



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



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 EGYBRA

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

Refrigerant R-410 A Alternatives	Technology Provider	ASHRAE classification	GWP (100 years, RTOC)
R-32	Daikin	A2L	704
R-447A (L-41-2)	Honeywell	A2L	600
R-454 B (DR-5) Opteon XL-41	Chemours (Du Pont)	A2L	510
R-459 A (ARM – 71a)	Arkema	A2L	466

Prototypes Capacities

28 individually made
prototypes units

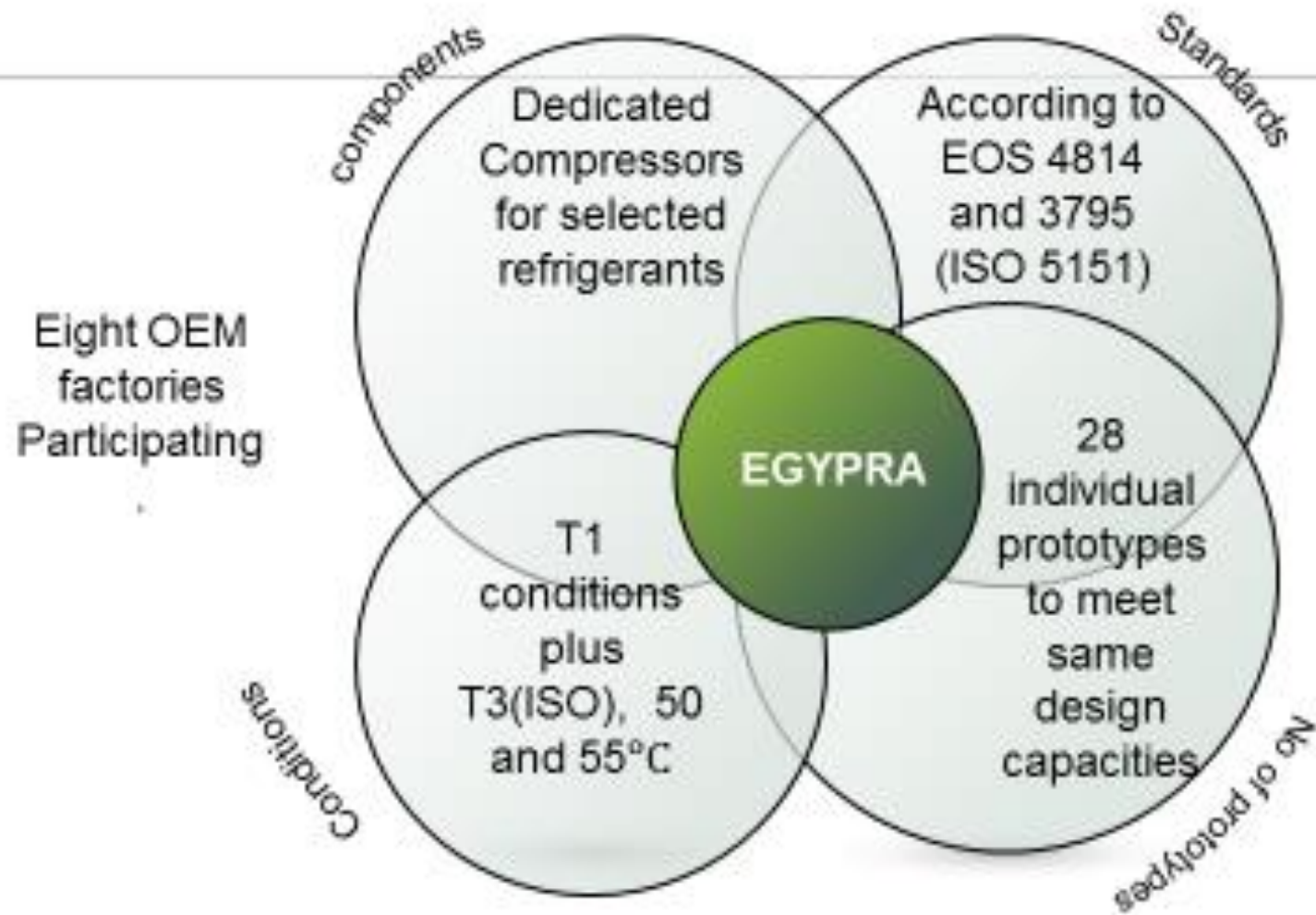
Splits 12 MBH

Splits 24 MBH

Splits 18 MBH

Central 120
MBH
And with micro-
channels HE

Constrains



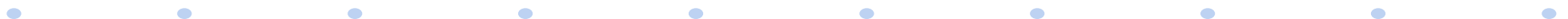
Number of Prototypes, Base Units and Tests

No. of split units		No. of central units	
Prototype	Base units	Prototype	Base units
24	9	4	4
33		8	
41			
Number of tests, splits		Number of tests, central	
132		32	
164			



Testing Parameters

Test conditions and how they are different from other projects



EGYPRA Testing Conditions				
Conditions	T ₁	T ₃	T _{high}	T _{extreme}
Outdoor, °C db/wb	35/24	46/24	50/24	55/24
Indoor, °C db/wb	27/19	29/19	32/23	32/23

PRAHA program Testing Conditions	Window Type		
	Indoor Temp DB/WB °C	Outdoor Temp DB/WB °C	
T1	Tdb = 27 °C, Twb=19 °C	Tdb = 35 °C, Twb = 24 °C	
T3	Tdb = 29 °C, Twb = 19 °C	Tdb = 46 °C, Twb = 24 °C	
T3+	Tdb = 29 °C, Twb = 19 °C	Tdb = 50 °C, Twb = 24 °C	
Endurance	Tdb = 32 °C, Twb = 23 °C	Tdb = 52 °C, Twb = 24 °C	Running continuously for two hours
All Other Types			
	Indoor Temp DB/WB °C	Outdoor Temp DB/WB °C	
T1	Tdb = 27 °C, Twb=19 °C	Tdb = 35 °C, wet bulb temperature not controlled	
T3	Tdb = 29 °C, Twb = 19 °C	Tdb = 46 °C, wet bulb temperature not controlled	
T3+	Tdb = 29 °C, Twb = 19 °C	Tdb = 50 °C, wet bulb temperature not controlled	
Endurance	Tdb = 32 °C, Twb = 23 °C	Tdb = 52 °C, wet bulb temperature not controlled	Running continuously for two hours

