Low GWP Chillers Development Update

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CHILLVENTA 2014

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Chiller Refrigerants Market Share

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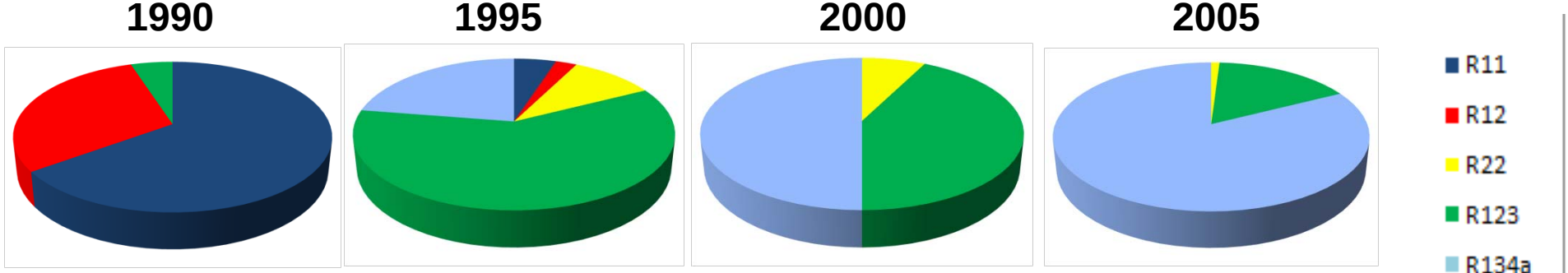
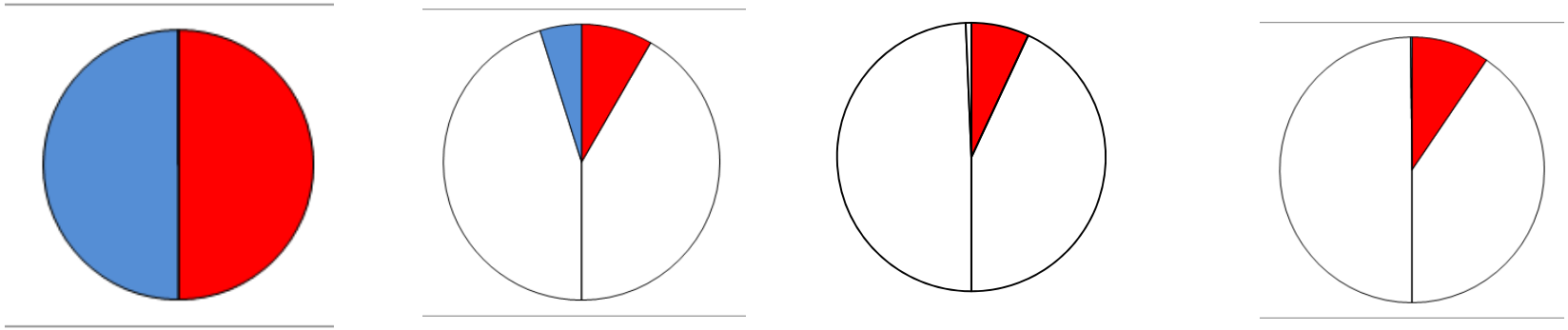
Centrifugal Chiller Refrigerants – Market Share

1990	1995	2000	2005
CFC-11 Dominant	HCFC-123 Dominant	HCFC-123 & HFC-134a Dominant	HFC-134a Dominant





Corresponding environmental impact

Further Reduction in environmental impact can be achieved through the use of Low GWP refrigerants.

New Solstice® molecules

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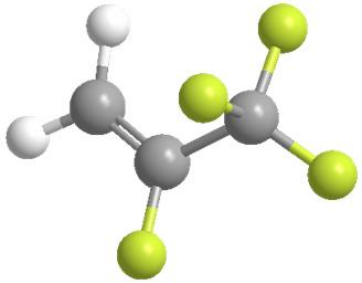
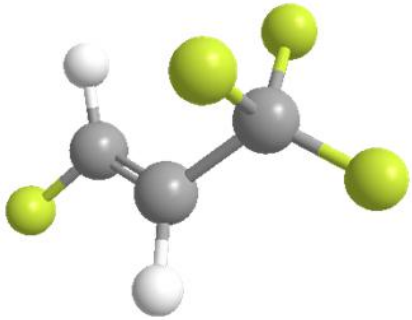
Solstice yf



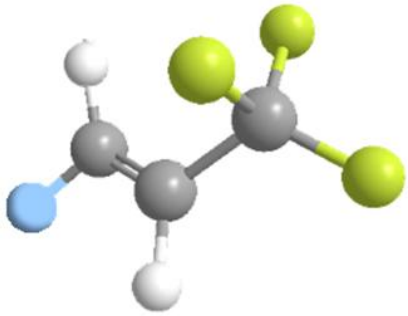
- Lifetime: 11 days
- GWP_{100} < 1
- Mildly flammable
- REACH registered +1,000+mT/y
- Registered for a/c & refrigeration use
- Commercially available

