Sébastien Casterman
Product Marketing Manager Refrigeration

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LONG-TERM REFRIGERANT SOLUTIONS AND SUSTAINABLE ARCHITECTURES FOR REFRIGERATION SYSTEMS

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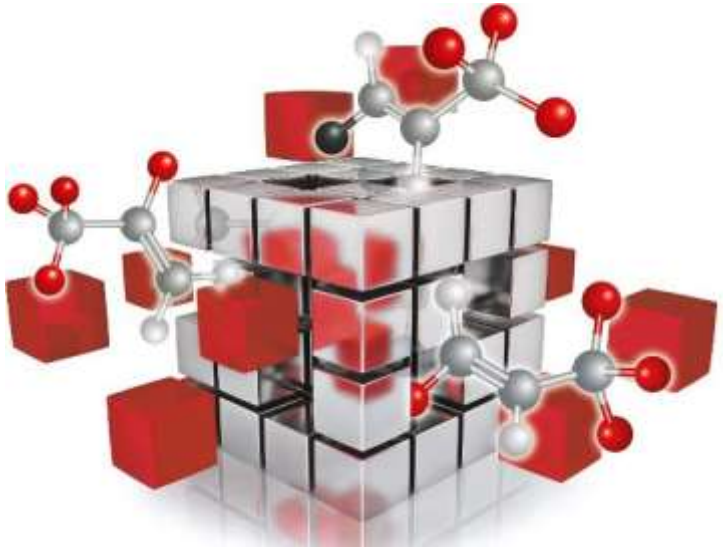
Long-Term Refrigerant Solutions and Sustainable Architectures for Refrigeration Systems



Agenda

- **Assessment of Refrigeration Systems**
- **Retail**
  - Food Service, Cold Rooms
  - Convenience & Forecourt Stores
  - Small/Medium-Size Supermarkets
  - Large Supermarkets
- **Industry**
- **Summary**

Introduction

- Retail & industrial refrigeration play a key role in reaching the CO_2 eq. reduction constraints of the F-Gas regulation
- The switch to lower GWP refrigerants has started, however much later than what would have been required to pass the CO_2 eq. availability reduction step of 2018
- Due to this late and still slow transition, there is now an absolute need for new installations to switch to cooling technologies using refrigerants with GWP below 150
- Beside industrial/chemical gases like CO_2, hydrocarbons or NH_3, the hydrofluoroolefins (HFO) with GWP<150 are and will remain long-term, F-Gas compliant refrigerant solutions
- These HFO solutions still represent in many applications and systems an optimum in terms of the combination efficiency (TEWI), capacity, safety risk & total cost of ownership

Assessment of Refrigeration Systems

- There is no single refrigerant solution for all applications
- The focus needs to shift away from the refrigerant only, towards the combination system + refrigerant
- Systems are evolving based on the possibilities and opportunities offered by each refrigerant
- What aspects should be considered to assess impact of any refrigeration system or installation?
  - **Environmental parameters**
    - Direct emissions (coming from leaks) expressed in ton of CO_2 eq. throughout life span of the refrigeration installation
    - Indirect emissions, coming from CO_2 emissions through the energy production necessary for the installation to be operated, expressed in tons of CO_2 throughout life span of the refrigeration installation
  - **Financial parameters (for the end user of the installation)**
    - CAPEX
    - OPEX (including maintenance, refrigerant top-off, repairs throughout life span of refrigeration installation)
  - **Safety Risk**

		% of capture of impact	
	Metric type	Environmental	Financial
GWP	1 dimension	up to 35%	0%
TEWI	1 dimension	up to 95%	0%
LCCP	1 dimension	up to 100%	0%
Eco-Efficiency	2 dimensions	up to 95%	up to 100%

