

Fachprogramm

**Technical
Programme**





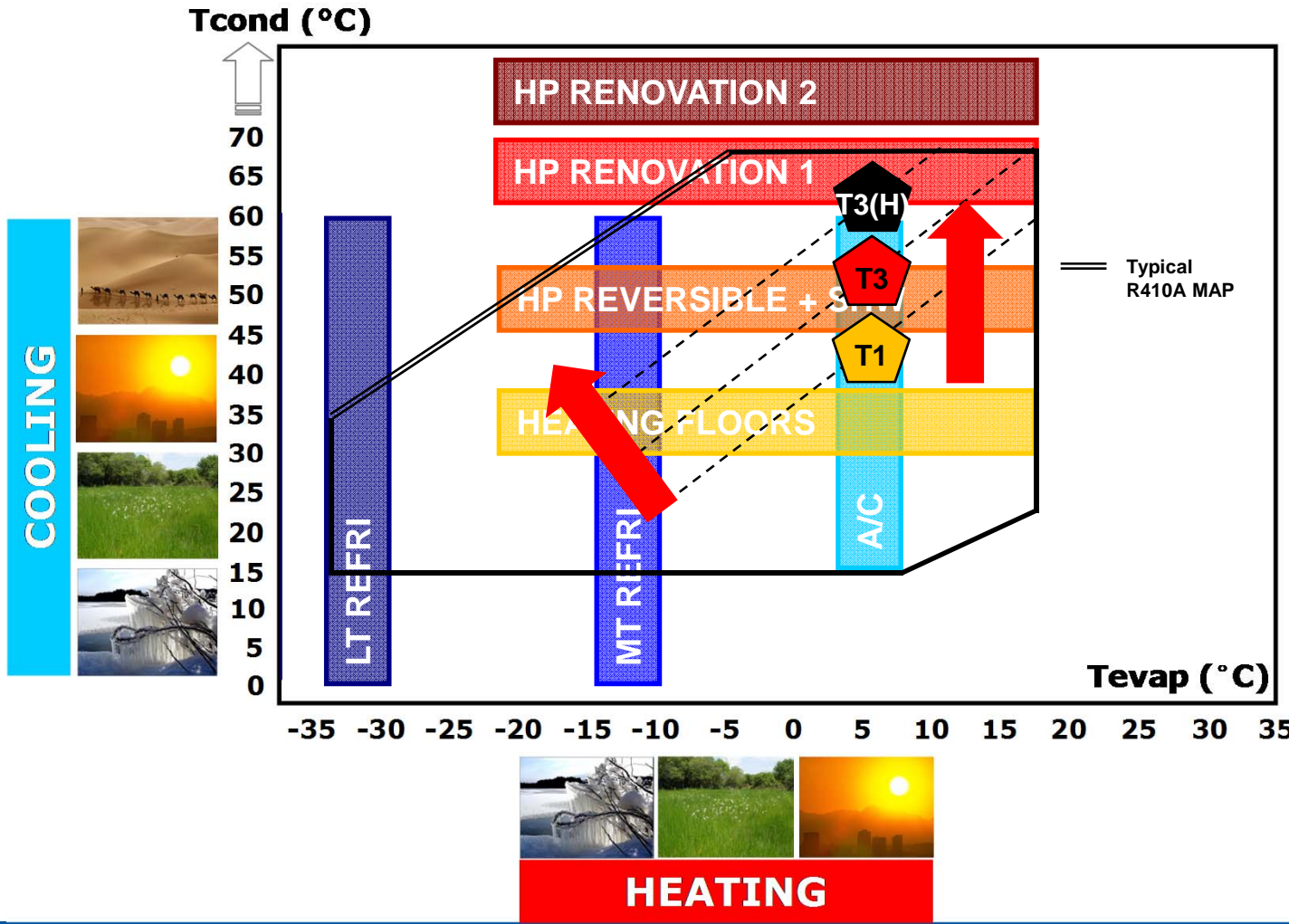
R410A and R22 low GWP alternatives for A/C
Focus on high ambient performances

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Honeywell

Middle East is an evolving market

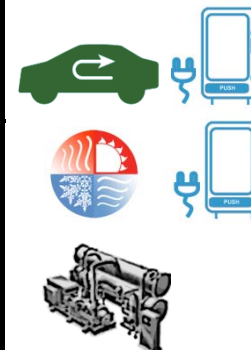
- R22 will be banned in pre-charged equipment in Saudi from 2015 / UAE should follow
- New EERs for ACs to be implemented from Jan'15 in all ME: new rating conditions
- R407C, R410A show a decline in efficiency at high ambient temperatures