Solstice ze



- Lifetime: 16 days
- GWP_{100} < 1
- Mildly flammable
- REACH registered 1,000+ mT/y
- Registered for foam, aerosols and refrigeration
- Commercially available

Solstice zd



- Lifetime: 40 days
- GWP_{100} = 1
- Non-flammable
- REACH registered +1,000+mT/y
- Registered for foam, aerosols and refrigeration
- Commercially available

Honeywell's Solstice® low GWP refrigerants

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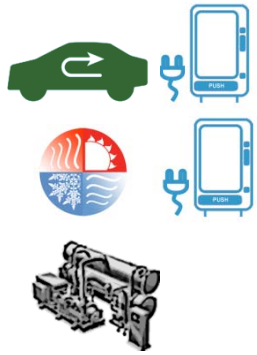
Solstice® HFO's – low and medium pressure applications			
Current Product	**Non Flammable** (ASHRAE A1)	**Mildly Flammable** (ASHRAE A2L)	**Examples of Potential Applications**
R-134a GWP=1430		**Solstice yf** GWP* < 1	Auto A/C, Vending, Refrigerators
		Solstice ze GWP* < 1	Chillers, CO_2 Cascades Refrigerators
R-123 GWP= 77	**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=1430	**N13 (R-450A)** GWP* = 546		Chillers, Med-temp Refrigeration
R-22 GWP=1810	**N20** GWP* = 891	**L20 (R-444B)** GWP* = 295	Stationary A/C, Refrigeration
R-404A GWP=3922	**N40 (R-448A)** GWP* = 1273	**HDR 110** GWP* < 150	Low-Temp Refrigeration
R-410A GWP=2088		**L41 (R-447A)** GWP* = 572	Stationary A/C Applications

GWP*: GWP based on IPCC5

Chiller Fluids

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	Molar Mass	Critical Temperature ºC	Normal Boiling Point ºC	GWP	ODP
R11	137	197.6	23.71	4750	1.000
R123	153	183.68	27.82	77	0.020
Solstice© zd	131	165.5	19	1	0.000
R12	121	111.97	-29.75	10900	1.000
R134a	102	101.06	-26.07	1300	0.000
Solstice© yf	114	94.7	-29.45	1	0.000
Solstice© ze	114	109.37	-18.95	1	0.000
R22	86	96.15	-40.81	1810	0.055

Some working fluids properties

- Solstice® zd is best-suited for low pressure chiller applications
- Solstice® yf and Solstice© ze are best-suited to medium pressure chiller applications

The new refrigerants also possess essential properties required for use in chiller applications.

Refrigerant Cycle Efficiency

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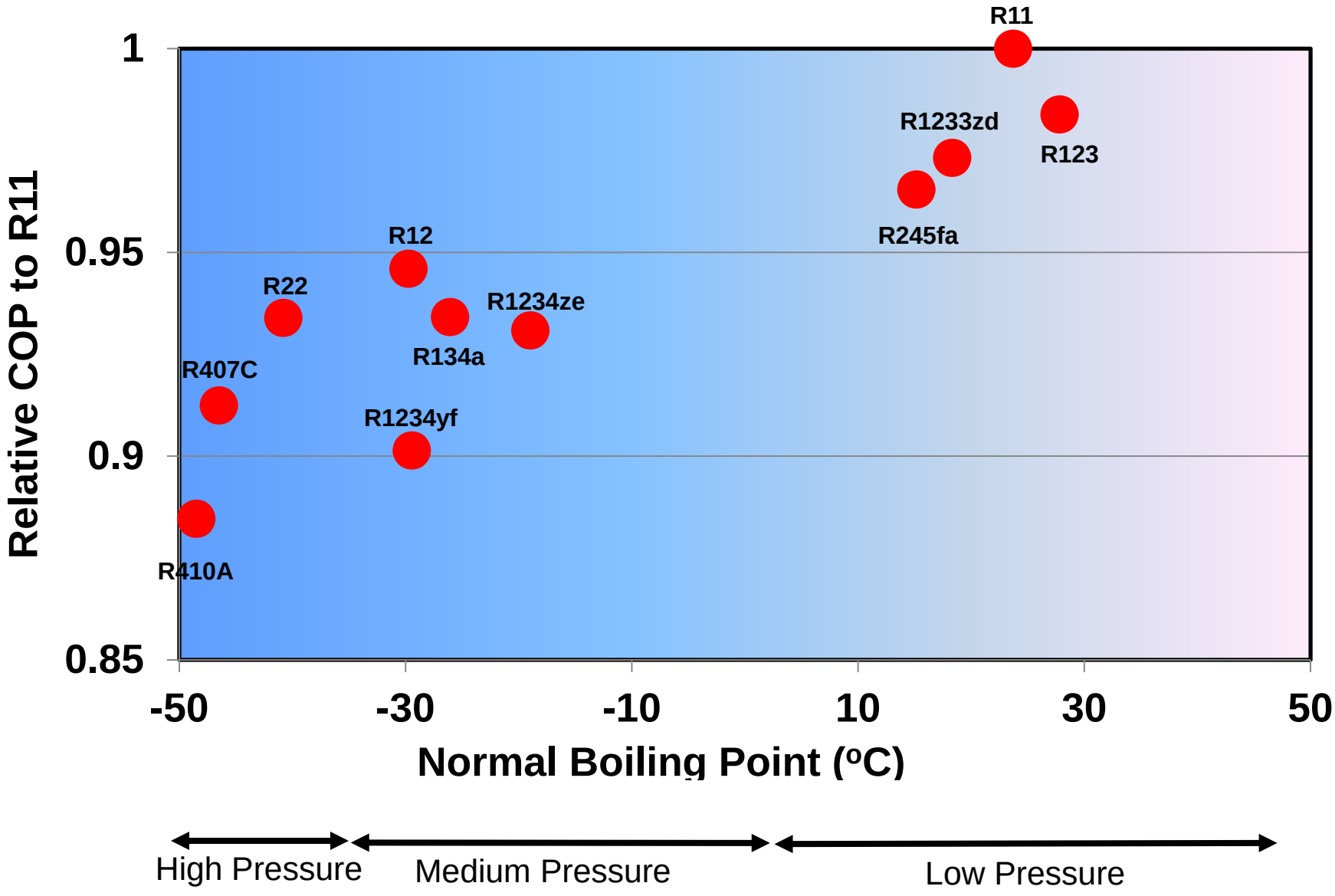

