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## FORUM SUR L'ÉNERGIE DURABLE DE LA CEDEAO ESEF 2024

### Vers Une Transition Energétique Juste en Afrique de l'Ouest

# Natural Refrigerants in Africa (SophiA – IIR)

SOPHIA
Sustainable Off-grid solutions for Pharmacies and Hospitals In Africa


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Parc des Expositions - Abidjan, Côte d´Ivoire
28 - 29 novembre 2024

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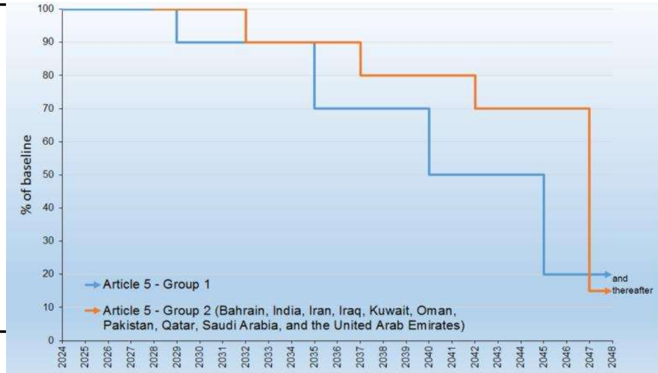
# Historical perspective

- Natural refrigerants were predominant until the 1930s and 1940s, when they were replaced by synthetic refrigerants
- Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) <u>deplete the ozone layer and also contribute to GHG emissions</u>
- As of 2024, the Parties to the Montreal Protocol have phased out nearly 99% of ozone depleting substances, including CFCs and some HCFCs


Source: Daniel Overbey, Global Warming Potential of Common Refrigerants

# Environmental impact of HFOs

- The Montreal Protocol banned the production of CFCs, and the 2016 Kigali Amendment established the phase-out of high-GWP HFCs
- HFOs (hydrofluoroolefins) are a low GWP alternative to HFCs…
- However, HFOs can convert into TFA in the atmosphere: a highly persistent pollutant, suspected to affect biological organisms at higher concentrations, including being toxic to reproductive systems

| | Article 5 Parties: Group 1 | |
|---|---|---|
| Baseline Years | 2020, 2021 & 2022 | |
| Schedule |  | |
| Reduction Steps Freeze | 2024 | |
| Step-1 | 2029 | 10% |
| Step-2 | 2035 | 30% |
| Step-3 | 2040 | 50% |
| Step-4 | 2045 | 80% |

# Refrigerants by application

Current refrigerant use in various African 5 countries

| Sector | Refrigerants predominantly being used currently (GWP) |
|---|---|
| Residential air conditioning (RAC) | HFC- 32 (677) |
| Commercial air conditioning (CAC)<br>Ducted Packaged AC<br>Scroll Chillers<br>VRF<br>Screw & Centrifugal Chillers | HFC- 410A (1924)<br>HFC- 407C (1774)<br>HFC-134a (1300) |
| Residential refrigeration (RR) | HC 600a (3) |
| Commercial refrigeration (CR)<br>Display Cabinets<br>Vaccine /Medical Storage<br>Cold Storage<br>Cold Chain | HFC-404A (3922)<br>HCFC- 22 (1760) |
| Mobile air conditioning (MAC) | HFC 134a (1300) |

Natural Refrigerants

No concern related to GWP
Not concerned by F-gas, PFAS ...
No risk to invest in technologies in the phase out agenda

| | $CO_2$ / R744 | $NH_3$ / R717 | HC | $H_2O$ / R718 | Air / R729 |
|---|---|---|---|---|---|
| Domestic applications | ☺ | | ☺ | | |
| Commercial refrigeration | ☺ | ☺ | ☺ | | |
| Industrial refrigeration and heat pump systems, | ☺ | ☺ | ☺ | ☺ | |
| Water and space heating heat pumps | ☺ | ☺ | ☺ | | |
| Chillers | ☺ | ☺ | ☺ | ☺ | |
| Vehicle air conditioning | ☺ | | ☺ | | ☺ |

# Benefits of natural refrigerants

- Moderate use and emissions do not cause unknown changes in the environment
- Natural refrigerants offer energy efficiency improvements over systems using synthetic refrigerants
- When correctly selected in suitably designed systems, applications include:
  - Domestic refrigeration and AC (e.g. R600 and R290)
  - Commercial refrigeration (e.g. R744)
  - Industrial refrigeration (e.g. ammoniac)

# Characteristics of selected natural refrigerants

| Refrigerant | GWP | PFAS | Flammable | Toxicity | Comparative Costs | | Swept Volume of compressor | Theoretical COP |
|---|---|---|---|---|---|---|---|---|
| | | | | | Refrigerant | Installation | | |
| HFCs | high | Some are and a few from TFA | no<br>GWP < 750 moderate | Low, but highly toxic fumes when combusted | moderate | low | medium | good |
| HFOs | Low[1)] | Some are and several form TFA | moderate | Low, but highly toxic fumes when combusted | high | moderate | medium | good |
| Hydrocarbons | low | no | yes | no | low | moderate | small to large | very good |
| Carbon Dioxide | low | no | no | above 10 % | low | moderate | small | Moderate to very good[2)] |
| Ammonia | none | no | Yes, but less than HFOs | yes | low | moderate | medium | very good |
| Water | none | no | no | no | low | moderate | very large | good |

# Systems with natural refrigerants in Africa

- Over 220 transcritical R744 units operating in South Africa by 2020, twice more than in 2018 (ATMOsphere, 2022).
- In 2018, 59% of household refrigerators sold in Kenya used R600a (isobutane) (Kenya NCAP, 2023).
- In Nigeria, “ColdHubs Ltd.” has been designing, installing, commissioning and operating solar-powered R290 cold rooms since 2016
- SophiA container in Burkina Faso

# SophiA container in Burkina Faso

1- Power system
2- Storage at -70°C
3- Storage at -30°C
4- Storage at +5°C

5- Thermal energy storages
6- Machinery room
7- Emergency lithium batteries

# Challenges and Barriers

- Supply and availability of equipment, components and refrigerants
- Technical issues related to refrigeration and safety engineering
- Regulations and standards to direct technology application
- Practical training to safely handle flammable natural refrigerants(e.g. hydrocarbons), install and service specific systems (e.g. R744 transcritical systems)

# Policy recommendations

- Raising awareness of the environmental, energy, technical, economic/life-cycle cost and other related benefits of using natural refrigerants
- Setting up training programmes to empower the workforce
- Market development through collaboration with local manufacturers and financial incentives
- Drafting and implementation of standards and regulations on the storage, distribution, handling and application of natural refrigerants.

# Call for Contributors - SophiA Policy brief on Natural Refrigerants in Africa


Authored by partners from SophiA and IIR network, and reviewed by ECREEE

Aims to guide the technological adoption of natural refrigerants based on environmental, climatic, safety and economic factors

Sustainable Off-Grid Solutions Program for Pharmacies and Hospitals in Africa (SophiA) Workshop 2024

# Thank you

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