Snapshot

- T1 reflects traditional A/C conditions
- Increasing T_{cond} ratings = need high $T_{critical}$ refrigerants
- Increasing Pressure ratio ratings = compressors Heat Pump optimization needed for cooling mode

| Solstice® HFO's – low and medium pressure applications | | | |
|--|------------------------------|-------------------------------|---|
| Current Product | Non Flammable (ASHRAE A1) | Mildly Flammable (ASHRAE A2L) | Examples of Potential Applications |
| R-134a GWP=1300 | | Solstice yf GWP <1 | Auto A/C, Vending, Refrigerators |
| | | Solstice ze GWP <1 | Chillers, CO ₂ Cascades Refrigerators |
| R-123 GWP= 79 | Solstice zd GWP =1 | | Centrifugal Chillers High temperature heat pumps |

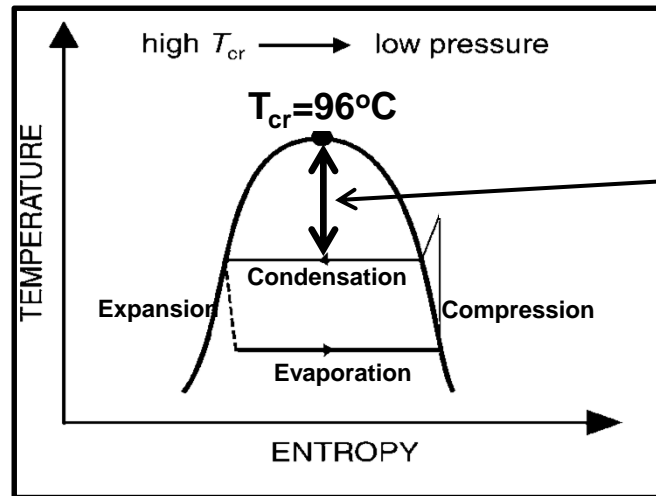


| Solstice® HFO Blends | | | |
|----------------------|---|--|------------------------------------|
| Current Product | Solstice® N Series Reduced GWP Option Non Flammable (ASHRAE A1) | Solstice® L Series Lowest GWP Option Mildly Flammable (ASHRAE A2L) | Examples of Potential Applications |
| R-134a GWP=1300 | N13 (R-450A) GWP = 547 | | Chillers, Med-temp Refrigeration |
| R-22 GWP=1760 | N-20 GWP = 891 | L20 (R-444B) GWP = 295 | Stationary A/C, Refrigeration |
| R-404A GWP=3943 | N40 (R-448A) GWP = 1273 | HDR 110 GWP <150 | Low-Temp Refrigeration |
| R-410A GWP=1924 | | L41 (R-447A) GWP = 572 | Stationary A/C Applications |



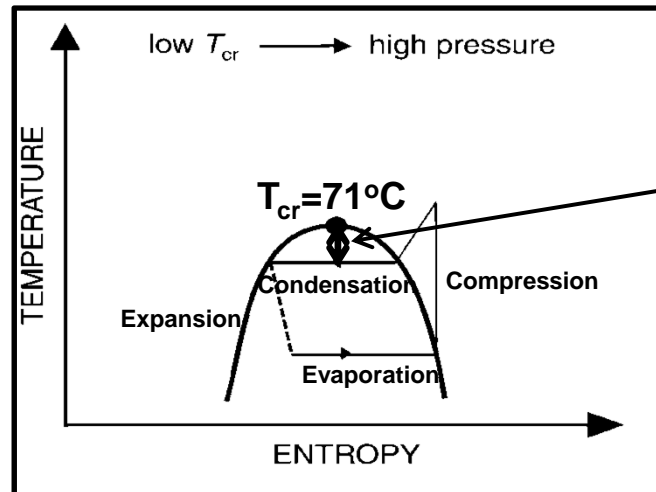
Note: All GWP values use the latest assessment from the ICCP, "AR5"