Operating Pressures

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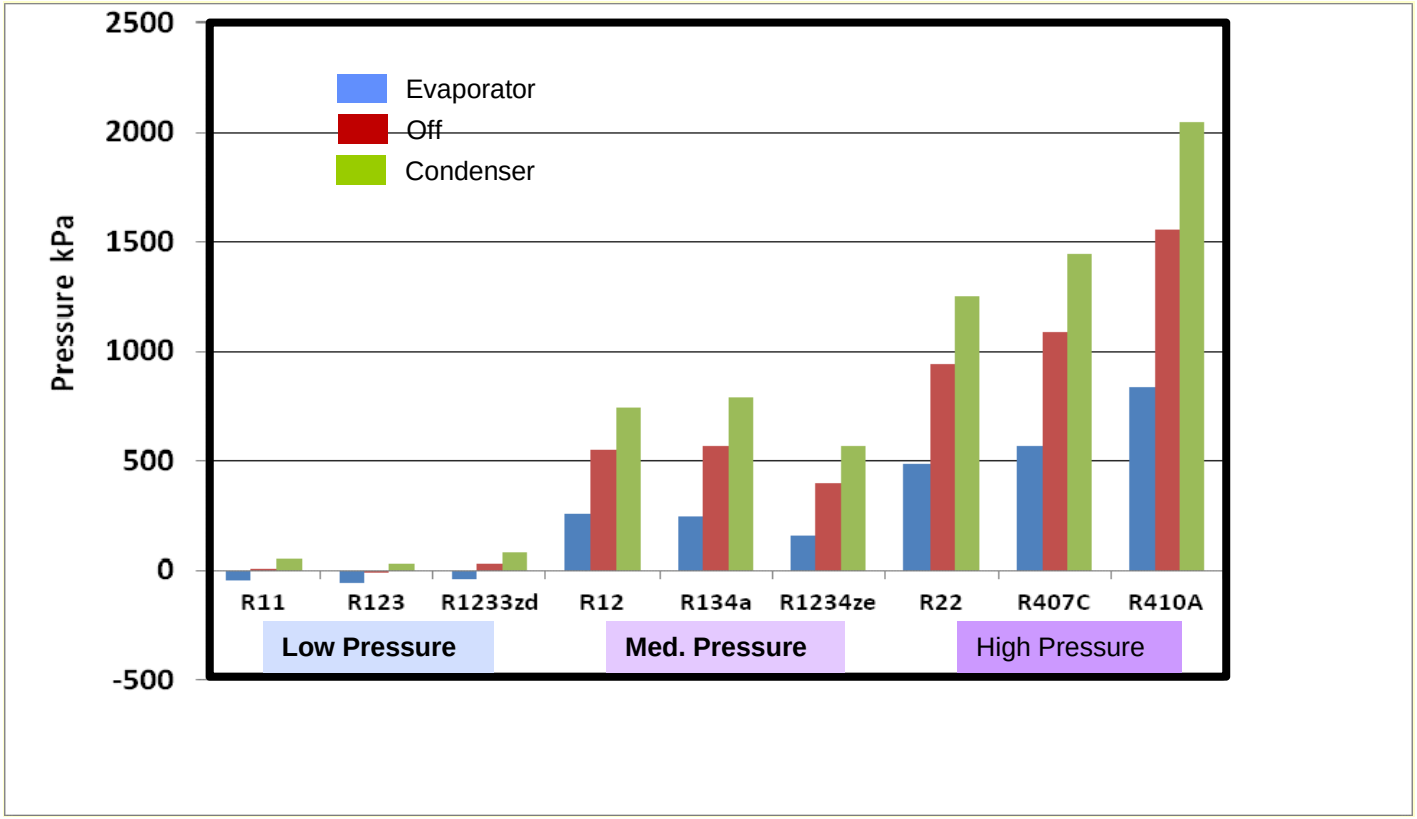