ORNL DOE testing program	Outdoor ^a	Indoor			
	Dry-Bulb Temp.	Dry-Bulb Temp.	Wet-Bulb Temp	Dew Point Temp ^b	Relative Humidity
	°C (°F)	°C (°F)	°C (°F)	°C (°F)	%
AHRI B^c	27.8 (82)	26.7 (80.0)	19.4 (67)	15.8 (60.4)	50.9
AHRI A^c	35.0 (95)	26.7 (80.0)	19.4 (67)	15.8 (60.4)	50.9
T3*^d	46 (114.8)	26.7 (80.0)	19 (66.2)	15.8 (60.4)	50.9
T3	46 (114.8)	29 (84.2)	19 (66.2)	13.7 (56.6)	39
Hot	52 (125.6)	29 (84.2)	19 (66.2)	13.7 (56.6)	39
Extreme	55 (131)	29 (84.2)	19 (66.2)	13.7 (56.6)	39



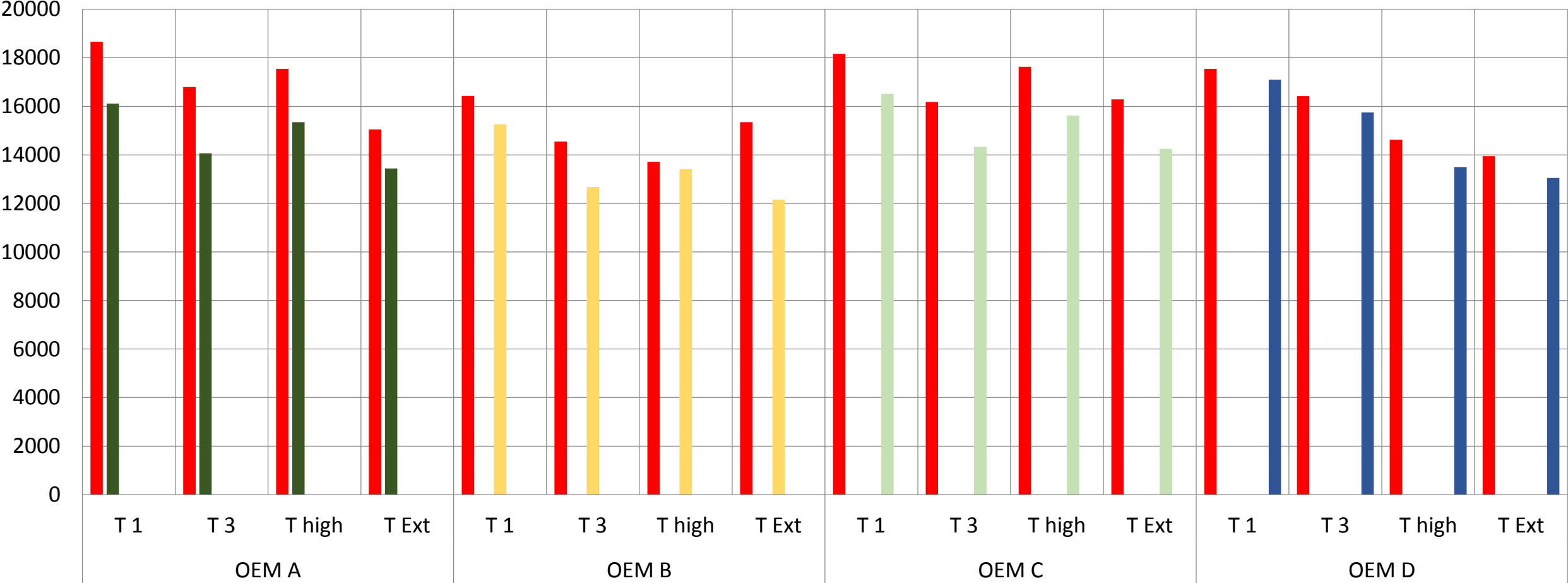
Results and Key Findings

Results & Key findings

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

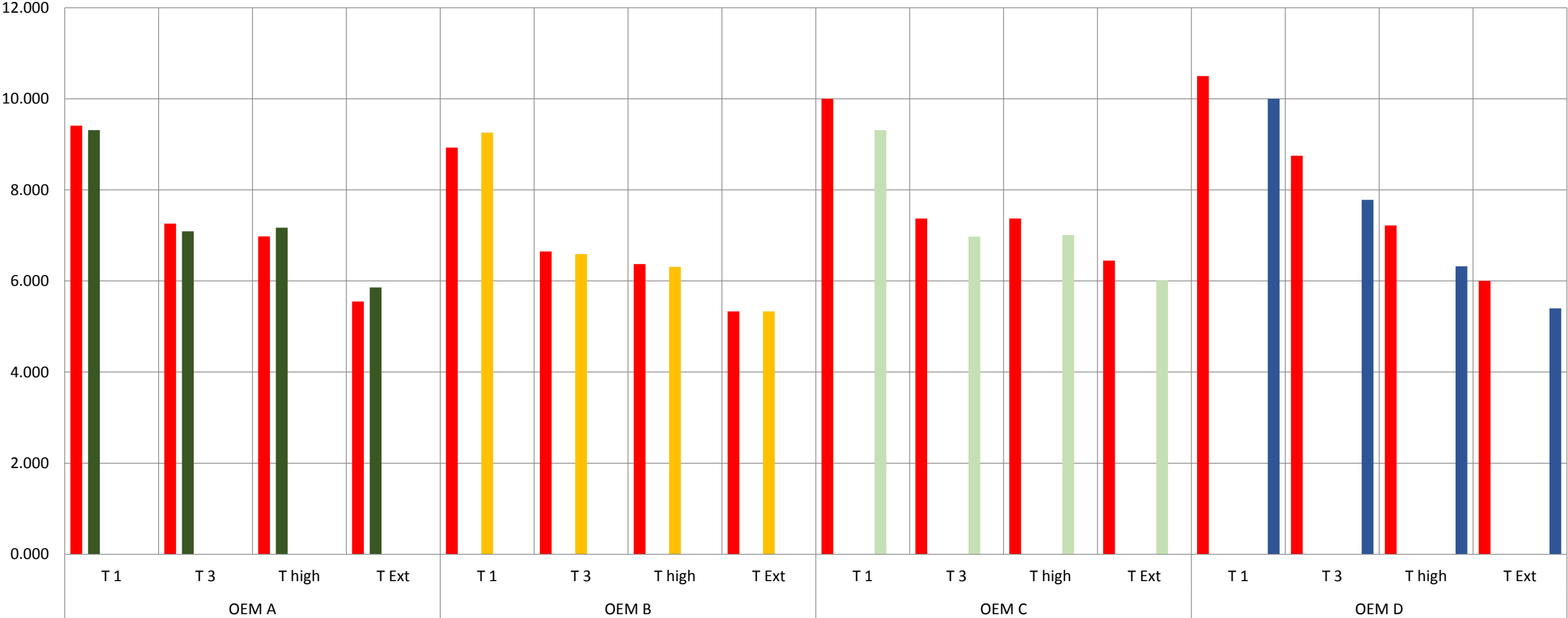
18K R22 EQUIVELANT CAPACITY CHART

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



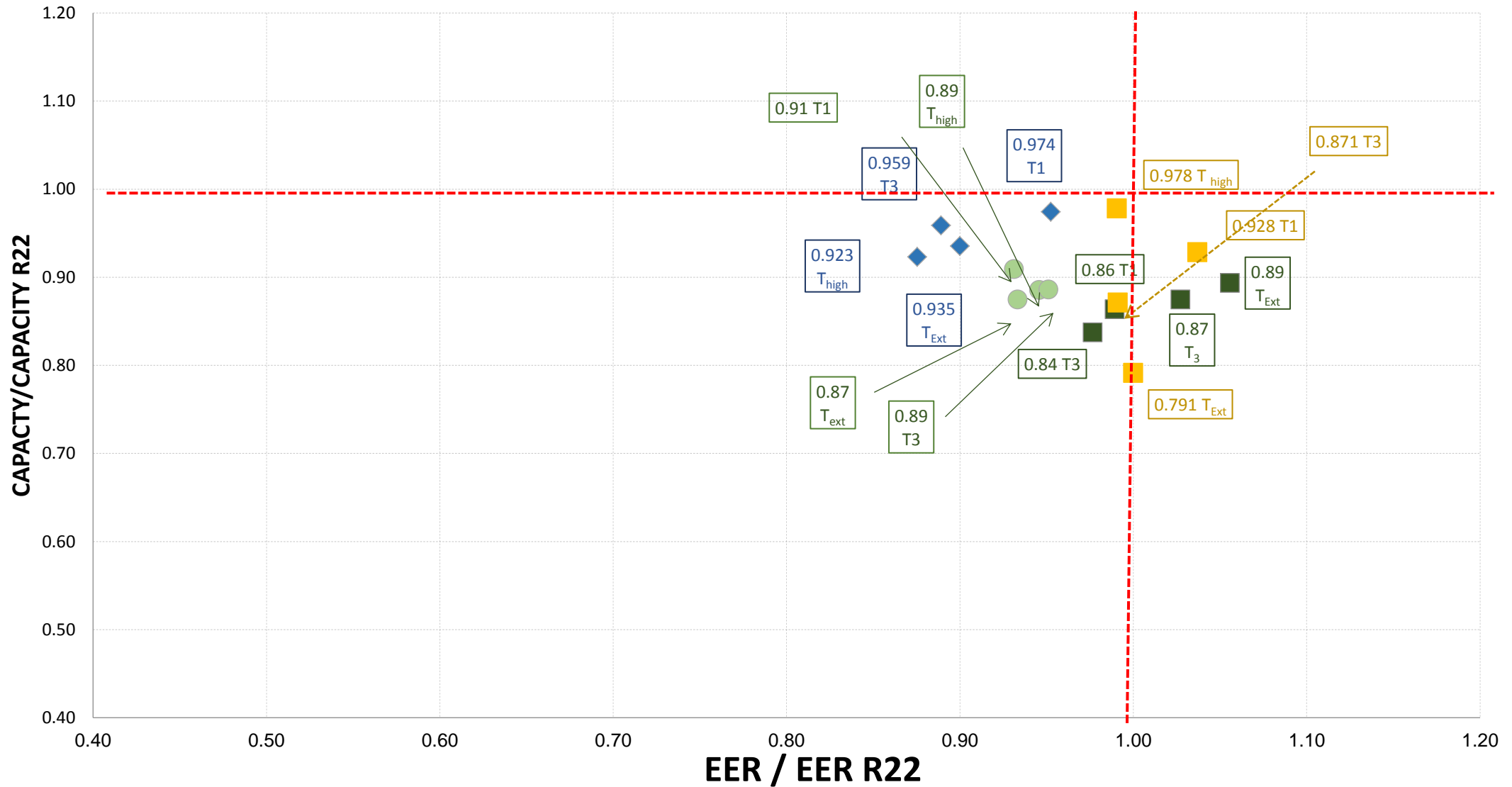