**R22
like**



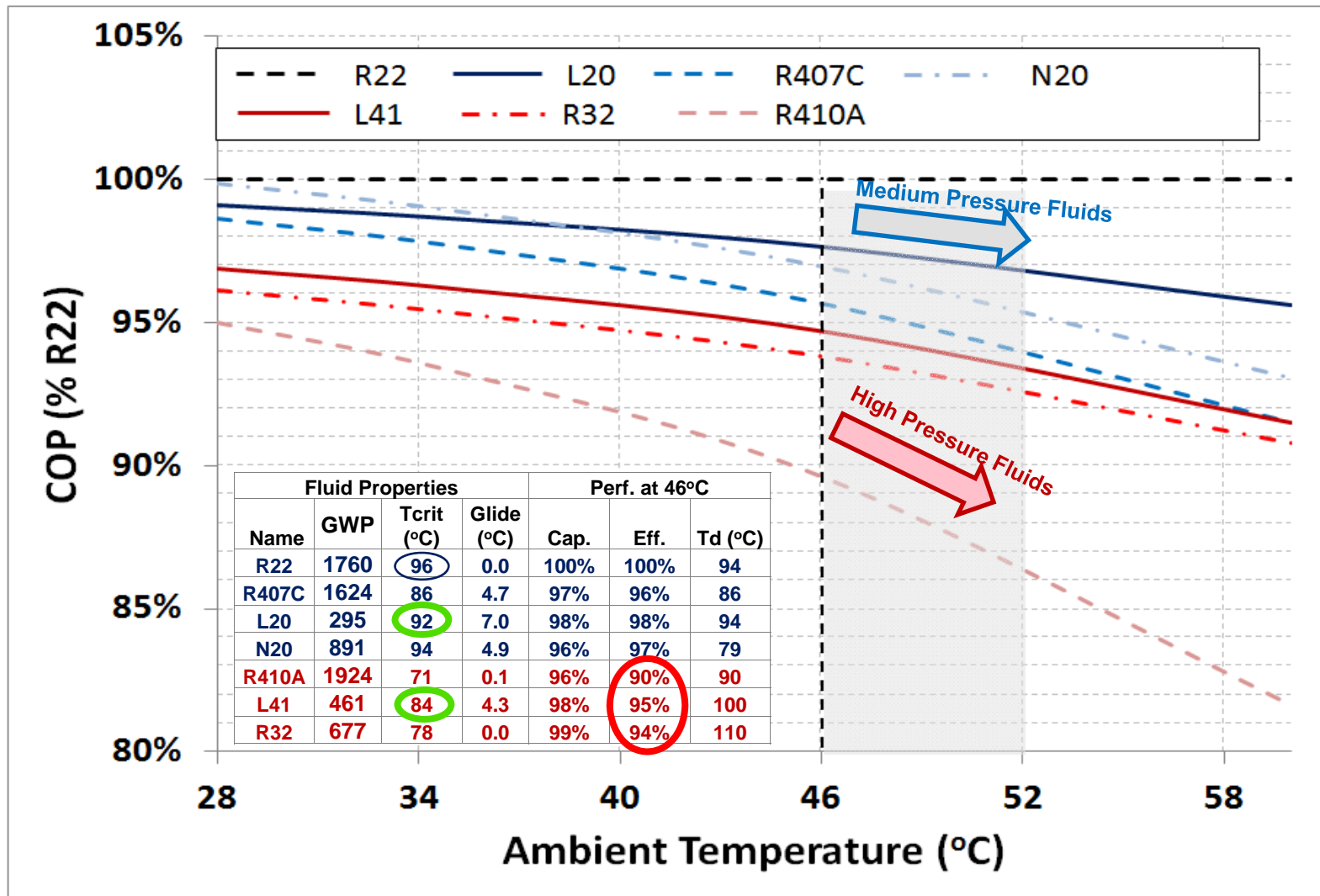
**More efficient as cycle
operates away from
critical temperature**

**R410A
like**



**Less efficient as cycle
operates close to critical
temperature**

Thermodynamic Performance



Condenser subcooling = 5°C; condenser TD = 10°C; Evaporating temperature = +10°C; evaporator exit superheat = 5°C; suction line superheat = 0°C; volumetric efficiency = 100%; isentropic efficiency = 70%; Capacity equalized at 35°C ambient.

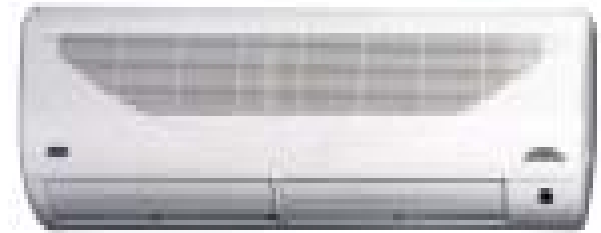
R22 Replacement

Solstice[®] L20 (R-444B)