- Operating pressures are function of refrigerant type used.
- Leaks are pressure dependant.
- Low pressure fluids are key to “leak-tight” chillers.

Solstice® ze Operating envelope*

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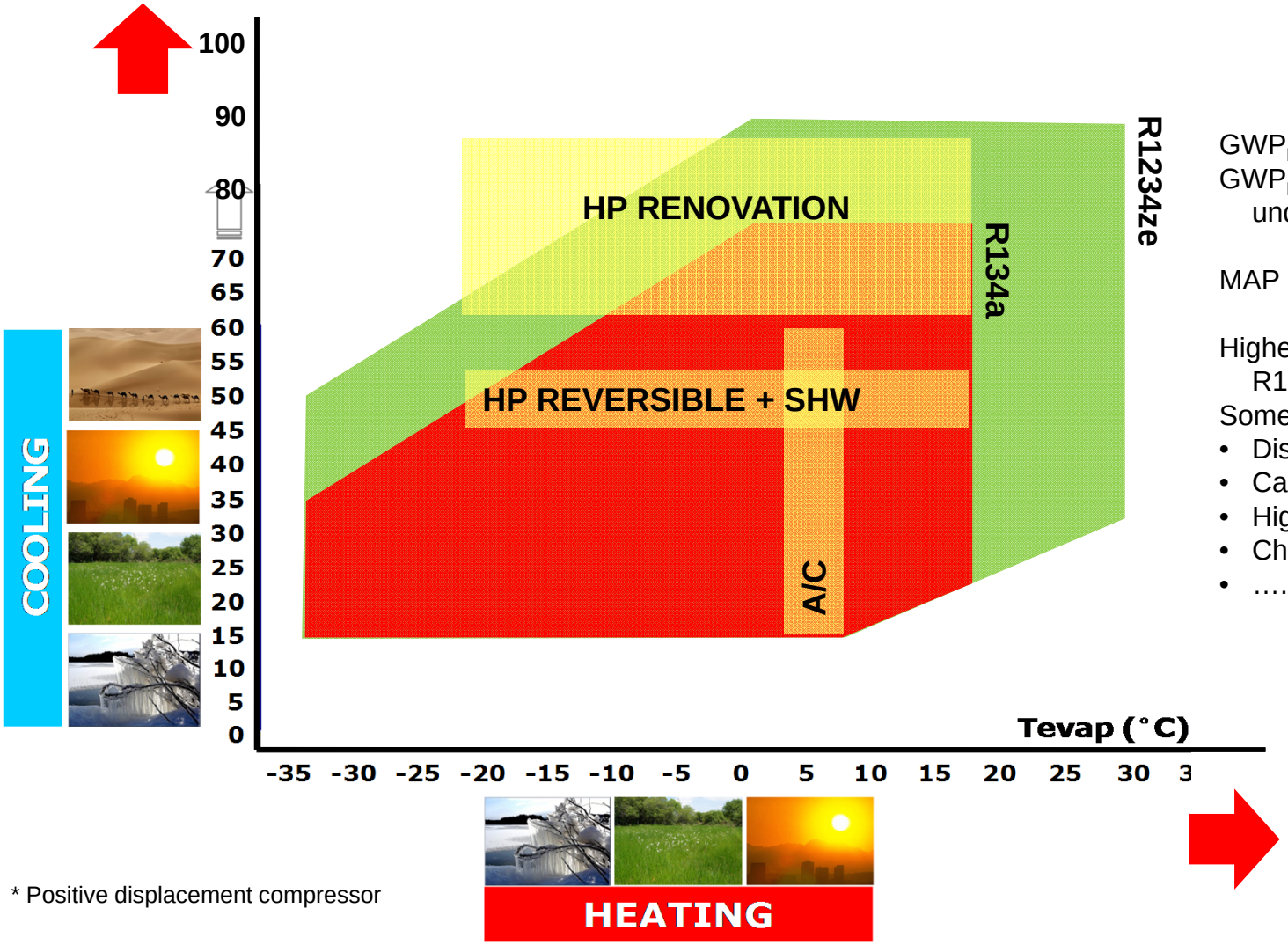

* Positive displacement compressor

GWP_{R134a}= 1430 / A1

$GWP_{R1234ze}$= 6 / A2L (not flammable under 30°C)

MAP extension.

