams
CO2, (HC)	HC	HC, CO2, NH3	NH3, HC, CO2	HC, NH3	CO2, HC

The „Green Cooling“ Approach



Cooling and air conditioning with natural refrigerants and equal or better energy efficiency

Benefits of natural refrigerants

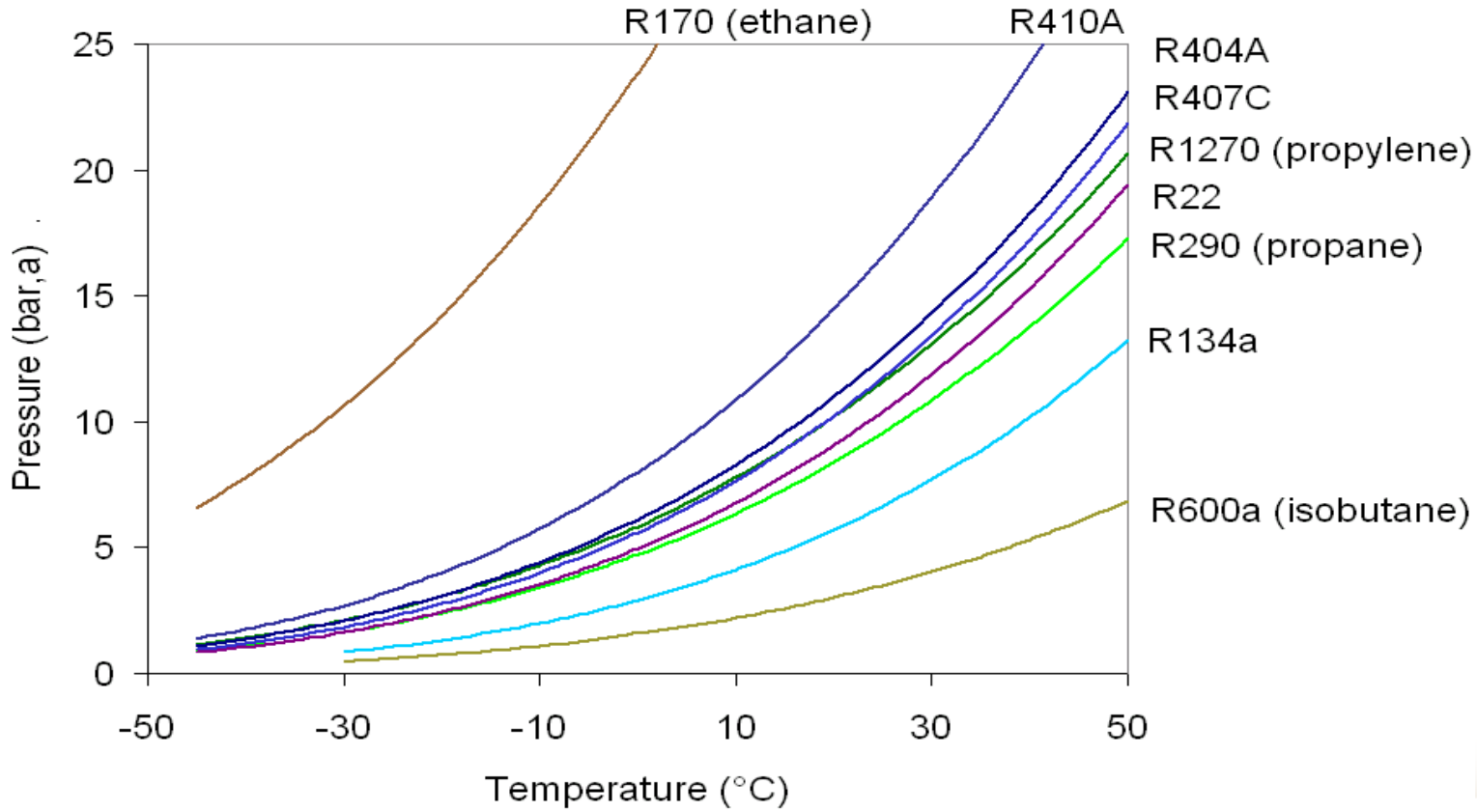
	HCFC	HFC	u-HFC	NH_3	CO_2	HC
Ozone depletion	🔴	🟢	🟢	🟢	🟢	🟢
High GWP	🔴	🔴	🟢	🟢	🟢	🟢
Persistent wastes	🔴	🔴	🔴	🟢	🟢	🟢
Depletable resources	🔴	🔴	🔴	🟢	🟢	🟢
Recycling/disposal	🔴	🔴	🔴	🟢	🟢	🟢
Safety issues	🟢	🟢/🔴	🔴	🔴	🟢	🔴
Energy efficiency	🟢	🟢	🟢	🟢	🟢/🔴	🟢
Costs	🟢	🟢	🔴	🔴	🔴	🟢
Local production	🔴	🔴	🔴	🟢	🟢	🟢

