Phasing-in for a Change: Natural Refrigerants

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> 20 years > 240 projects in 40 partner countries → reduction of ~10,000 ODP t and ~ 100 Mio tons CO₂eq.
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

<table>
<thead>
<tr>
<th>Substance</th>
<th>Ozone Depletion Potential (ODP) (R11=1)</th>
<th>Atmospheric lifetime (yrs)</th>
<th>Global Warming Potential (GWP) 100yrs CO2eq</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFC-12</td>
<td>1</td>
<td>100</td>
<td>10,900</td>
</tr>
<tr>
<td>HFC-404a</td>
<td>0</td>
<td>14 – 52</td>
<td>3922</td>
</tr>
<tr>
<td>HFC 410a</td>
<td>0</td>
<td>5 – 29</td>
<td>2,088</td>
</tr>
<tr>
<td>HCFC-22</td>
<td>0.055</td>
<td>12</td>
<td>1,810</td>
</tr>
<tr>
<td>HFC-407c</td>
<td>0</td>
<td>5 – 29</td>
<td>1,800</td>
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<tr>
<td>HFC-134a</td>
<td>0</td>
<td>14</td>
<td>1,430</td>
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<tr>
<td>HFC-32</td>
<td>0</td>
<td>4.9</td>
<td>675</td>
</tr>
<tr>
<td>HC-290</td>
<td>0</td>
<td>0.04</td>
<td>3</td>
</tr>
<tr>
<td>HC-600a</td>
<td>0</td>
<td>0.02</td>
<td>3</td>
</tr>
<tr>
<td>HC-1270</td>
<td>0</td>
<td>0.0001</td>
<td>2</td>
</tr>
<tr>
<td>Ammonia (NH3)</td>
<td>0</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>CO2</td>
<td>0</td>
<td>30-95</td>
<td>1</td>
</tr>
</tbody>
</table>
There are climate-friendly, sustainable alternatives for (nearly) all applications.
The "Green Cooling" Approach

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

Focus not only on the ozone hole but also on the climate protection!
## Benefits of natural refrigerants

<table>
<thead>
<tr>
<th></th>
<th>HCFC</th>
<th>HFC</th>
<th>u-HFC</th>
<th>NH₃</th>
<th>CO₂</th>
<th>HC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ozone depletion</td>
<td></td>
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<tr>
<td>High GWP</td>
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<td>Persistent wastes</td>
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<tr>
<td>Depletable resources</td>
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<tr>
<td>Recycling/disposal</td>
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<tr>
<td>Safety issues</td>
<td></td>
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<tr>
<td>Energy efficiency</td>
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<tr>
<td>Costs</td>
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<tr>
<td>Local production</td>
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</tbody>
</table>

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

Source: Green Cooling Technologies, 2014, GIZ Proklima/ HEAT GmbH
Thermodynamic properties $\rightarrow$ refrigerant operation

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

- R22: GWP 1810, HCFC Phase-Out
- R410A: GWP 2088, HFC Phase-Down
- R32: GWP 675
- R290: GWP 3

Source, UNEP

65% Air-conditioning
35% Refrigeration
45% Air-to-Air
4% Heating only heat pumps
15% Chillers
36% Mobile
2% Domestic
5% Transport
20% Industrial
73% Commercial

Source: shecco
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

<table>
<thead>
<tr>
<th>Models</th>
<th>Model</th>
<th>CC (kW)</th>
<th>ISEER</th>
<th>Refrigerant</th>
<th>Unit Price (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daikin</td>
<td>TKM35SRV16</td>
<td>3.6</td>
<td>5.6</td>
<td>R32</td>
<td>718</td>
</tr>
<tr>
<td></td>
<td>Godrej GSC 12 FIXH 7 GGPGGb</td>
<td>3.5</td>
<td>5.8</td>
<td>R290</td>
<td>905</td>
</tr>
<tr>
<td>Hitachi</td>
<td>RAU512AWEA</td>
<td>3.6</td>
<td>5.7</td>
<td>R410A</td>
<td>916</td>
</tr>
<tr>
<td>Daikin</td>
<td>JTKM50SRV16</td>
<td>5.0</td>
<td>5.2</td>
<td>R32</td>
<td>819</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>MSY-GK24VA</td>
<td>6.7</td>
<td>4.8</td>
<td>R410A</td>
<td>936</td>
</tr>
</tbody>
</table>
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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