Higher Tcond achievable with R1234ze:

Some Possible applications:

- District Heating/cooling
- Cascade system
- High temperature heat pump
- Chillers
- ….

Opportunity to Extend R134a Operating Range

Solstice® ze chillers

Solstice ze Screw Chiller (Geoclima)

Solstice ze Centrifugal Chiller (Geoclima, Turbocor Compressor)

Solstice ze in chillers in exhibition shows

Turbocor Compressor

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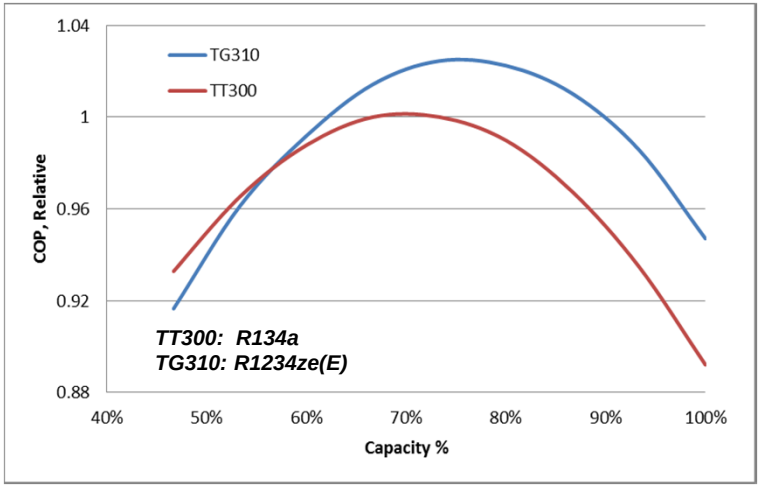

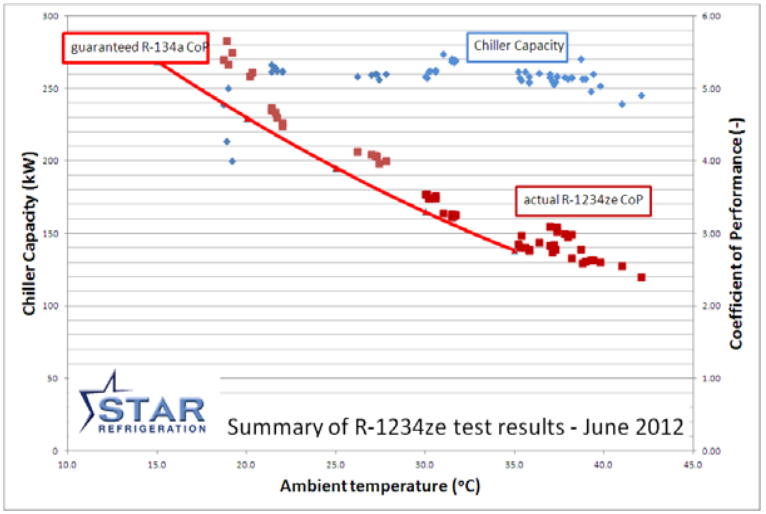

High performance at part load and at higher ambient temperatures

Comparative LCCP

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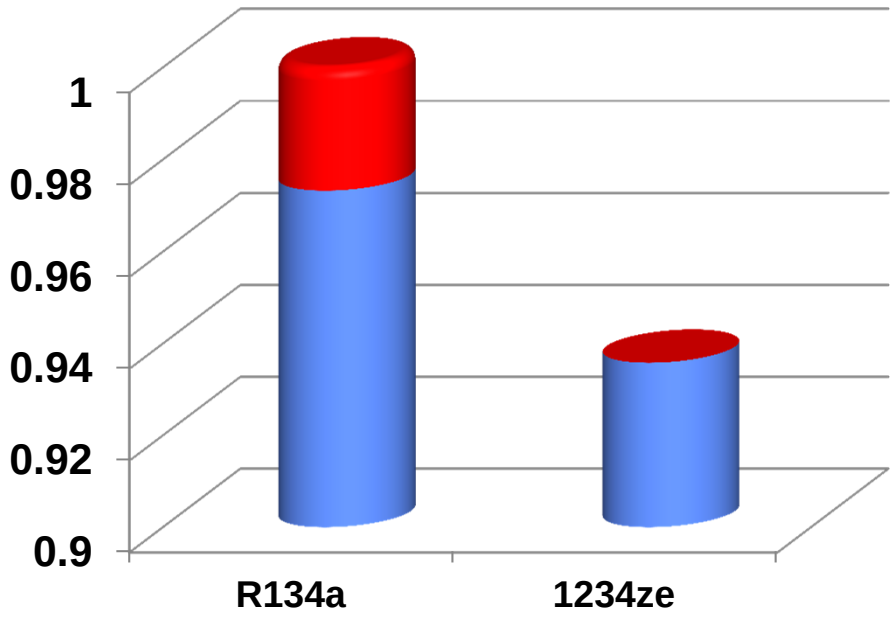