18K R22 EQUIVELANT EER CHART

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



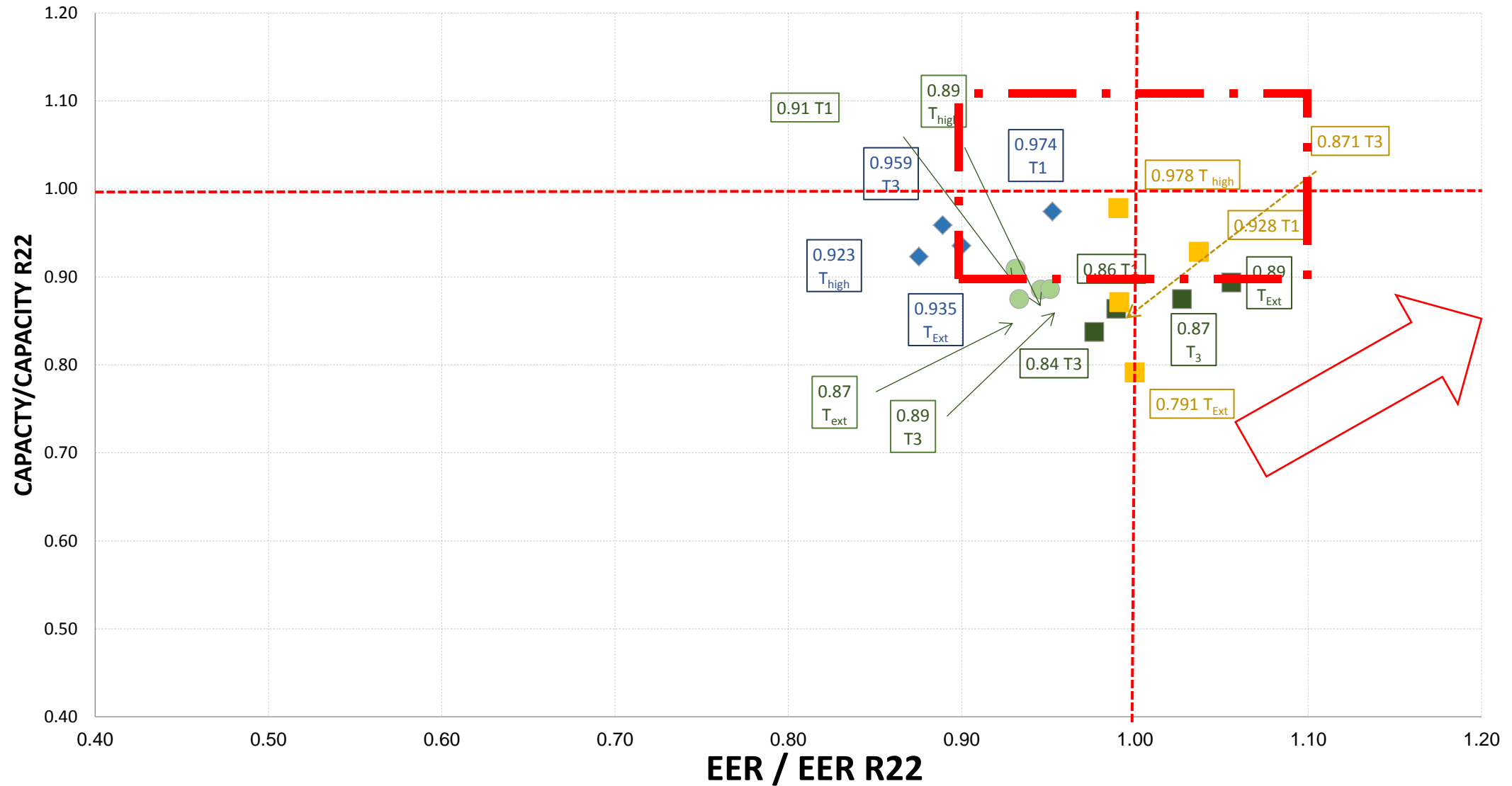
18K CAP.RATIO VS EER RATIO

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



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



18K R410a EQUIVELANT CAPACITY CHART

R-410A

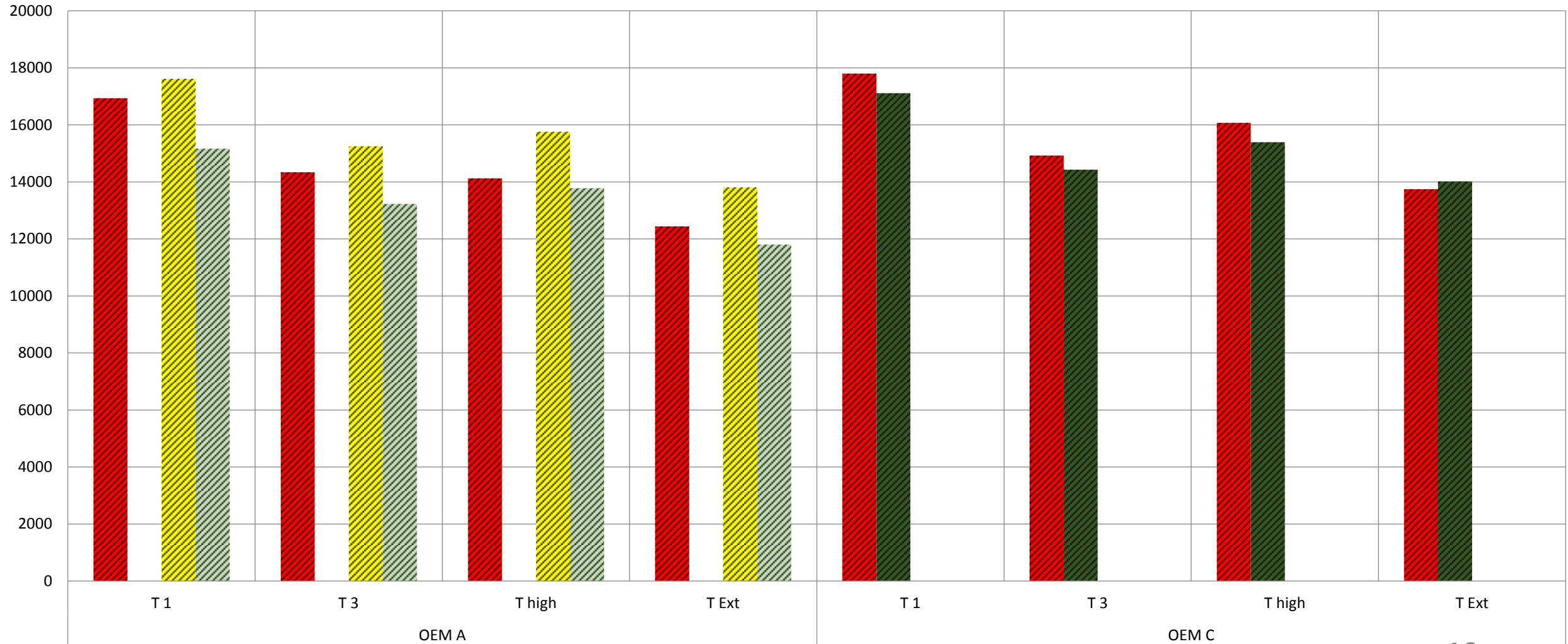
ARM-71a

R-32


Opteon XL-41 DR-5

R-459A

R-454B