Source: Green Cooling Technologies, 2014,
GIZ Proklima/ HEAT GmbH

- ✓ High energy efficiency (also in high ambient temperatures)
- ✓ Low/cero GWP
- ✓ No persistent wastes
- ✓ Can be produced locally
- ✓ Smaller refrigerant charge
- ✓ Lower material costs

Thermodynamic properties → refrigerant operation

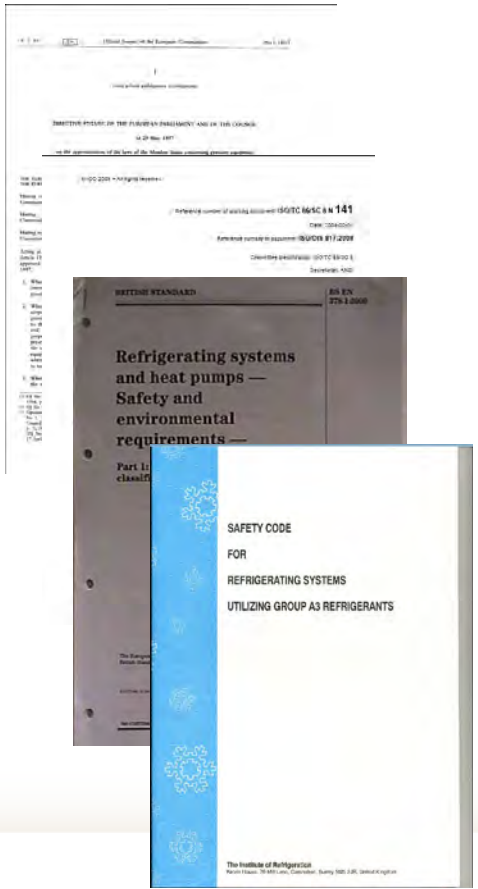
- Vapour pressure can be used as a general indication for “equivalent” replacement refrigerant



R-22
R-404A
R-407C
⇔
R-290
R-1270

R-12
R-134a
⇔
R-290/
R-600a
mix

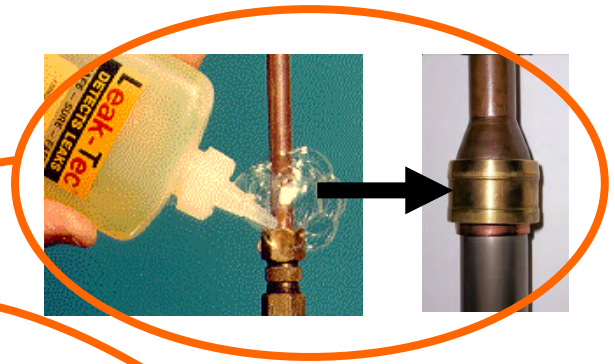
Safety Standards



- Legislation
  - Regional, national
- Standards
  - National, Regional, International
- Codes of practice
  - E.g. UK Institute of Refrigeration Safety Code on A2/A3 refrigerants (incl. HCs)
  - Building standards

General safety rules for alternative refrigerants

- Must recognise that most new refrigerants (HCs, unsat-HFCs) are flammable
  - Conventional refrigerants non-flammable
- Must therefore follow new measures:
  - Limiting charge size of direct systems
  - Avoid potential ignition sources on equipment
  - Minimise leakage
  - Marking on equipment
- All must be handled by trained technicians
  - Should be certified
- Follow safe application guidelines
  - e.g., for servicing, conversion, etc