Based on 500kw chiller
15 years lifetime

Chillers have low leakage,
Because of its lower pressure and higher efficiency, **Solstice® ze** Chiller leads to 7% lower LCCP

Airedale Solstice® ze Chiller

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- **TurboChill™ range available with HFO1234ze.**
  - Single circuit 200-640kW (TCC) & 200-735 kW (TCF)
  - Dual circuit 200-1260kW & 200-1430kW (TCF)
  - Flooded evaporator improves part load efficiencies.
  - Variable speed for efficient, tighter setpoint control and capacity matching.

TurboChill™ FreeCool with low GWP refrigerant R1234ze is currently cooling shoppers visiting the new John Lewis store in York (UK).

Airedale
APPLIED THERMAL INNOVATION

See it in Hall 7, Stand 7-422

RC-group Solstice® ze Chiller

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rcgroup.it

UNICO TURBO FLG FREE SIZE		410 T2 VT4
Cooling capacity (1)	**kW**	**410**
Unit power input	kW	118,8
Free-Cooling capacity (2)	**kW**	**358**
Total water flow rate	m³/h	75,6
Total pressure drop	kPa	92
Compressors		centrifugal
Quantity	n.	2
Cooling capacity control	%	37...100%
Axial fans	n.	8
Total air flow	m³/h	170360
Air circuits	n.	1
Refrigerant		HFO 1234 ze
Total refrigerant charge (optional excluded)	kg	123
Gas circuits	n.	1
Power supply	V/Ph/Hz	400/3/50
Max unit operating current (FLA)	A	340
Unit starting current (LRA)	A	40
EER (1)	kW/kW	3,60
ESEER		4,80
Sound power level [Lw] (3)	dB(A)	94,8
Average sound pressure level [Lpm] (4)	dB(A)	74,8
Net weight	kg	3923

UNICO TURBO FLG FREE:

- **Air Cooled Chiller with capaty up to 1200kW**
- **Turbocor compressors**
- **Capacity control 37 to 100%**

Cofely Solstice® ze Chiller

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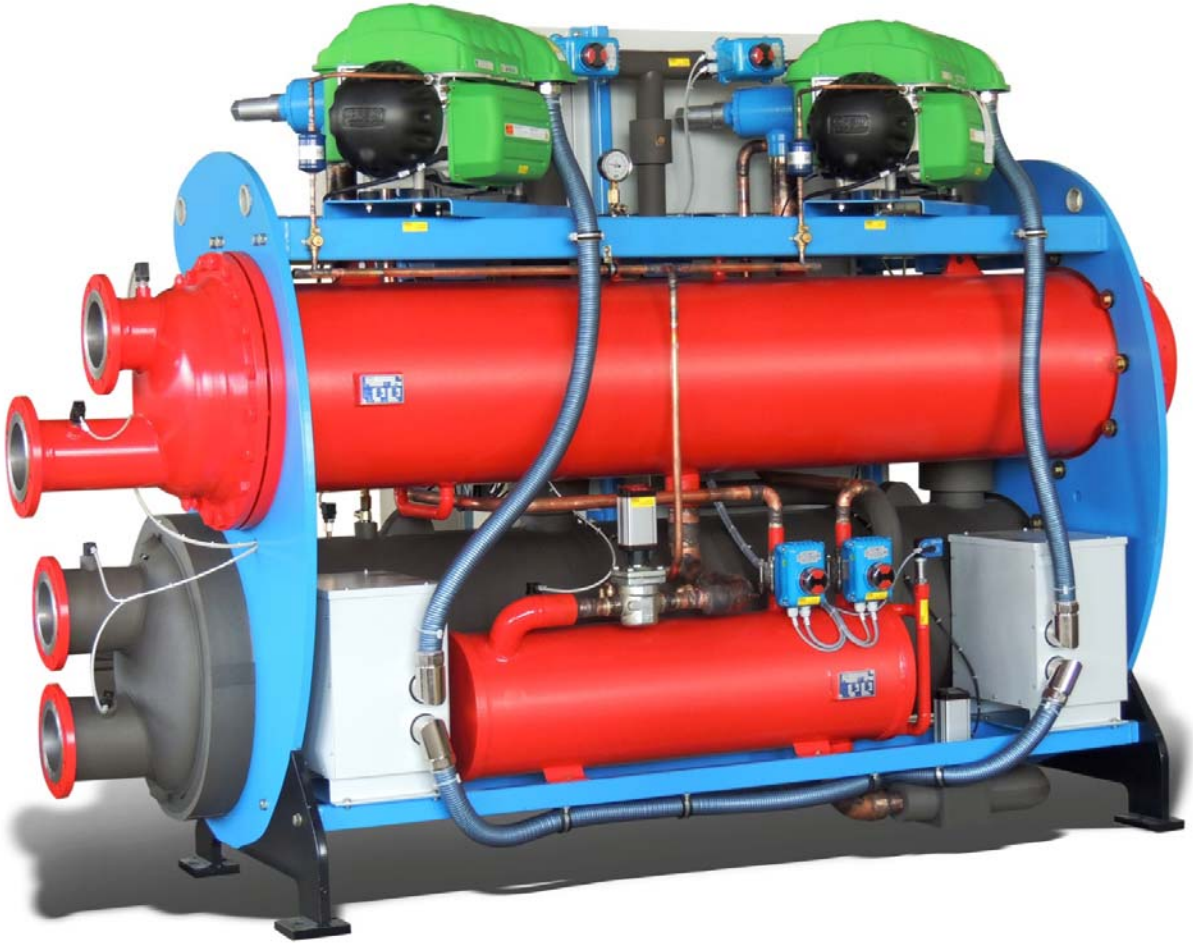