18K R410a EQUIVELANT EER CHART

 R-410A

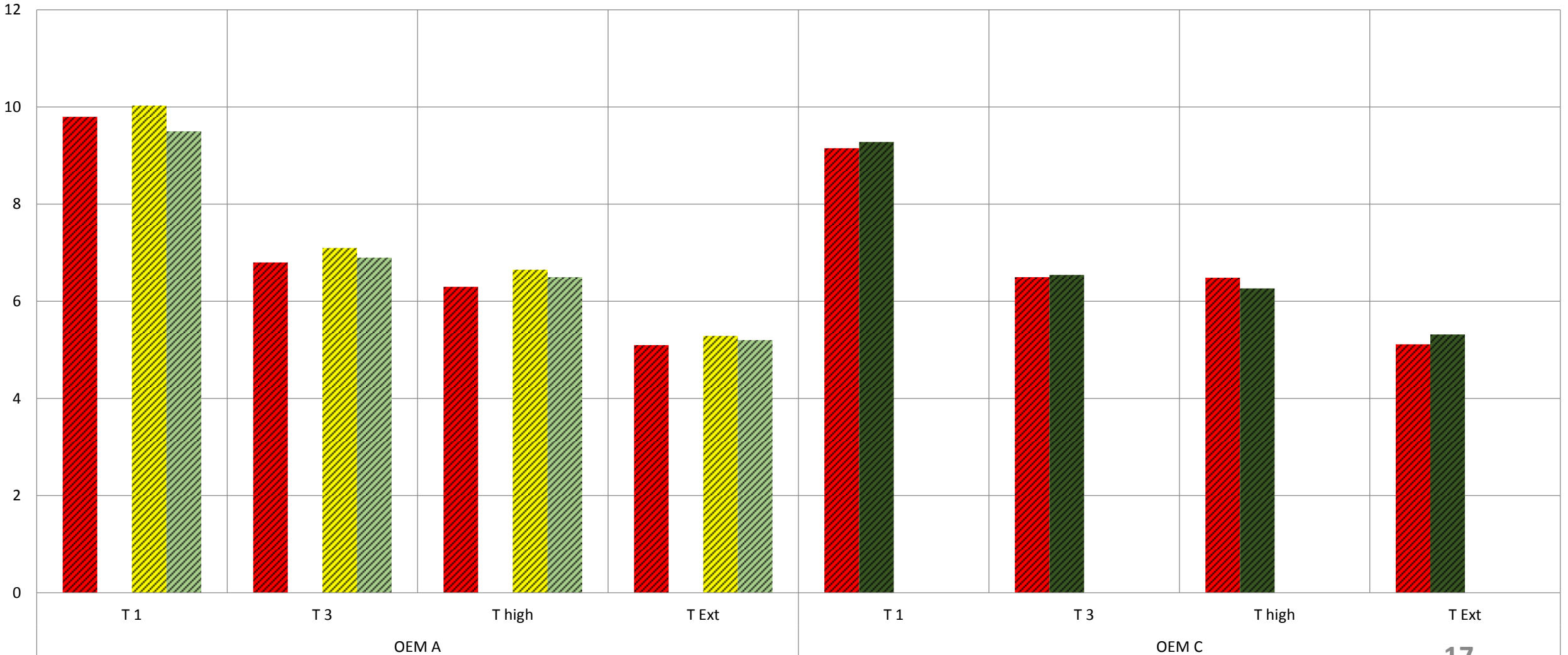
 ARM-71a

 R-32

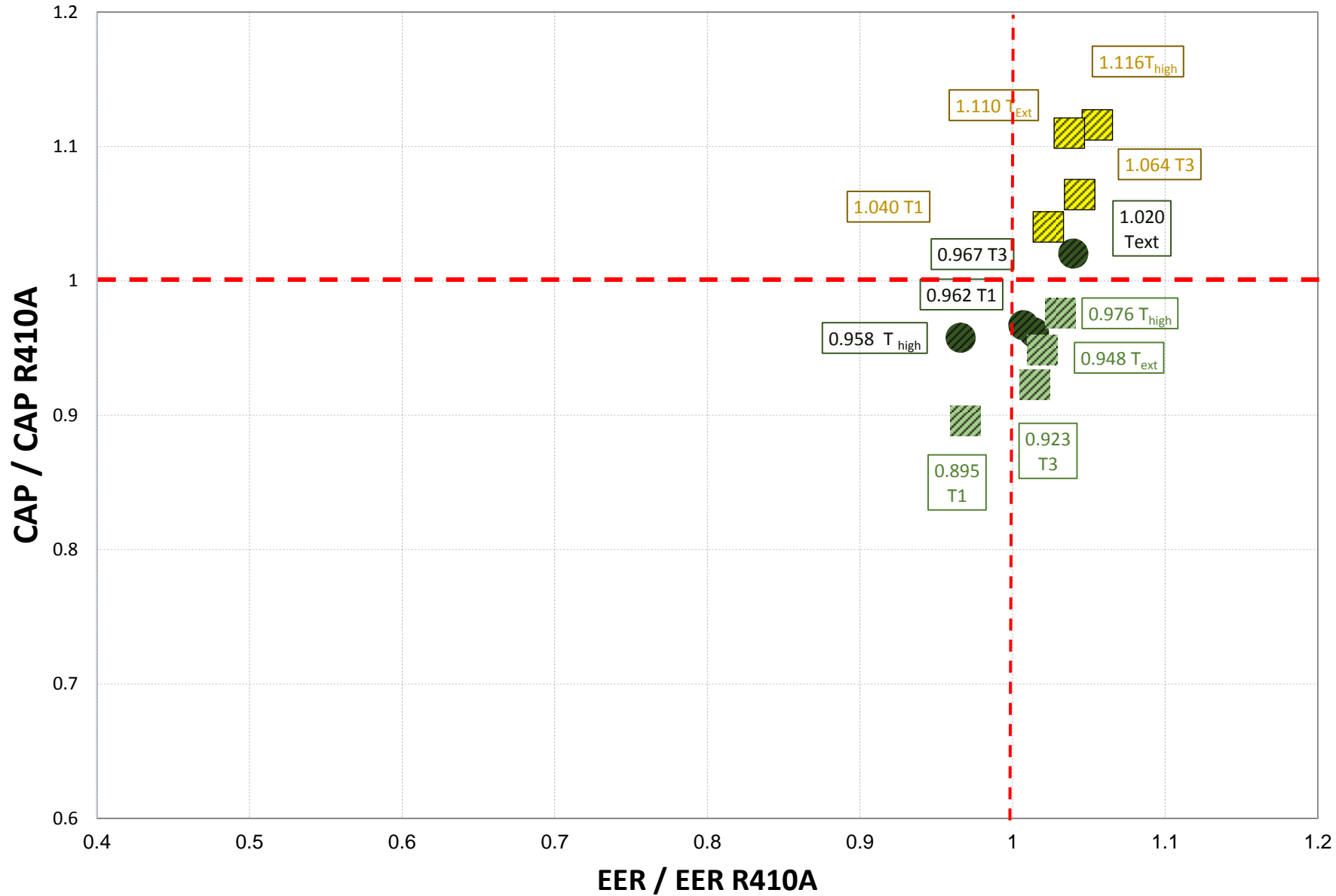
 Opteon XL-41 DR-5

R-459A

R-454B

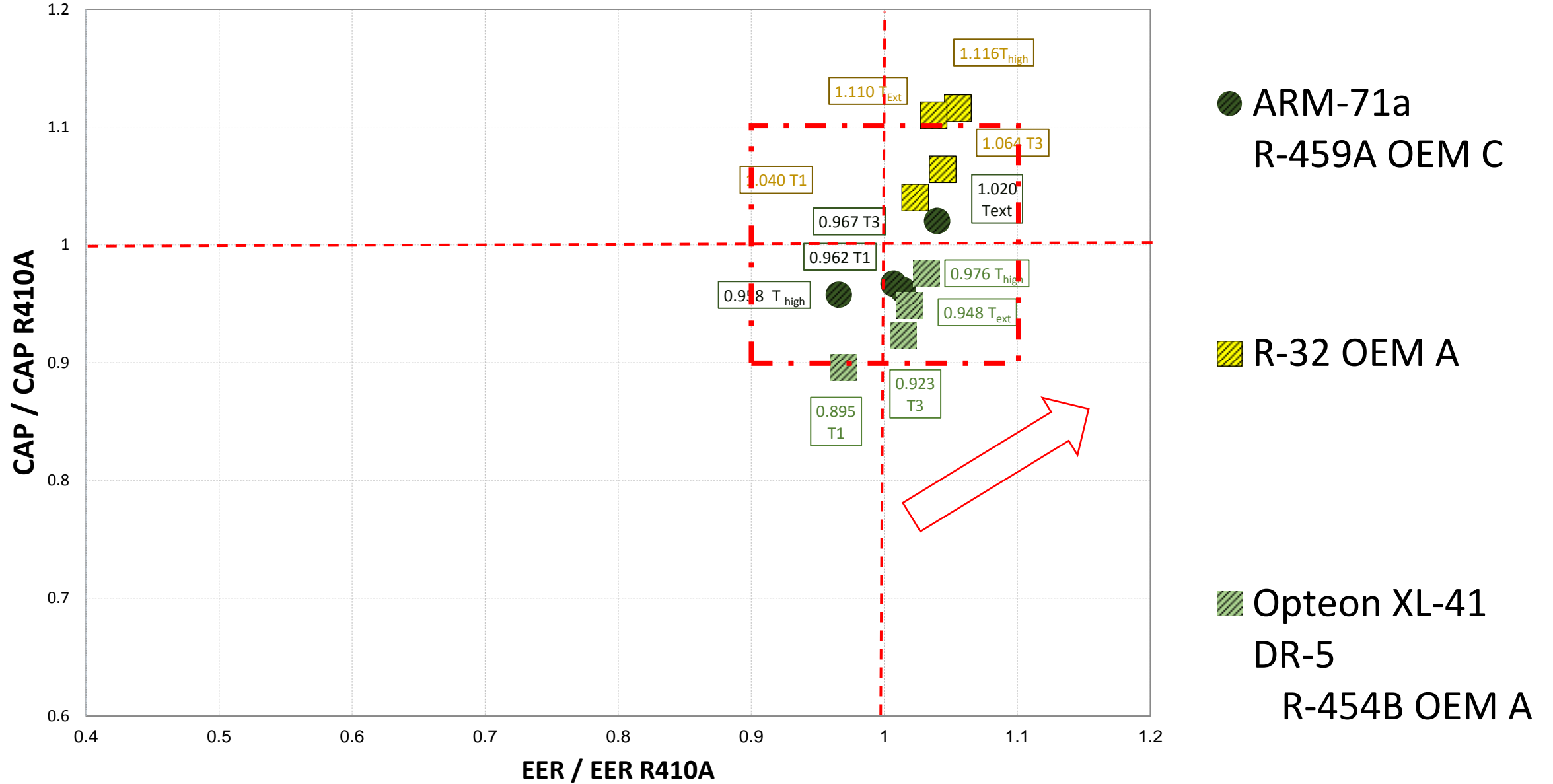


18K Capacity ratio Vs EER ratio



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

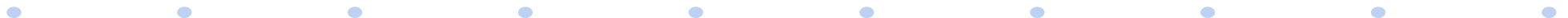
18K Capacity ratio Vs EER ratio





Conclusion