Solstice[®] L20 (R-444B) as R22 replacement

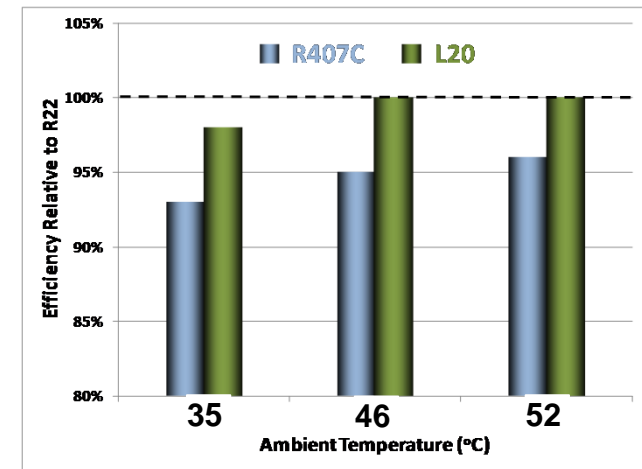
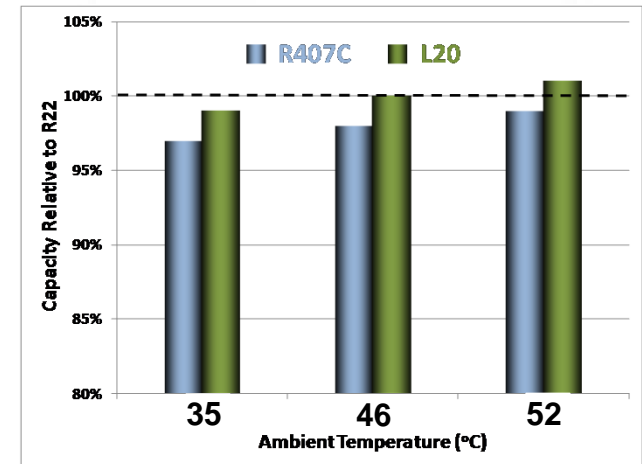
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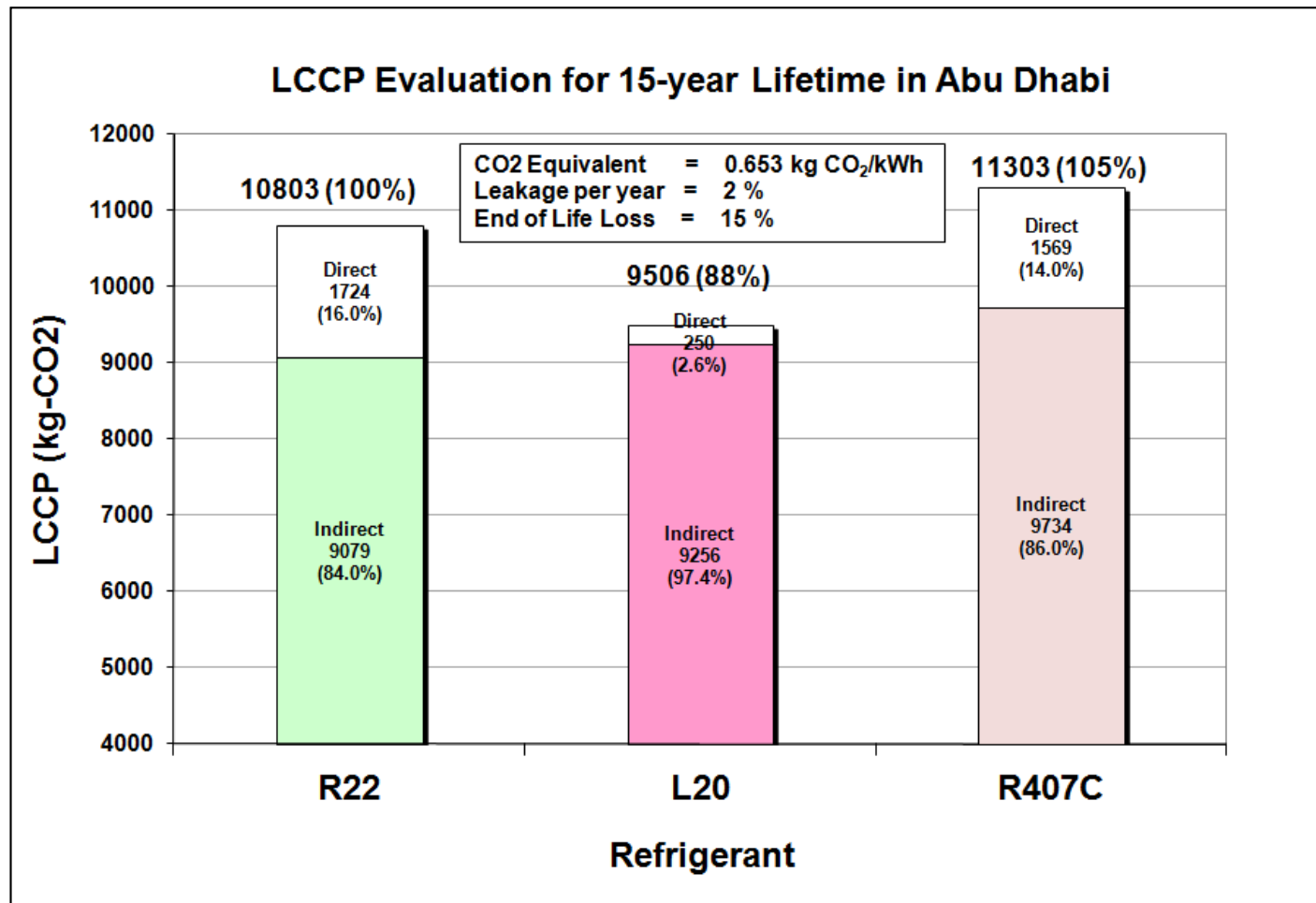
- 7.0 kW Cooling only system with nominal COP of 3.0
- Capillary tube designed for L20 & R407C
- The circuitry of heat exchangers were modified to account for the glide and obtain better matching of temperature profiles of the air and the refrigerant with no cost increase