COFELY
GDF SUEZ

- Quantum-G “Green” Chiller added to Cofely Portfolio.
- Based on HFO1234ze
- Capacity Up to 1.1 MW.

See it in Hall 4- Booth 508

TRANE CenTraVac™ Solstice® zd Chiller

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R-1233zd based chillers are now part of TRANE European product range.

CVHH
- *3-Stage Direct Drive*
- *Heat Recovery*

CDHH
- *3-Stage Direct Drive*
- *Dual Refrigerant Circuit*

TRANE

R-1233zd ensures Low Pressure Centrifugal Technology Revival

TRANE CenTraVac ™ Solstice® zd Chiller

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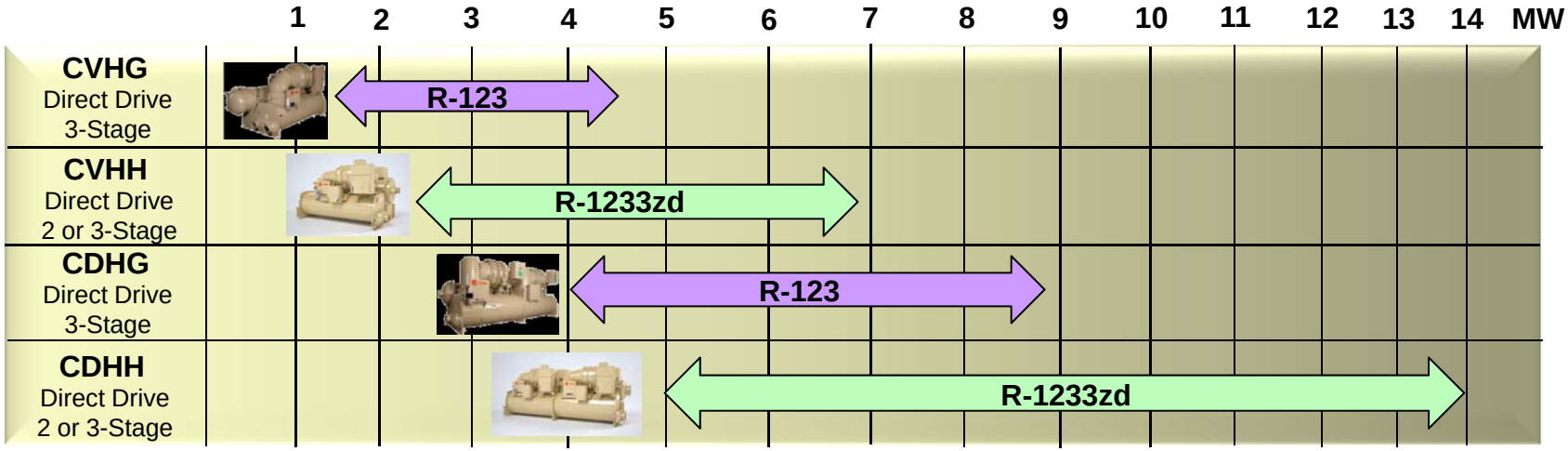
- The First Low Pressure Centrifugal Chiller using 1233zd, released by TRANE.
- Range extended to 14MW (largest HFO Chiller Capacity on the market).
- Up to 13.5% more energy efficiency than the next best chiller available in this tonnage range.
- Combining high efficiency benefits associated with low pressure fluids and high capacity due to slightly higher pressure than R123.