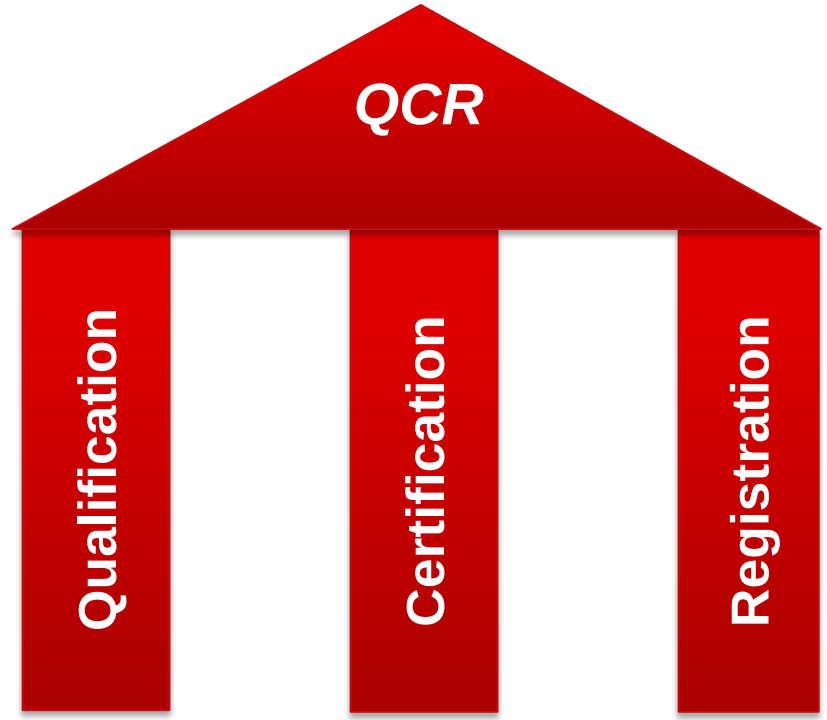


Required qualification, certification and registration (QCR)

- The introduction of new alternatives and their characteristics require extra training
- All new alternatives have safety related issues, which can be a barrier to their introduction
- Certification is a quality assurance measure helping to overcome these barriers and mitigation possible risks from personnel operations
- Establishment of a registration system (online)

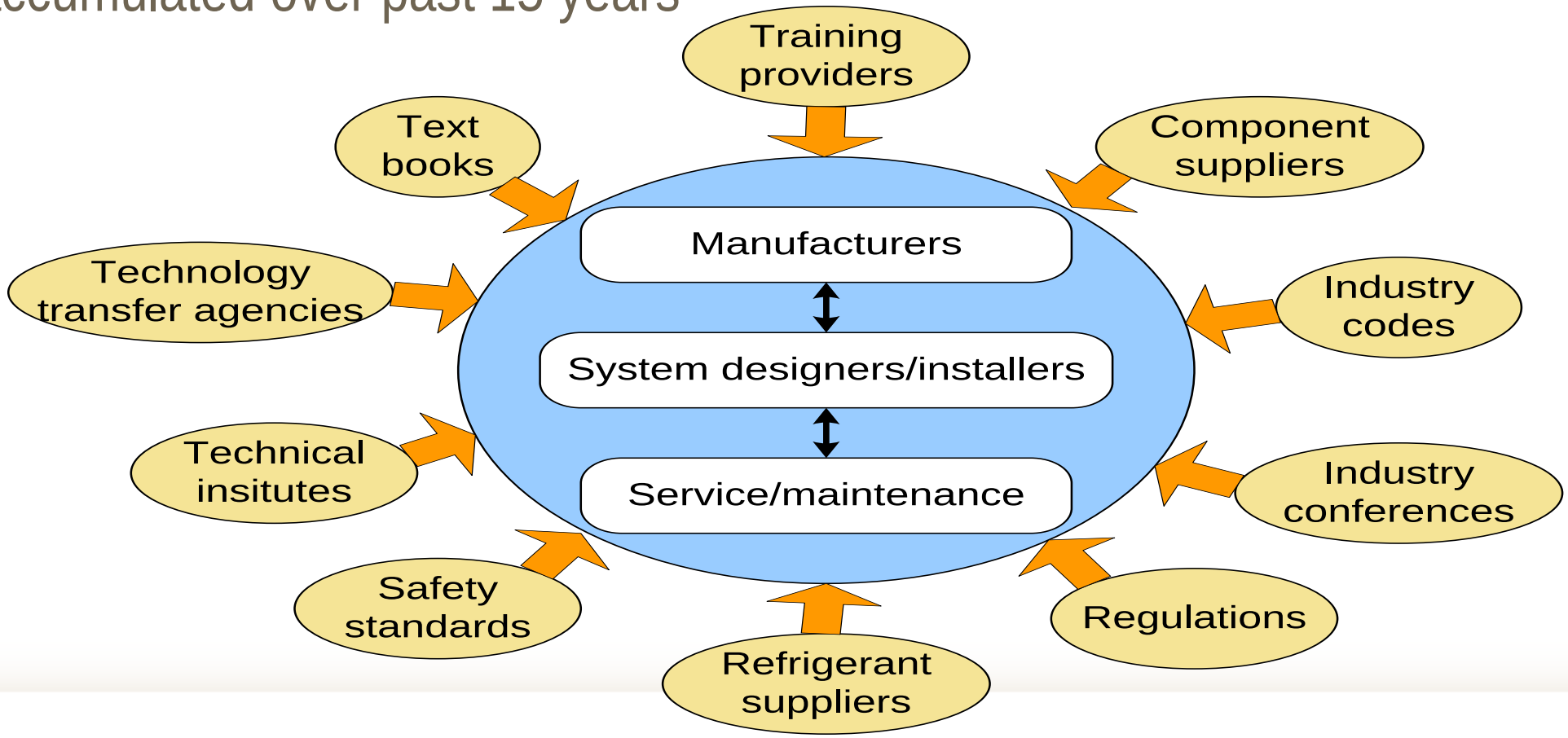
Extra training is required for:

