

Indo-EU workshop on  
"A Sustainable Transformation of RAC Sector  
with a Specific Focus on Improving Energy Efficiency"  
The Delegation of EU in India and GIZ;  
7 November 2014; New Delhi

# Non-HFC Alternatives in the AC & R - Challenges

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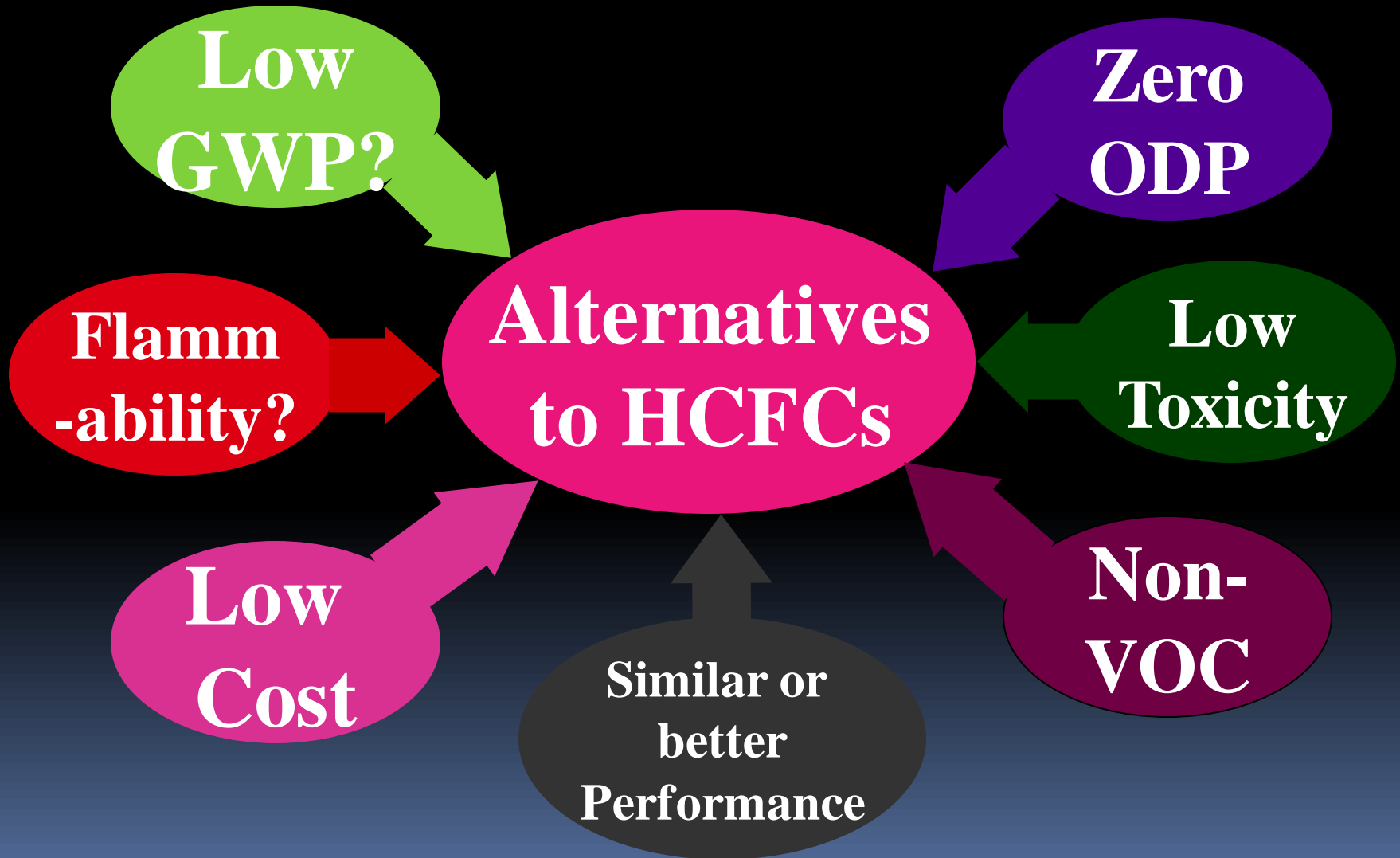
# Outline