TRANE

Market Leading Efficiency/Capacity achieved with Solstice zd

Chiller Life Cost Analysis

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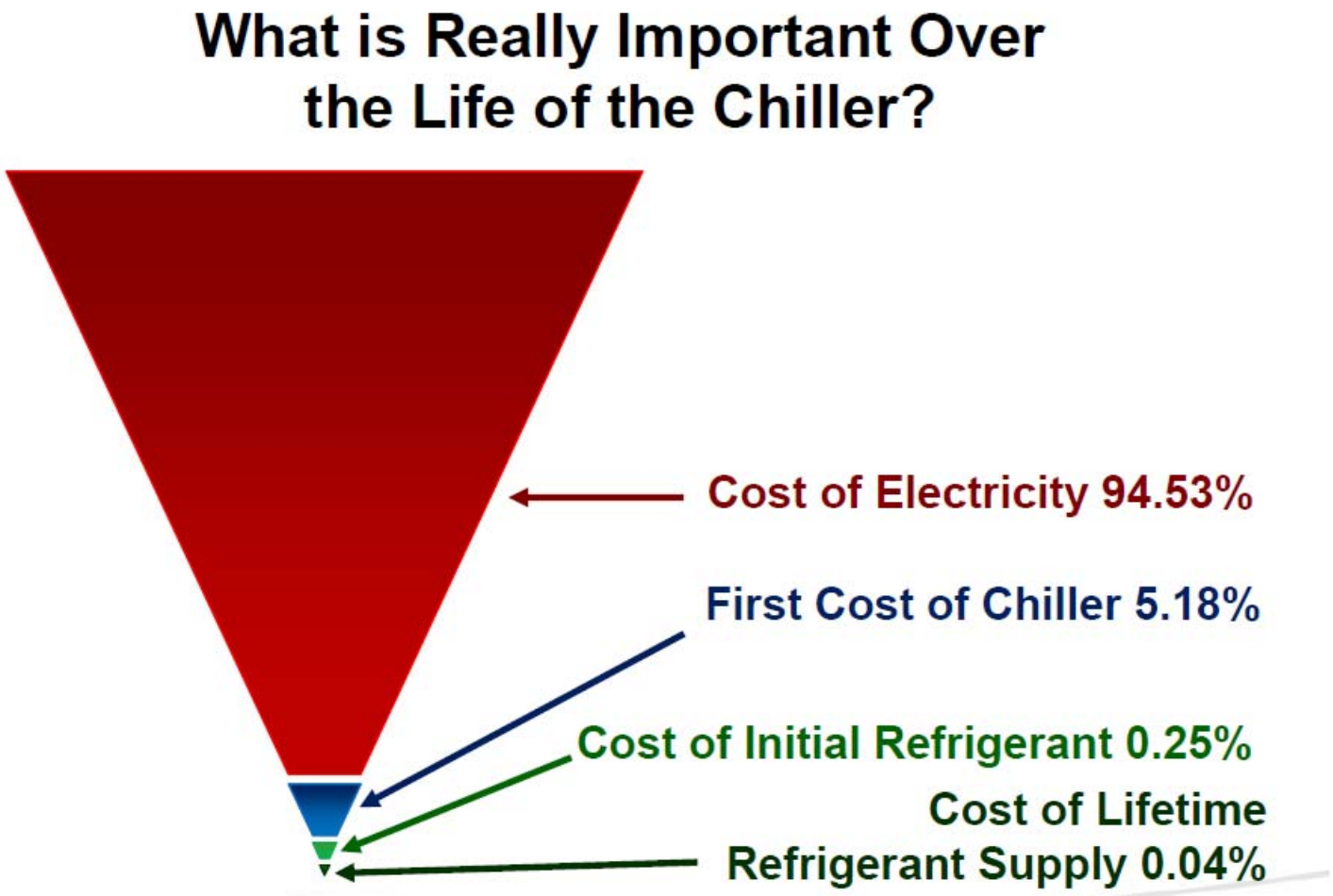

Efficiency, an important criteria in Chiller selection

Summary

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- Honeywell Fluorine Products has Established Technical Leadership in Offering Energy Efficient and Environmental Friendly Solutions
- Solstice® Low Global Platform Covering a Broad Spectrum of Applications are Being Commercialised Globally
- Solstice ze successfully replacing R134a in medium pressure chillers.
- Solstice zd matches R123 efficiency with higher capacity in low pressure chillers.
- Solstice Platform ready to meet F-Gas Cap & Phase Down Needs in Europe and Support High Growth Region's

Technology Leader in Energy Efficient Environmentally Friendly Products

Honeywell

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