Performance Results

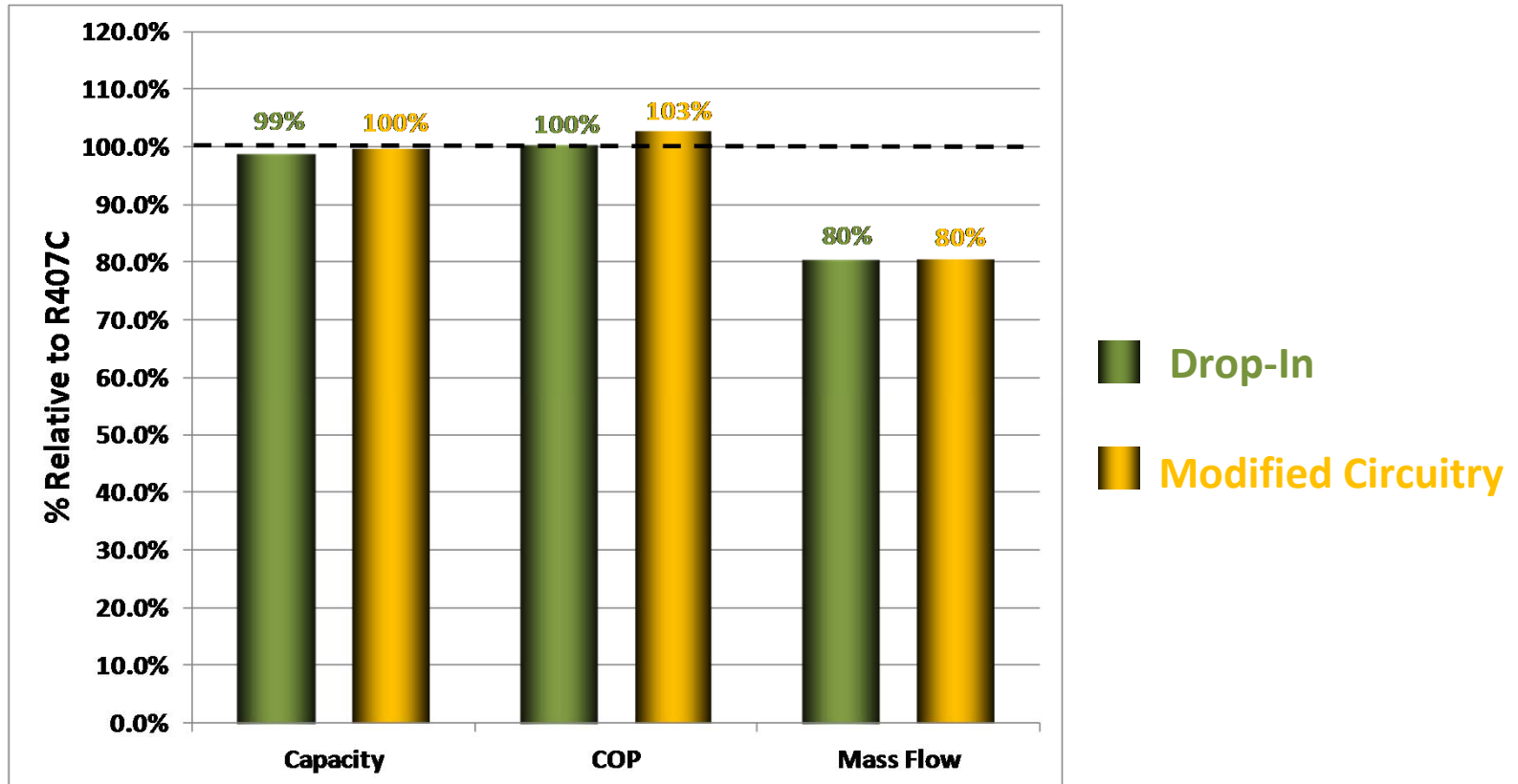
- L20 shows similar capacity and efficiency relative to R22 over range of ambient temperatures observed in warm climates
- L20 shows 4% to 5% higher efficiency than R407C
- L20 has 20% lower mass flow than R22 which leads to lower pressure drop in the system and offers potential for further improvement in performance
- L20 reduces the direct emissions substantially due to lower GWP (295) and lower charge (85%)





- System meets new efficiency requirements for the Middle East
- Overall, Solstice[®] L20 (R-444B) offers 12% reduction in CO₂ emissions compared to R22

Solstice[®] L20 (R-444B)



- Drop In performance shows similar capacity (99%) and COP (100%) and lower mass flow (80%)
- L20 shows higher efficiency (103%) when heat exchangers circuitry modified to increase mass velocity.