- **Alternative refrigerants – Desirable Characteristics**
- **Alternatives to HCFCs**
- **Non-HFC Alternatives**
- **Commercial Refrigeration**
- **Industrial Refrigeration**
- **Unitary A/C Sector**
- **HC-290 in A/C - Issues**
- **Concluding Remarks**

# HCFCs & RAC Sector

- Currently, HCFC-141b and HCFC-142b are mainly used in the manufacturing of foam products (32.5%) and HCFC-22 in AC&R sector, including servicing sector (66.2%).
- HCFC-22 is used in Commercial, Unitary AC and Industrial refrigeration
- HCFC-22 is also significantly used for servicing of air conditioning and commercial refrigeration.
- Other HCFCs used in the RAC are HCFC-123 in centrifugal chillers.

# Alternatives to HCFCs- Desirable Characteristics



# GWP – What is Low?

In the XXI/9 report, TEAP proposed the following classification for refrigerant chemicals:

- **Low-GWP: < 300**
  - **GWP < 100**                      very low
  - **GWP < 30**                      ultra low
- **MODERATE GWP: 300-1,000**
- **HIGH GWP: > 1,000**
  - **GWP > 3,000**    very high
  - **GWP > 10,000**                      ultra high

**This was not accepted by parties to MP!**

# Alternative Refrigerants

Refrigerant	GWP
HCFC-22	1700
HFC-32	675
<b>R</b> -404A	3780
<b>R</b> -407C	1650
<b>R</b> -410A	1980
<b>HC</b> -290 (propane)	3
R-717 (ammonia)	0
R-744 (Carbondioxide)	0
<b>HFC</b> -1234yf	4
<b>HFC</b> -1234ze	6

R-410A, the current most popular alternative, has higher GWP than HCFC-22!

# Alternatives to HCFC22:

## Commercial Refrigeration (Stand-alone Units)

- The main substitutes are R-404A and R-507A and lower GWP options including R-407A, C and F.
- **HCs or CO<sub>2</sub>** or HFC refrigerant blends are the low GWP options.
- **HCs and CO<sub>2</sub>** are replacing HFC-134a and R-404A and represent a significant market share in Europe and Japan.
- Vending machines increasingly use **HCs (HC-290 & HC-600a) and CO<sub>2</sub>** (high ambient temperature could decrease efficiency significantly); Ice cream freezers increasingly use HCs in Europe
- In supermarkets in Europe, **two-stage CO<sub>2</sub>** systems are recognized as viable option especially in moderate temperature countries.
- Newer HFC refrigerant blends, may be the immediate options.
- **Indian supermarkets are much smaller compared to global practices including neighboring developing countries**
- **Low-GWP options require a significant technical background, for the life cycle of a system, especially under Indian climates.**
- **Very limited experience on the use of HC or CO<sub>2</sub> or R-717.**

# Chillers:

## Low GWP Alternatives to R-410A

- Many chiller manufacturers converted scroll and screw chillers to R-410A because of the early phase-out of HCFC-22.
- No low GWP HFC is known yet.
- There is an increasing emphasis on HFC-32 (or HFC-32 and unsaturated HFCs) with lower GWPs; Safety for HFC-32 will also be an issue.
- R-717 and HCs are not yet chosen because of safety concerns.