Make sure to use the most eco-efficient „system + refrigerant“

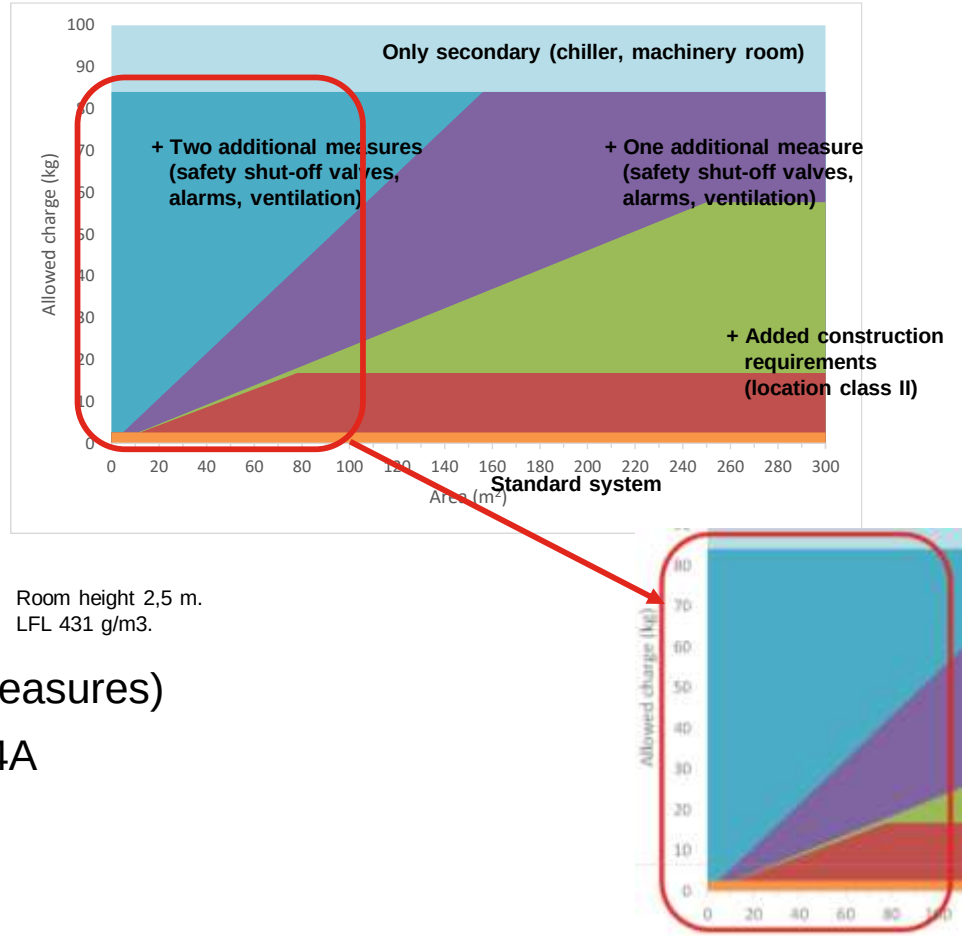
Food Service, Cold Rooms

Typical Examples of Systems

- **Condensing Units**
- **Monoblock Systems**

Recommended Refrigerant Solution

Solstice® L40X (R-455A)



Room height 2,5 m.
LFL 431 g/m3.

Key Benefits System + Refrigerant

- EN 378: Direct expansion possible in public buildings with up to 84 kg of R-455A per circuit (with 2 additional safety measures)
- High efficiency in medium- & low-temp, comparable with R-404A
- Higher capacity per circuit vs. R-290 and lower safety risk
- Cost comparison vs. R-744 condensing units (MT) result in:
  - ca. 46% lower CAPEX
  - ca. 36% lower OPEX (calculated for 15 years life span for average European ambient temperatures)
- Eco-Design: GWP<150 gives access to reduction of MEPS

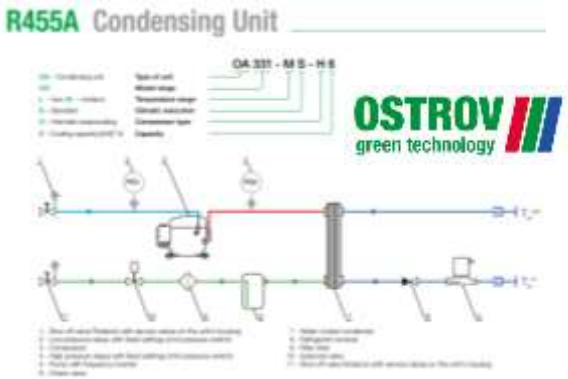
Solstice L40X (R-455A) covers most capacity requirements