And way forward









Comparison of data

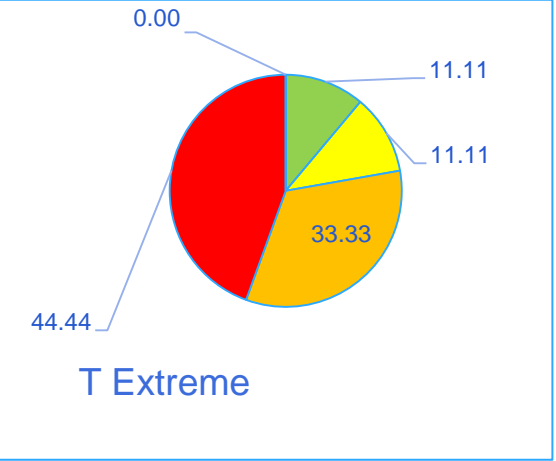
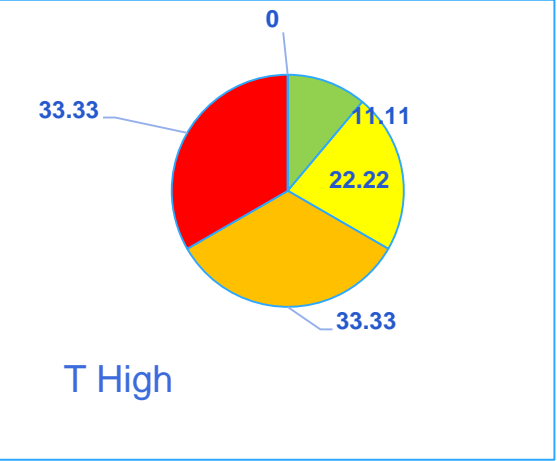
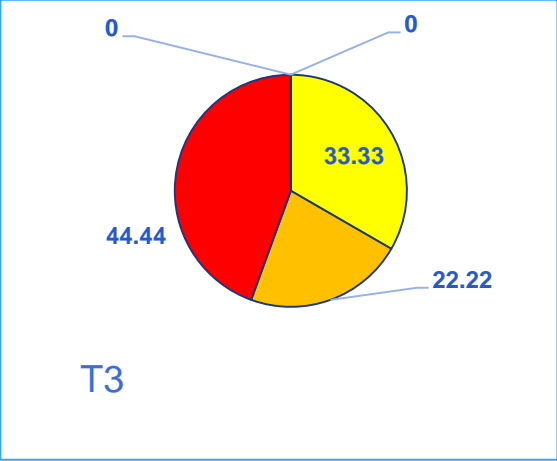
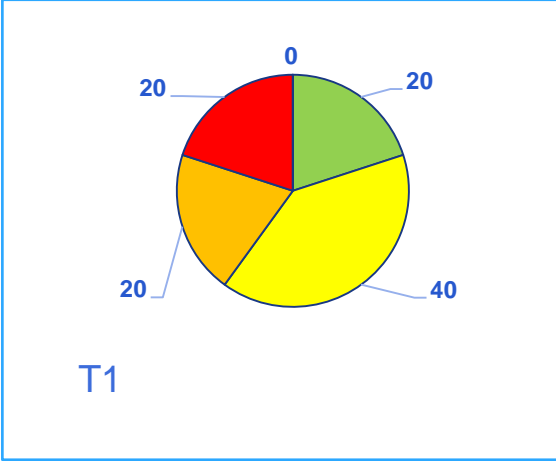


- Combining all data for all categories and all refrigerants at the four temperatures conditions.
- Pie charts show the results compared to both HCFC-22 and R-410A

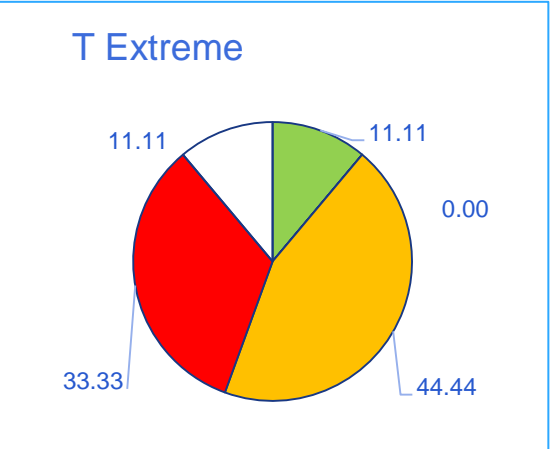