R410A Replacement

Solstice[®] L41 (R-447A)

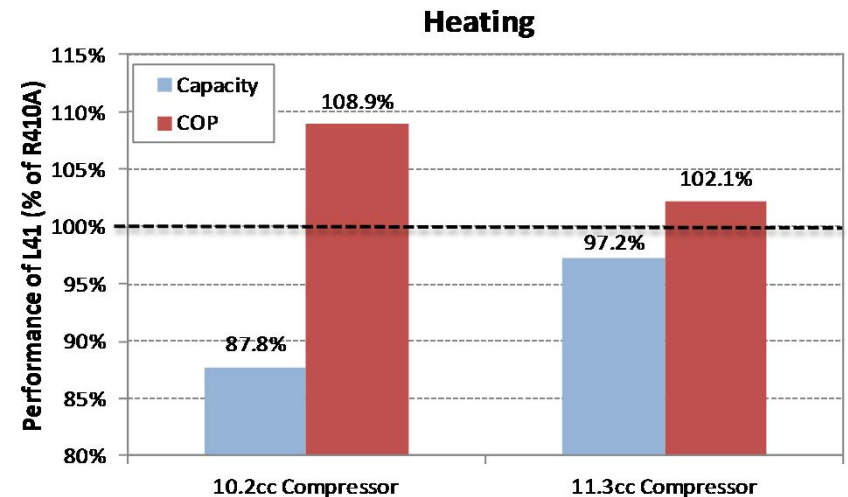
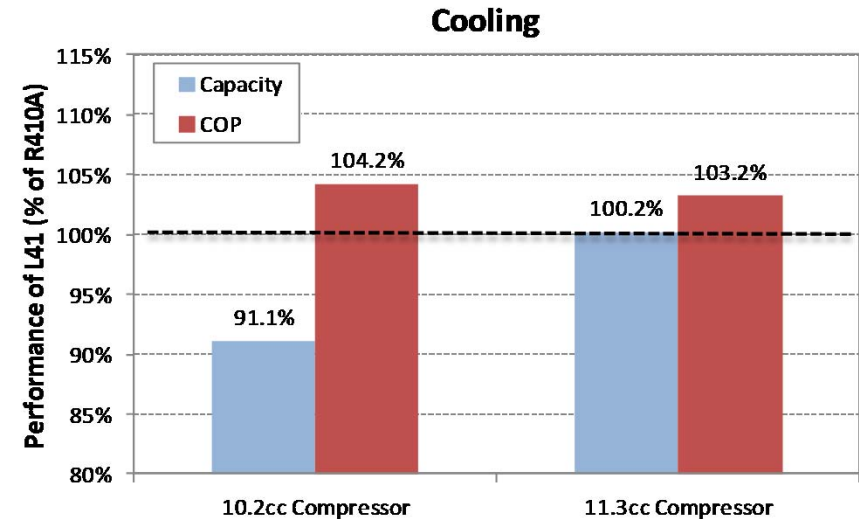
Solstice[®] L41 (R-447A) in Mini-Split



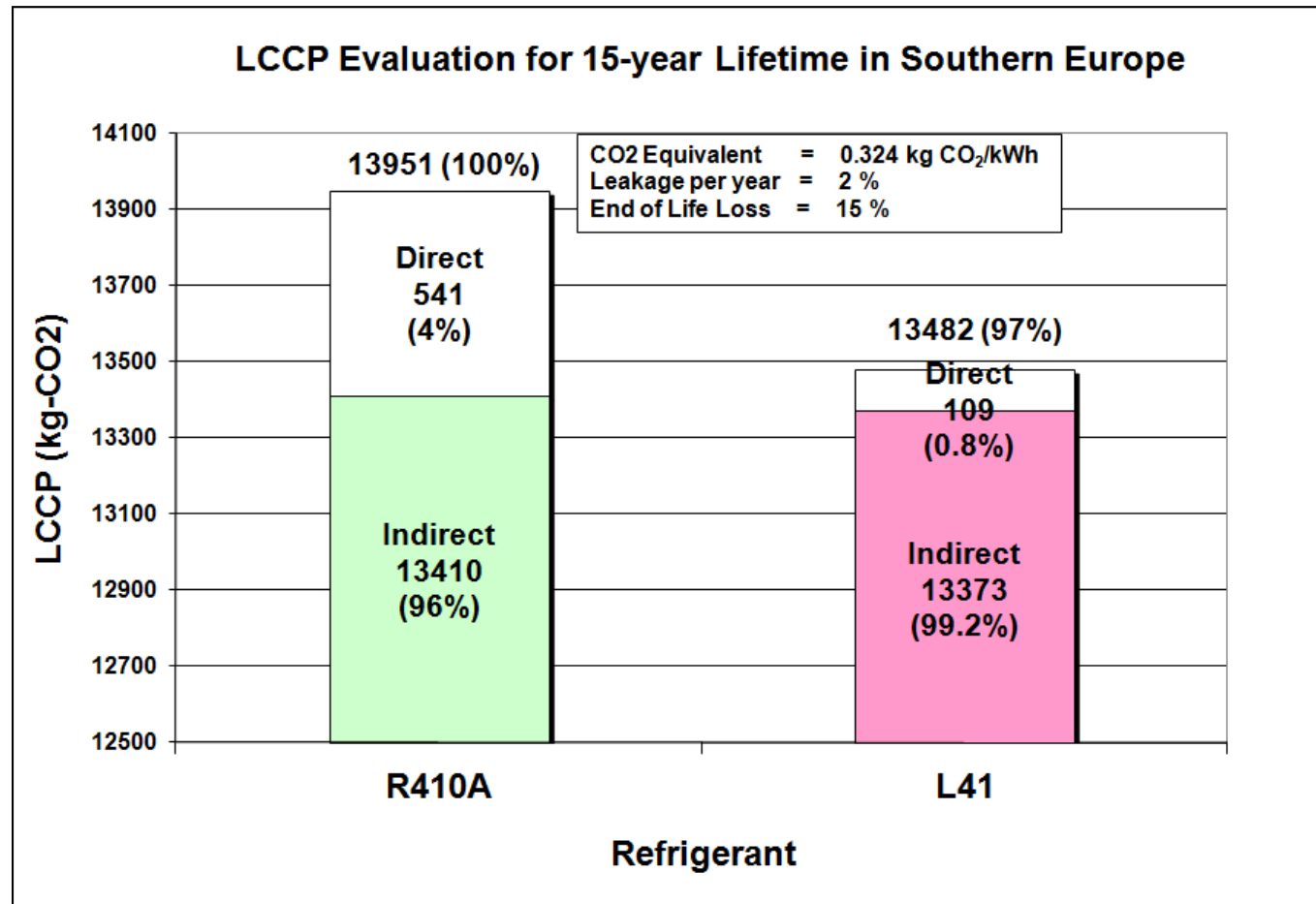
- Honeywell Labs in Shanghai: Reversible split system of 3.6 kW Cooling / 5.0 kW Heating
- Compressor displacement tested: 10.2 & 11.3cc

