EGYPRA
Testing Low-GWP Refrigerants for the Air Conditioning Industry in Egypt
Agenda

1. Project Scope
2. Testing parameters
3. Results & key findings
4. Conclusion and way forward
Project Scope

1. Project Scope:
   a. Background and goal
   b. Stakeholders, categories & number of prototypes
   c. Constraints
1- Objectives

HPMH of Egypt

- The first stage of the HCFC Phase-out Management Plan (HPMP) for Egypt was approved at the 65th Meeting of the Executive Committee for the Implementation of the Montreal Protocol with UNIDO as the lead implementing agency.

Technical Assistance Program of HPMP

- Enabling activities are undertaken in the Refrigeration and Air Conditioning (A/C) sector. In this framework, an initiative has been launched for the promotion of low-Global Warming Potential Refrigerants for the Air-Conditioning Sector.

Exploring Alternative Low- GWP Refrigerants

- Replicate a similar successful and ongoing approach being followed by A/C manufacturers in West Asia to examine future alternatives for A/C within the PRAHA project and to link it to the suggested project in Egypt in terms of results sharing and exchange of experience with global technology providers i.e. compressor and refrigerant manufacturers.
### Refrigerants of EGYPRA

<table>
<thead>
<tr>
<th>Refrigerant R-22 Alternatives</th>
<th>Technology Provider</th>
<th>ASHRAE classification</th>
<th>GWP (100 years, RTOC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-290</td>
<td>-</td>
<td>A3</td>
<td>5</td>
</tr>
<tr>
<td>R-444 B (L-20 A)</td>
<td>Honeywell</td>
<td>A2L</td>
<td>310</td>
</tr>
<tr>
<td>R-454 C (DR-3) Opteon XL-20</td>
<td>Chemours (Du Pont)</td>
<td>A2L</td>
<td>295</td>
</tr>
<tr>
<td>R-457 A (ARM – 20d(a))</td>
<td>Arkema</td>
<td>A2L</td>
<td>251</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Refrigerant R-410 A Alternatives</th>
<th>Technology Provider</th>
<th>ASHRAE classification</th>
<th>GWP (100 years, RTOC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-32</td>
<td>Daikin</td>
<td>A2L</td>
<td>704</td>
</tr>
<tr>
<td>R-447A (L-41-2)</td>
<td>Honeywell</td>
<td>A2L</td>
<td>600</td>
</tr>
<tr>
<td>R-454 B (DR-5) Opteon XL-41</td>
<td>Chemours (Du Pont)</td>
<td>A2L</td>
<td>510</td>
</tr>
<tr>
<td>R-459 A (ARM – 71a)</td>
<td>Arkema</td>
<td>A2L</td>
<td>466</td>
</tr>
</tbody>
</table>
28 individually made prototypes units

- Splits 12 MBH
- Splits 18 MBH
- Splits 24 MBH
- Central 120 MBH
  And with micro-channels HE

Refrigerants: R-32, R-290, HFOs (3 Types) eq. to R-22 and HFOs (3 Types) eq. to R-410A
Constrains

Eight OEM factories Participating

Dedicated Compressors for selected refrigerants

According to EOS 4814 and 3795 (ISO 5151)

28 individual prototypes to meet same design capacities

T1 conditions plus T3(ISO), 50 and 55°C
## Number of Prototypes, Base Units and Tests

<table>
<thead>
<tr>
<th>No. of split units</th>
<th>No. of central units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prototype</strong></td>
<td><strong>Base units</strong></td>
</tr>
<tr>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>33</td>
<td>8</td>
</tr>
<tr>
<td>Number of tests, splits</td>
<td>Number of tests, central</td>
</tr>
<tr>
<td>132</td>
<td>32</td>
</tr>
<tr>
<td>164</td>
<td></td>
</tr>
</tbody>
</table>
Testing Parameters

Test conditions and how they are different from other projects
# EGPRA Testing Conditions

<table>
<thead>
<tr>
<th>Conditions</th>
<th>$T_1$</th>
<th>$T_3$</th>
<th>$T_{\text{high}}$</th>
<th>$T_{\text{extreme}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outdoor, °C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>db/wb</td>
<td>35/24</td>
<td>46/24</td>
<td>50/24</td>
<td>55/24</td>
</tr>
<tr>
<td><strong>Indoor, °C</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>db/wb</td>
<td>27/19</td>
<td>29/19</td>
<td>32/23</td>
<td>32/23</td>
</tr>
</tbody>
</table>