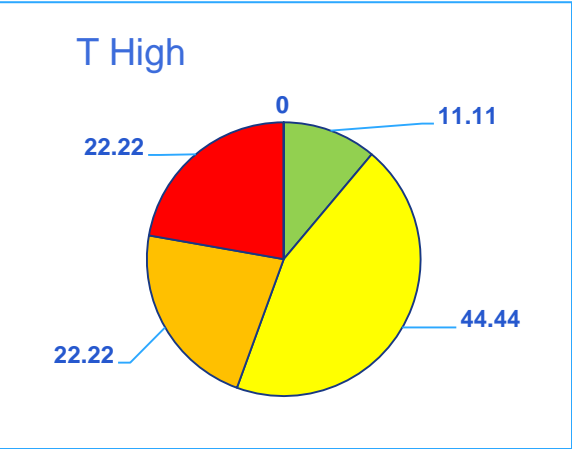
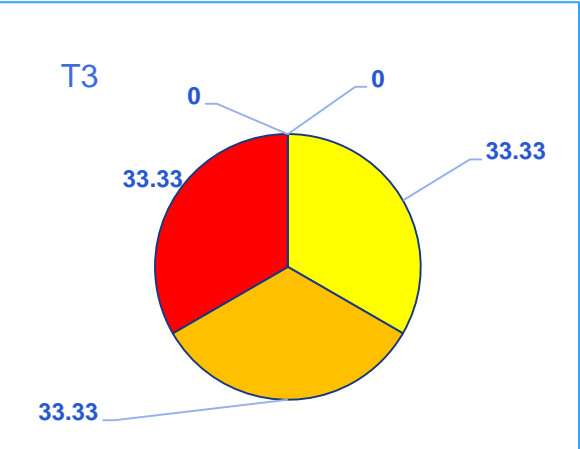
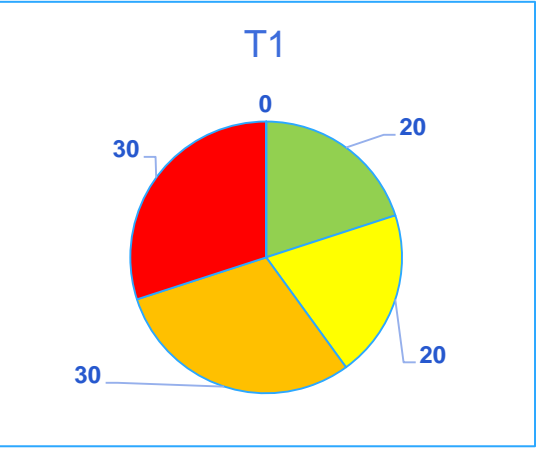
-  – Green: increase in performance or cooling capacity,
-  – Yellow: decrease in performance or cooling capacity, - 0.01 % to - 5 %,
-  – Orange: decrease in performance or cooling capacity from -5 % to - 10 %,
-  – Red: decrease in performance or cooling capacity over -10 %.