- Operators, responsible for management and operation of installations
- Technicians doing installation, maintenance and end of life de-commissioning
- Engineers doing design of systems and components

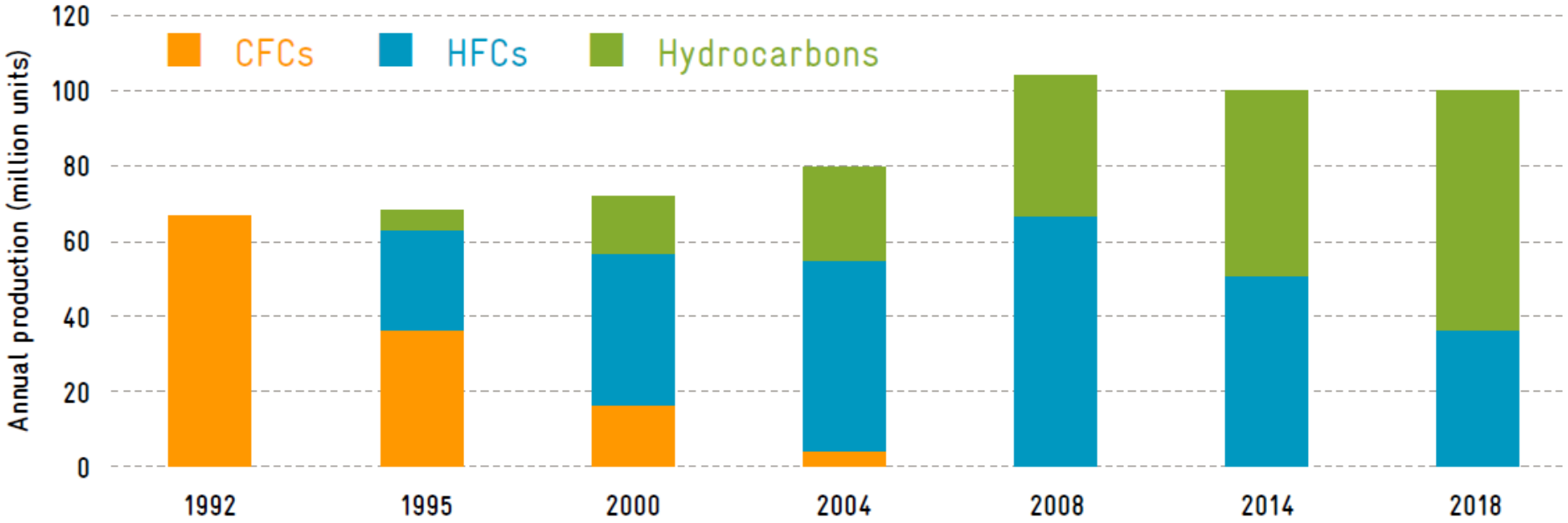


All necessary information (know-how) is available

- Considerable research, development, practical experience accumulated over past 15 years



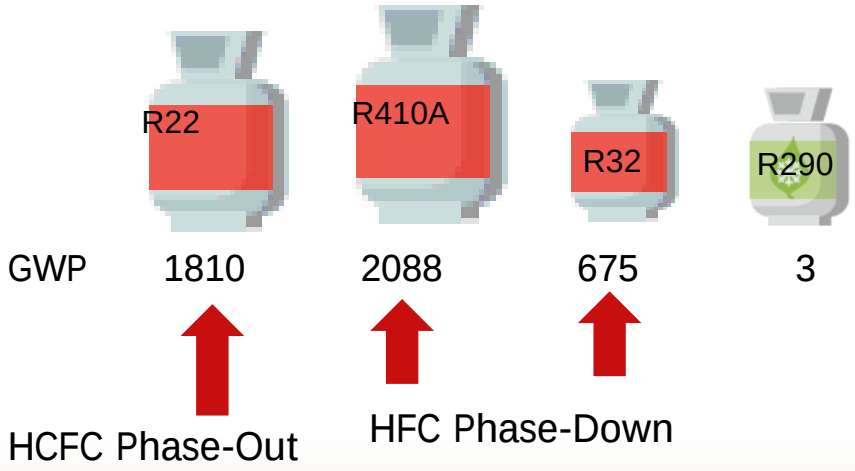
The success story of domestic refrigeration