Performance Results

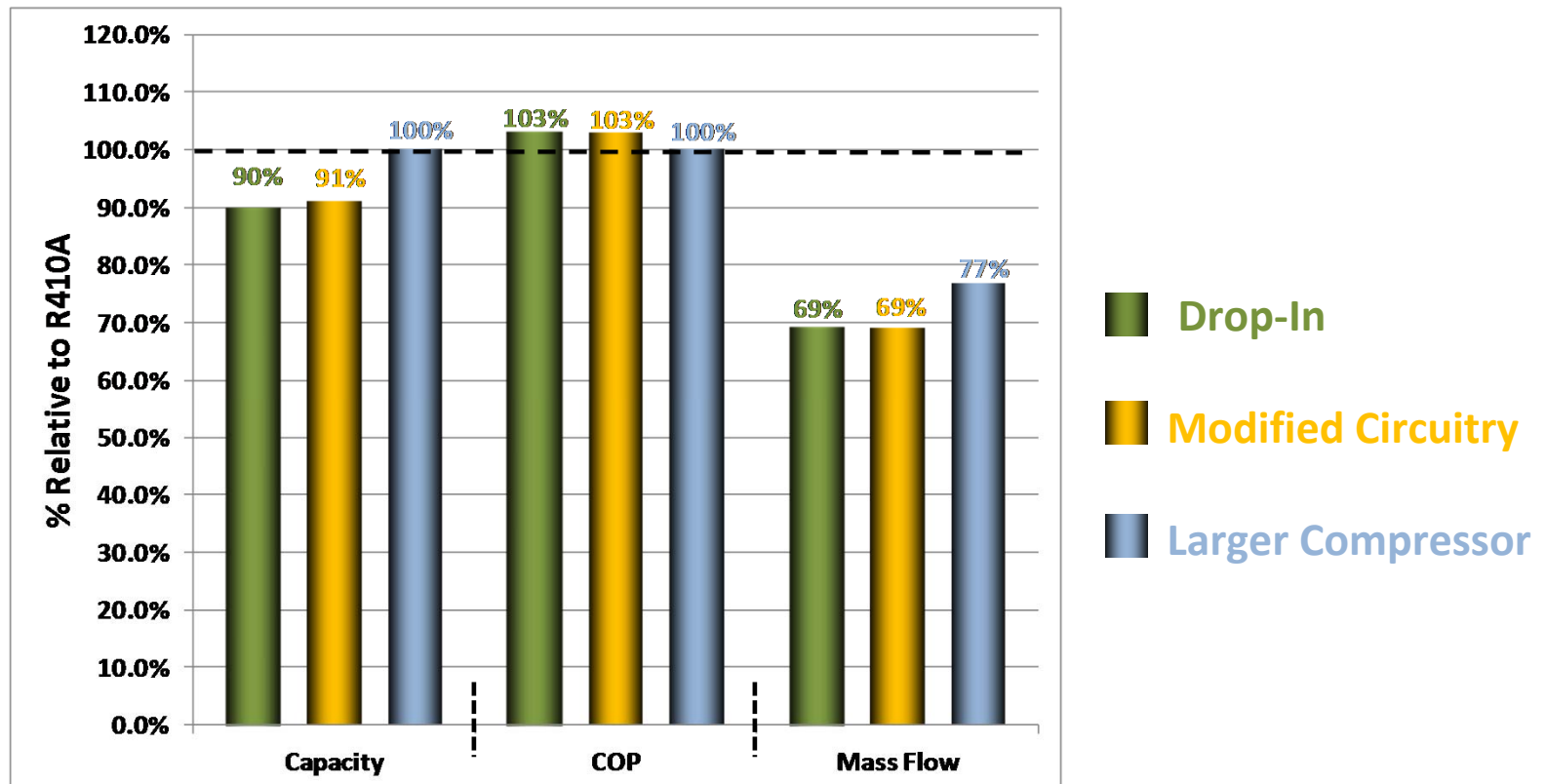
- Higher efficiency achieved for both heating and cooling modes relative to R410A
- ~11% higher displacement compressor required to match R410A capacity
- Discharge temperature was slightly higher with L-41 (~11°C) but well below maximum permissible and below temperatures typically seen with R-32