Combined data for HCFC-22 Alternatives

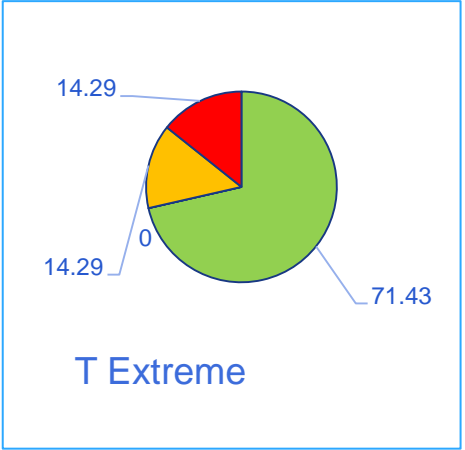
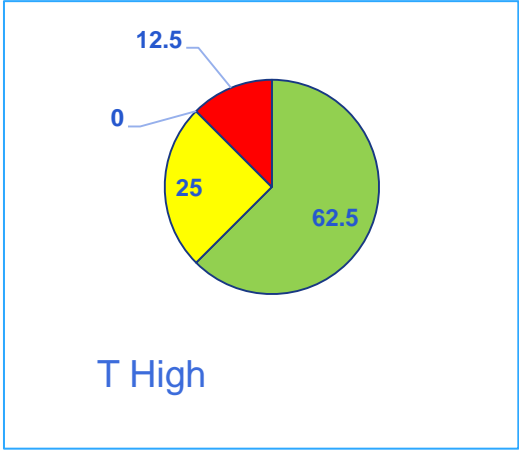
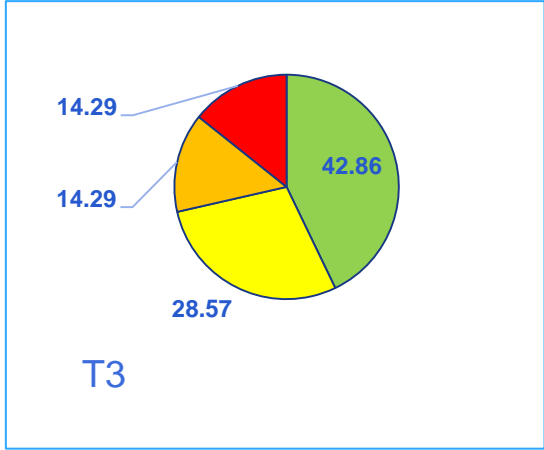
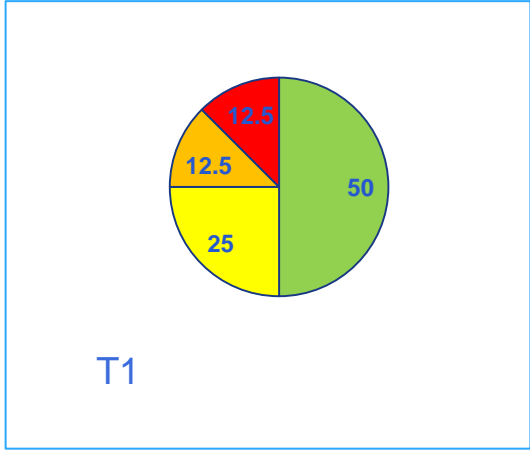


Capacity

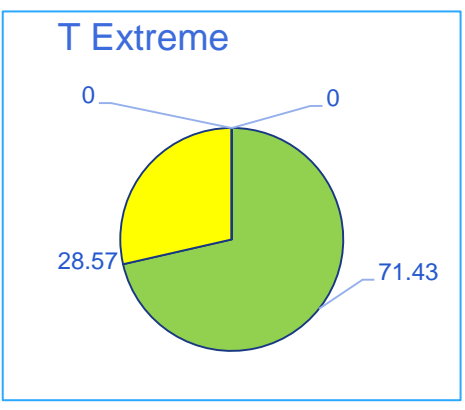
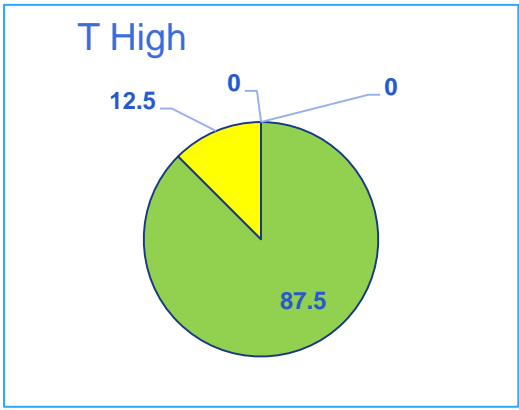
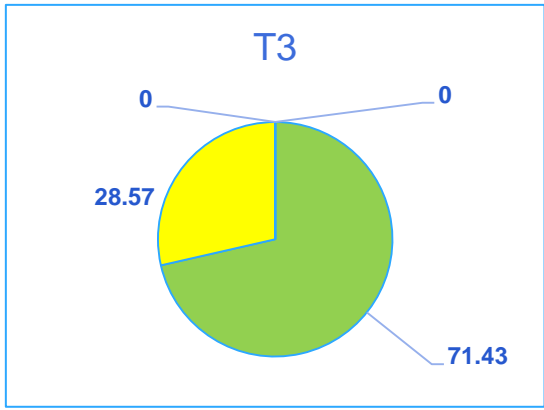
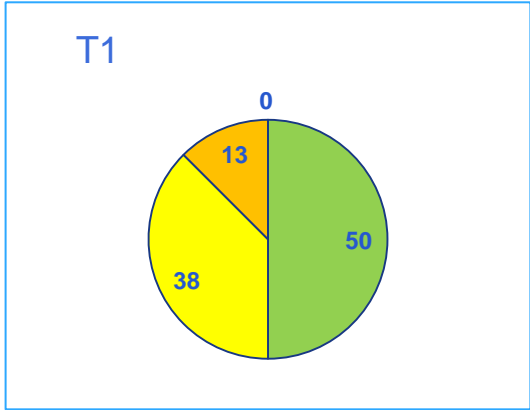


EER

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 !

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Questions