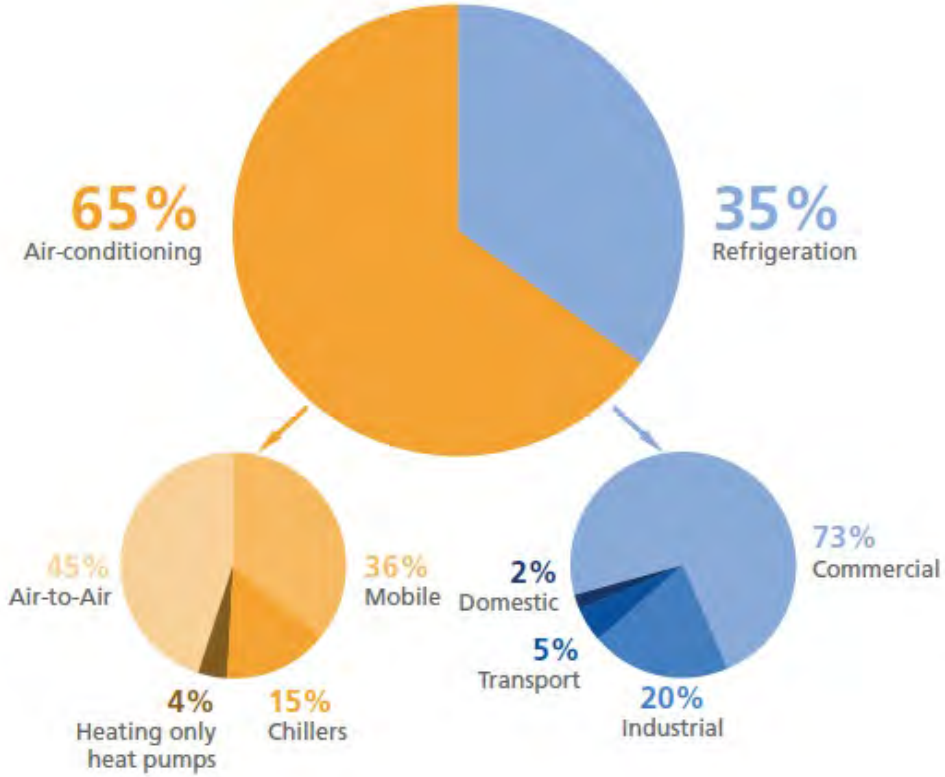


- **Global market share of R600 based domestic refrigerators today ranges around 70% of annual production**
- **HC-600a fridge compressors today are more energy efficient and come at less cost than HFC-134a compressors**

Relevance of Room Air Conditioning on HFC emissions

- 65% of HFC (R410a, R32) use comes from AC
- Split AC accounts for more than 30% of global HFC emissions
- Responsible for 20-40% of energy consumption in many households around the world
- Choice of refrigerant:





Source, UNEP

Market Trends of low GWP split AC

Supply of split AC units comes predominantly from Asia

China: Market share of 85%

- **20 RAC production lines converted** to R290 - potential to make 6 million R290 RAC units per year
- **< 10,000 units** installed

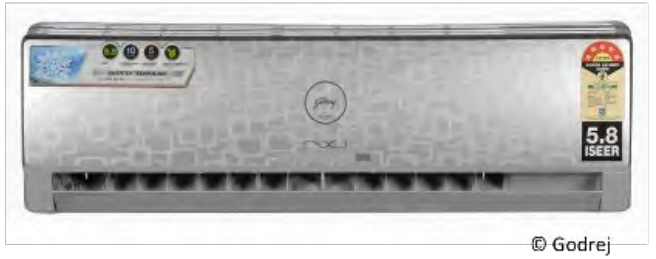
= active policy support, update of safety regulations, and stronger industry commitment are needed to unlock full R290 RAC market potential

India: Split AC represents 80% of total AC units sold in India

- Currently **>600,000 R290 units** installed in the market
- **>4,500 trained technicians** across the country
- **Export** to other countries: Maldives, Nepal, Grenada, Bhutan, Philippines, Costa Rica, Thailand, Ghana, etc.

Top efficient split AC models in India

Models	Model	CC (kW)	ISEER	Refrigerant	Unit Price (USD)
Daikin	TKM35SRV16	3.6	5.6	R32	718
Godrej	GSC 12 FIXH 7 GGPGb	3.5	5.8	R290	905
Hitachi	RAU512AWEA	3.6	5.7	R410A	916
Daikin	JTKM50SRV16	5.0	5.2	R32	819
Mitsubishi	MSY-GK24VA	6.7	4.8	R410A	936



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Market trends of residential AC

Europe: moving towards **R290 in portable AC**

- EU F-Gas Regulation bans the use of HFCs with GWP > 150 in portable AC as of 2020
- At least **8 manufacturers**
- Approx. **200,000 portable AC units**
- All new products are expected to use R290 within the next 2 years
- The use of R290 split AC in residential applications is widely untapped in Europe, although internationally there is progress