Test conditions based on ISO Std. 5151



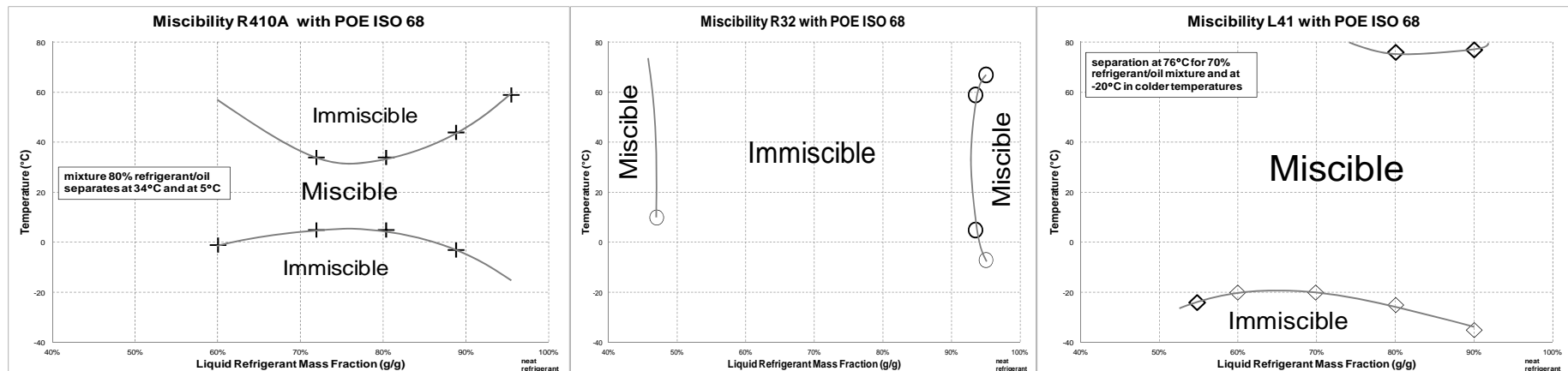
➤ Solstice® L41 reduces overall CO₂ emissions by 3% in Southern Europe compared to R410A



- Air temperature 35 °C, Water cooled from 12 °C to 7 °C, Superheat and subcooling of 5 °C
- Compressor Isentropic and Volumetric efficiency constant

- Drop In performance in a 70 kW chiller shows lower capacity (90%), slightly higher COP (103%) and lower mass flow (69%)
- Heat exchangers circuitry modified to increase mass velocity
- Shows performance similar to R410A by using a 13% larger compressor displacement

- Most current system designs assume that the refrigerant and oil are miscible (one liquid layer).
- Immiscibility can lead to oil logging in various parts of the system and can lead to poor oil return to the compressor or an oil slug to enter the compressor.
- Unlike R-32, Solstice[®] L41 (R-447A) has no immiscible region for all likely operating temperatures of the A/C or heat pump.



- Honeywell has developed a family of Low GWP Refrigerants to replace today's most common refrigerants in auto & stationary a/c and refrigeration applications.
- Solstice[®] L20 (R-444B) offers low GWP and superior performance for hot climates.
- Latest R-410A replacement, Solstice[®] L41 (R-447A) offers comparable performance to both R-410A and R-32 but avoids the issues of high discharge temperature and poor miscibility with existing lubricants that is associated with R-32 while offering lower GWP.
- We are continuing to work closely with industry to evaluate these products in a broad range of stationary air conditioning applications.
 - HFO's and HFO blends should be considered as part of the solution to transition away from high GWP refrigerants.

Thank you!!!

Questions?

DISCLAIMER

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