# Centrifugal Chillers: Low GWP Alternatives

- No replacements for HCFC-123 (low pressure) or HFC-134a (high pressure) have been commercialized yet.
- HFC-1234yf may prove suitable alternative to HFC-134a in high pressure centrifugal chillers.
- It is not clear whether HFC-1234ze will find use in low pressure chillers.
- Some low GWP HFCs are being developed.
- HCs are only used in process applications but not for comfort cooling because of safety concerns with large refrigerant charges.
- Water (R-718) has been demonstrated in a few installations; with axial compressors operating under high vacuum, but chillers are physically large with higher costs

# Industrial Refrigeration: Ammonia

- Ammonia was the main alternative refrigerant to R-502 and is widely used in industrial systems but its adoption as an alternative to HCFC-22 in A5 countries is still low due to safety concerns.
- In the US the transition to ammonia is still slow.
- Alternatives are R-404A and R-507; Low GWP alternatives are yet to be demonstrated.
- **India has a good know how to use R-717 in cold store**
- **Use of R-717 in newer applications requires safety features with reduced charges**
- **There are many EU vendors this technology but still very little progress?**
- **Some demonstration projects with EU standards may be considered or EU industries operating in India may demonstrate the safe and efficient operation.**
- **The key requirements for India are manpower training and cost reduction.**

# Alternatives to HCFC-22:

## Unitary Air Conditioning

- High GWP refrigerants including R-407C (GWP=1800) and R-410A (2100) are already commercially used. R-407C can be used for retrofitting with some energy penalty. R-410A share is on the increase.
- **HC-290 (20)** is commercially applied in AC (equipment with small charges); China and India have launched up to 5.1 kW AC (**Indian non-inverter models have EERs of 3.7 and can be easily increased to 4.0 with the current designs**).
- **HFC-32 (675)** is used in both A5 and non-A5 countries.
- Other possible low GWP refrigerants include **HFC-152a (124)**, **HFC-161 (12)** and possibly blends of **HFC-1234yf (4)**; None has been commercialized yet.
- All low GWP HFC candidates (**HFC-32, HFC-152a, HFC-161**) are also flammable and have to follow, similar to HC-290, safety standards, such as, IEC-60335-2-40/ISO5149;

# HCs and Unitary ACs

- Currently sales of ACs using HC-290, made by a fully owned by an Indian company, are reported to have touched 100,000 each.
- HC-290 use is currently limited to 5.0 kW ACs due to the safety issues and safety standards. These standards although are not mandatory but are still followed in India.
- To handle HC-290, special training of technicians and additional safety measures during manufacture, installation and servicing will be required.
- **The EER of HC-290 systems can be raised to 4.0 with the current designs.**
- Additional costs for capital equipment, training and safety tool will be involved.

# HC A/C and Issues for India

- Unlike China, for India, the major market share is for 5.2 kW (1.5 TR) and above.
- Indian OEMs are hesitant to use HC-290 due the safety issues
- Indian AC market growth has been more or less stagnation in the last three years or so.
- The industry is concerned that any shift to new refrigerants with technological risk may further impact their growth in the future.
  - This has resulted in a stalemate in the decision making process.
  - **More awareness on safety standards, design, installation and maintenance is required**
  - **Safer design of energy efficient 7 kW Split AC is required to increase the acceptance of HC in AC**

# **Non-HFC Options for India**

- **HCs, NH<sub>3</sub> and CO<sub>2</sub> are more widely promoted by EU through regulations and safety standards but find very marginal use in India**
- **Issues related to availability of components, product re-design, manufacturing, cost competitiveness, energy efficiency, low emissions, flammability, standards for use of flammable refrigerants (HC and R-717), are all interrelated and difficult to quantify on time and cost scales**
- **Costs may be much more and vary significantly depending on the volume – affordability under MP funding will be a major issue**
- **Contradicting signals from US and Europe cloud the emerging options for A5 countries, which need to comply with immediate freeze and reductions, which itself is very challenging**

# **Non-HFC Options: Some Issues & Future Strategy**

- MNCs are still selling low energy efficient ACs using high GWP HFCs
- MNC manufacturing units are yet to lead using non-HFC systems and demonstrate openly
- Although there are many EU operators in India, there is very limited experience on non-HFC refrigerants
- Educate consultants, vendors and large users through EU operators on safe design, installation and operations with risk assessment
- Understand Indian RAC sector and its uniqueness better for future directions
- More demonstration project with respect to safe design, installation and maintenance under Indian conditions
- Cost reduction with local components
- Conduct more awareness programmes with success stories in developing countries having similar conditions

**Thank you!**

**Any questions?**