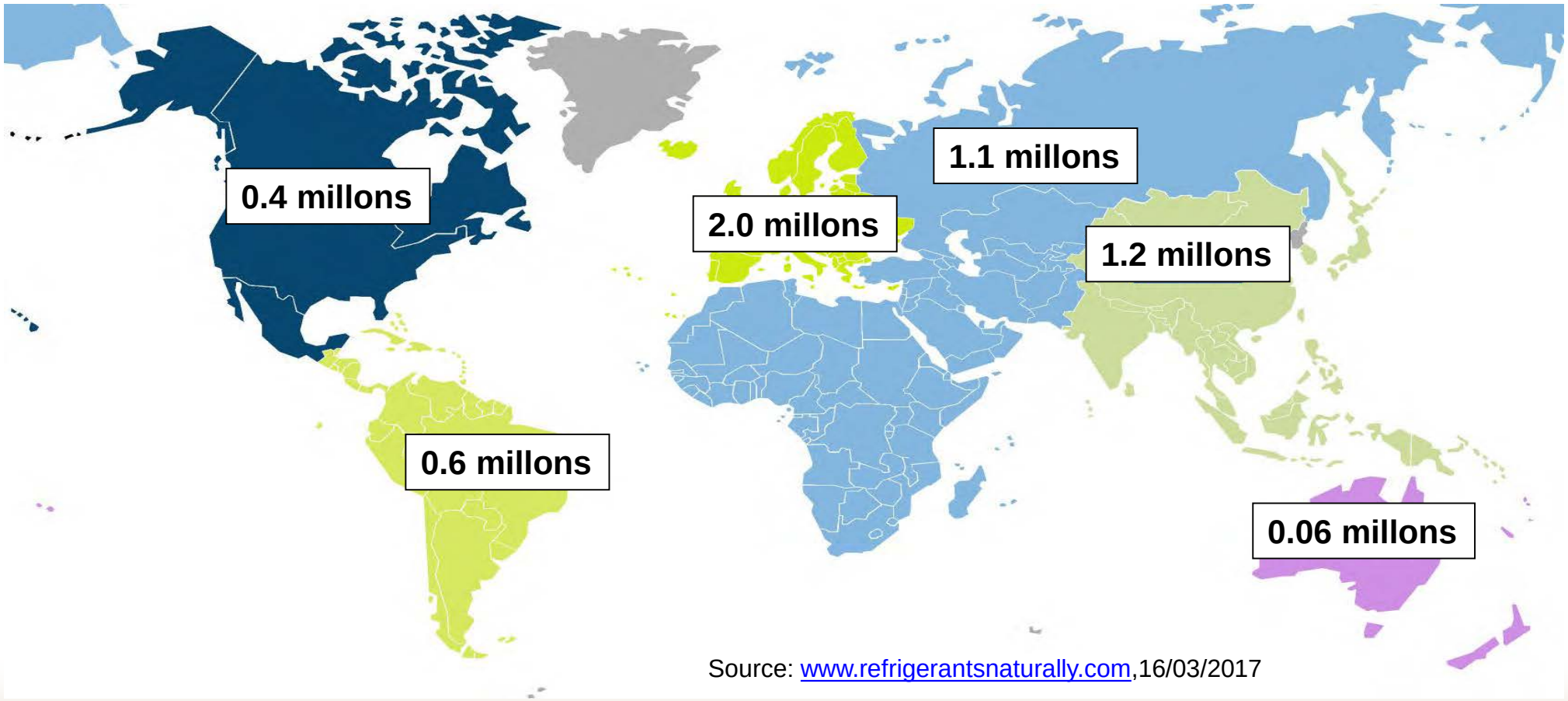
Consumer Brands Choose Natural Refrigerants

5.5 million units using natural refrigerants (HC & CO2) collectively installed

⇒ 33 million tones of avoided CO2 (equivalent emissions of more than 6.7 million passenger cars over one year)

Increasing number of consumer brands choosing HCs for their point of sale equipment - **often targeting global procurement 100%**

Diffusion of self-contained commercial plug-in HC and CO2 refrigeration equipment