### ORNL DOE testing program

<table>
<thead>
<tr>
<th>PRAHA program</th>
<th>Window Type</th>
<th>Outdoor $^a$</th>
<th>Indoor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dry-Bulb Temp.</strong></td>
<td><strong>Dry-Bulb Temp.</strong></td>
<td><strong>Wet-Bulb Temp.</strong></td>
<td><strong>Dew Point Temp. $^b$</strong></td>
</tr>
<tr>
<td>T1</td>
<td>Indoor Temp DB/WB °C</td>
<td>Outdoor Temp DB/WB °C</td>
<td>°C (°F)</td>
</tr>
<tr>
<td>T3</td>
<td>Tdb = 27 °C, Twb=19 °C</td>
<td>Tdb = 35 °C, Twb = 24 °C</td>
<td>27.8 (82)</td>
</tr>
<tr>
<td>T3+</td>
<td>Tdb = 29 °C, Twb = 19 °C</td>
<td>Tdb = 50 °C, Twb = 24 °C</td>
<td>35.0 (95)</td>
</tr>
<tr>
<td>Endurance</td>
<td>Tdb = 32 °C, Twb = 23 °C</td>
<td>Tdb = 52 °C, Twb = 24 °C</td>
<td>46 (114.8)</td>
</tr>
<tr>
<td>All Other Types</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### AHRI B $^c$

- Hot | 52 (125.6) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
- T3  | 46 (114.8) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
- T3+ | 46 (114.8) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
- Endurance | 55 (131) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
- T3+ | 46 (114.8) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
- Endurance | 55 (131) | 29 (84.2) | 19 (66.2) | 13.7 (56.6) | 39 |
Results and Key Findings

Results & Key findings

a. Bar charts for 18K R-22 and R-410A.
b. Scattered charts for the same
18K R22 EQUIVELANT EER CHART

- R-22
- R-290
- ARM-20a
- Opteon XL-20
- DR-3
- R-454C
- R-457A
- R-444B

OEM A

OEM B

OEM C

OEM D
18K CAP. RATIO VS EER RATIO

- R-290 OEM A
- ARMA-20a (R-457A) OEM B
- OPTEON XL-20
- DR-3 R-454C OEM C
- L-20 R444B OEM D

![Graph showing capacity ratio vs. EER ratio for different products.](image-url)
18K R410a EQUIVALENT CAPACITY CHART

- R-410A
- ARM-71a
- R-459A
- R-32
- Opteon XL-41 DR-5
- R-454B

OEM A
OEM C

T 1
T 3
T high
T Ext
18K R410a EQUIVELANT EER CHART

- R-410A
- ARM-71a
- R-32
- Opteon XL-41 DR-5
- R-459A
- R-454B
18K Capacity ratio Vs EER ratio

- ARM-71a
  - R-459A OEM C
- R-32 OEM A
- Opteon XL-41 DR-5
  - R-454B OEM A
18K Capacity ratio Vs EER ratio

- **ARM-71a**
  - R-459A OEM C

- **R-32 OEM A**

- **Opteon XL-41**
  - DR-5
  - R-454B OEM A
Conclusion
And way forward
Comparison of data

- Combining all data for all categories and all refrigerants at the four temperatures conditions.
- Pie charts show the results compared to both HCFC-22 and R-410A
  - Green: increase in performance or cooling capacity,
  - Yellow: decrease in performance or cooling capacity, - 0.01 % to - 5 %,
  - Orange: decrease in performance or cooling capacity from -5 % to -10 %,
  - Red: decrease in performance or cooling capacity over -10 %.
Combined data for HCFC-22 Alternatives

Capacity

EER
Combined data for R-410A alternatives

Capacity

EER
Way Forward

➢ Support OEMs on design with low-GWP refrigerants:
  ✷ Facilitating technology transfer;
  ✷ Participation at international workshops

➢ Support for OEM testing facilities:
  ✷ Make connection with international labs;
  ✷ Technical support to upgrade facilities

➢ Support national labs to test for flammable refrigerants
  ✷ Capacity building for national labs.
Thank you!

Questions