Source: www.refrigerantsnaturally.com,16/03/2017

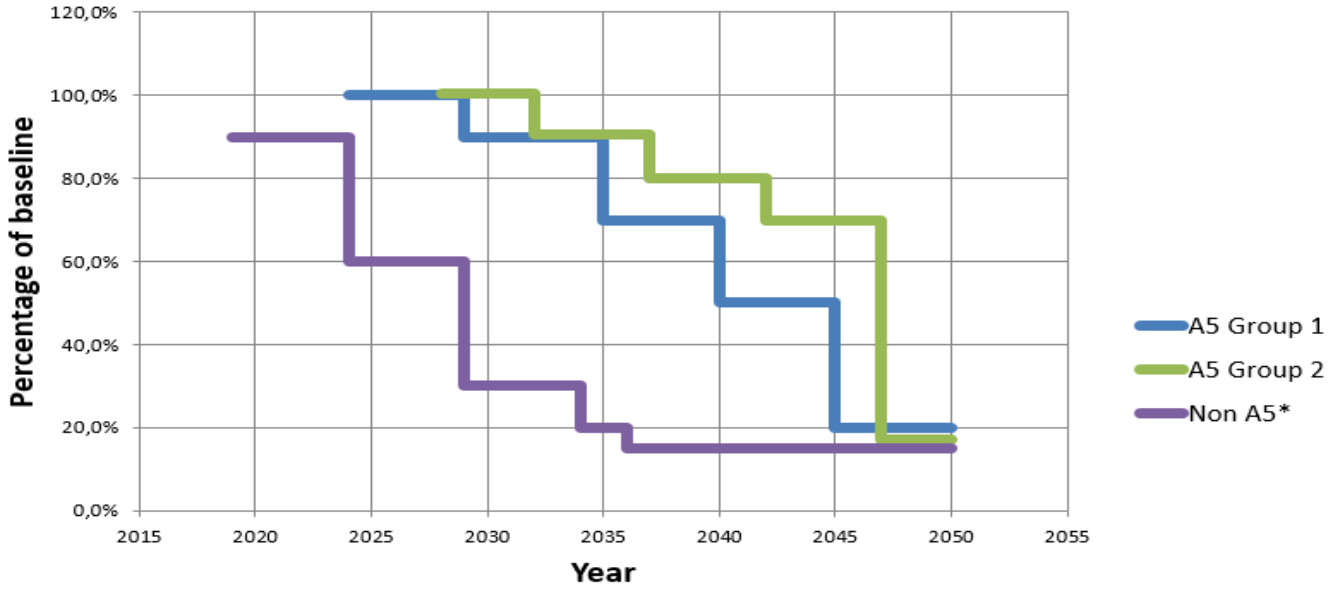
CO2 Stores Growing Globally (2016)

“Low Hanging Fruit”
RAC & Foam Subsectors with high emission reduction potential

- Household refrigerators
- Split ACs
- Commercial refrigeration
- Production of XPS insulation sheets
- Chillers
- Industrial refrigeration
- Buildings (District Cooling, Absorption cooling)
- Transport refrigeration

Preparing for the implementation of the Kigali Amendment

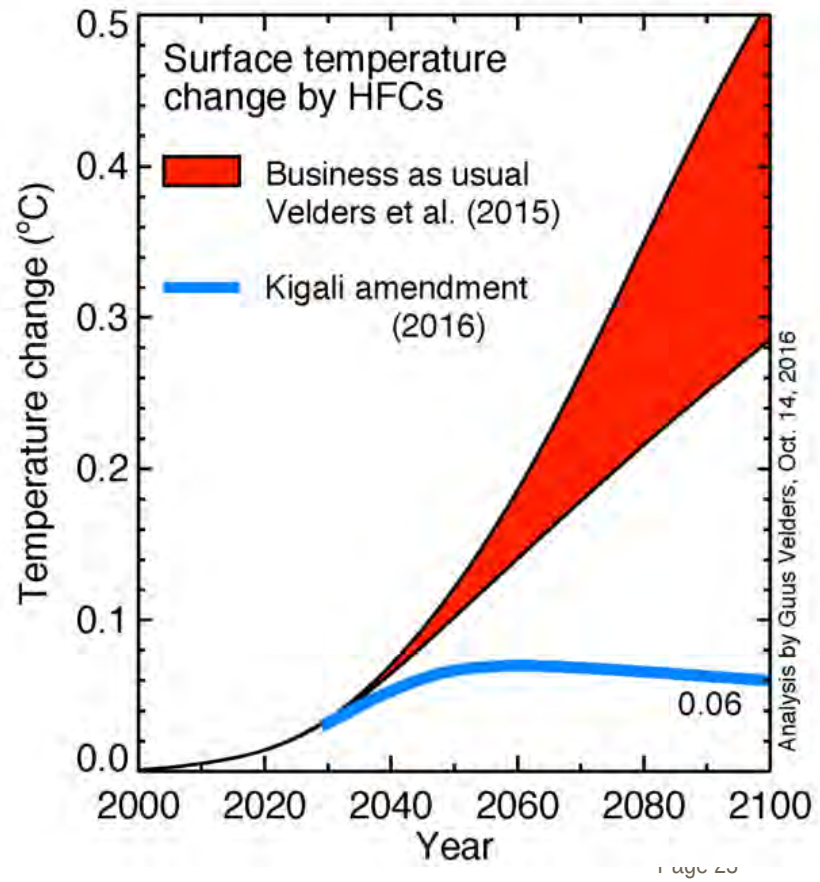
- Freezing HFC consumption in 2024 and introducing a first HFC phase-down step of 10% by the end of 2028 in most developing countries.
- The Kigali Amendment can therefore work alongside the Paris Agreement to achieve the level of emission reductions needed to achieve the internationally agreed “well below 2°C” warming limit



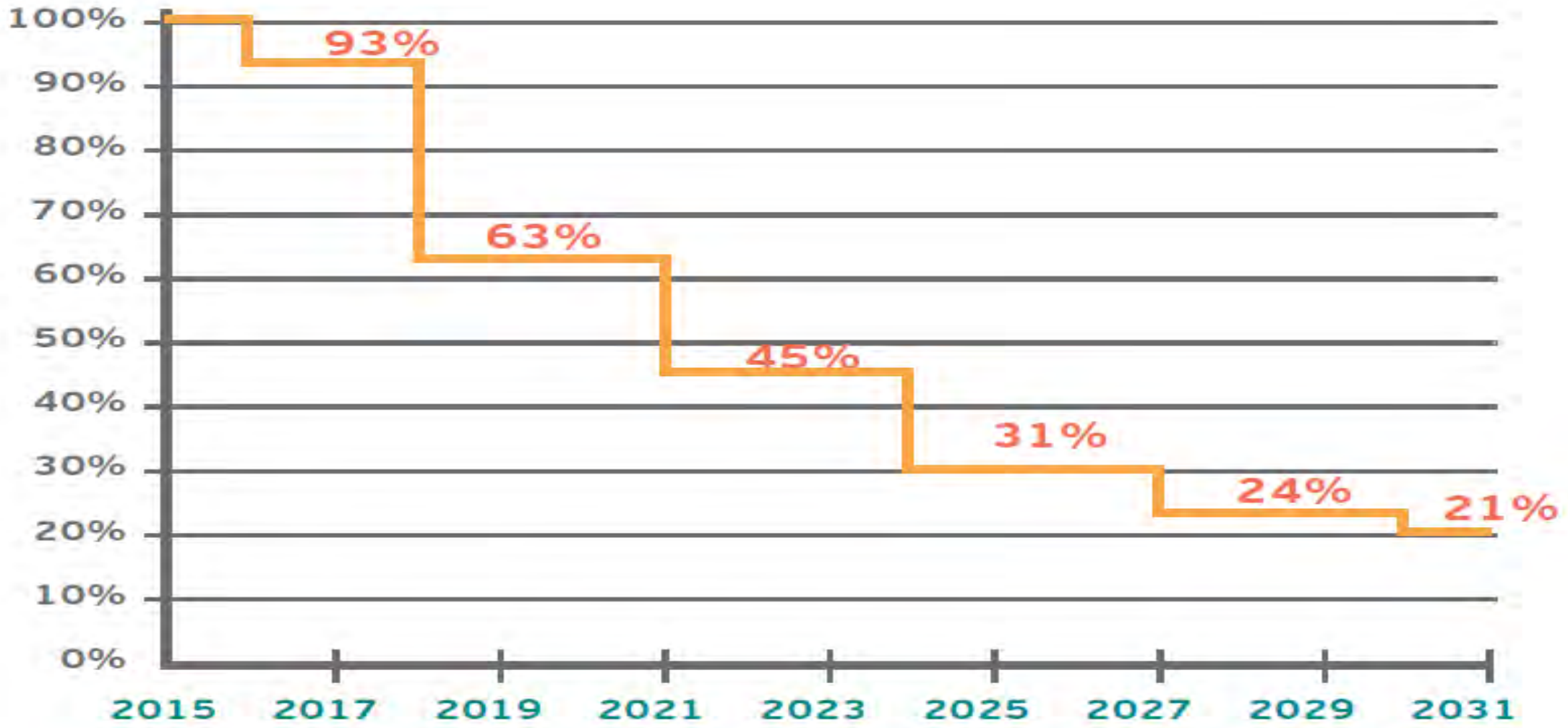
- **Baseline for Non A5** = Average HFC consumption levels for 2011-2013 + 15% of HCFC baseline*

  *For Belarus, Kazakhstan, Russian Federation, Tajikistan, Uzbekistan, 25% HCFC component of baseline and different initial two steps (1) 5% reduction in 2020 and (2) 35% reduction in 2025
- **Baseline for A5 Group 1** = Average HFC consumption levels for 2020-2022 + 65% of hydrochlorofluorocarbon (HCFC) baseline
- **Baseline for A5 Group 2** = Average HFC consumption levels for 2024-2026 + 65% of HCFC baseline

NOTE: the same phasedown schedule and formula apply to production and consumption



EU F-Gas Regulation HFC phase down is more ambiguous



Thank you for your attention!

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