Food Service, Cold Rooms

References

- **Alecto/Hawco:** Available (**booth 7A-624**) (https://www.hawcorefrigeration.com/wp-content/uploads/2017/04/alecto-condensing-unit-waterloop-aircooled-us.pdf)
- **Ostrov Green Technology:** Available (http://www.ostrovcomplete.com/data/file/OGT/OGT-catalogue-s-EN.pdf)
- **Zanotti:** Medium-Temp monoblock systems ready for R-455A (**booth 7-216**) (https://www.honeywell-refrigerants.com/europe/wp-content/uploads/2018/08/CaseStudy_Zanotti_210x297mm_EN_2482018_Web-Version.pdf)
- **Bitzer:** Condensing units LH qualified with R-455A (**booth 7-326**)
- **SCM Frigo:** Condensing units “CUBO Light” ready for R-455A (**booth 7-424**)
- **Rochhausen:** Condensing units with R-455A (**booth 5-442**)
- **Rivacold:** Testing R-455A (**booths of Rivacold 6-319, FIC 6-320 and Honeywell 6-126**)
- **Tecumseh:** Working on R-455A (**booth 5-334**)
- **Emerson:** Working on R-455A (**booth 6-318**)

hawco

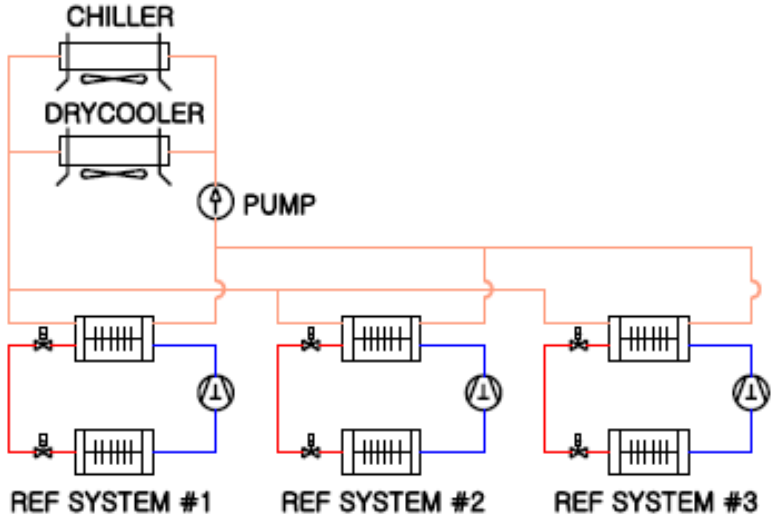


Systems already available and more to come soon

Convenience & Forecourt Stores

Example of System/Architecture

Waterloop-cooled stand-alone units with heat recovery



Recommended Refrigerant Solution

Solstice® L40X (R-455A)

Key Benefits System + Refrigerant

- EN 378: Charge up to 2,6 kg possible in public buildings without room size constraints nor additional measures
- Higher capacity per circuit vs. R-290 and lower safety risk
- Simplicity & speed of system construction vs. R-744 systems (reduced store downtime: faster store opening)
- Simplicity, safety & speed of maintenance vs. R-744 and R-290 systems
- Smaller systems allow for significantly reduced power consumption peaks & lower price per kWh for the operator
- R-455A is versatile and covers whole temperature range: low-temp, medium-temp and AC/heating chiller
- Evacuation of condensation heat from stand-alone systems i.e., lower load on AC system in warm periods, and lower load on heating system in cold periods (lower OPEX)

Safe, simple, flexible and cost-effective solution

Convenience & Forecourt Stores

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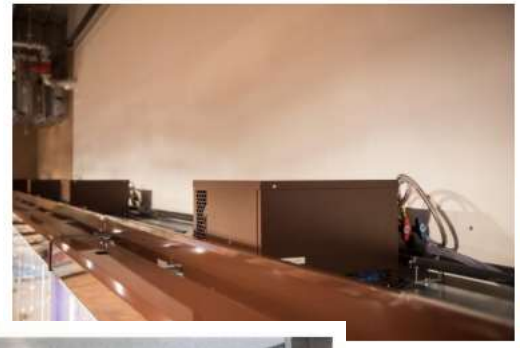
References

- **KMW Limburg:** Available (**booth 6-126**)



KMW KÜHLMÖBELWERK Qualität aus Deutschland

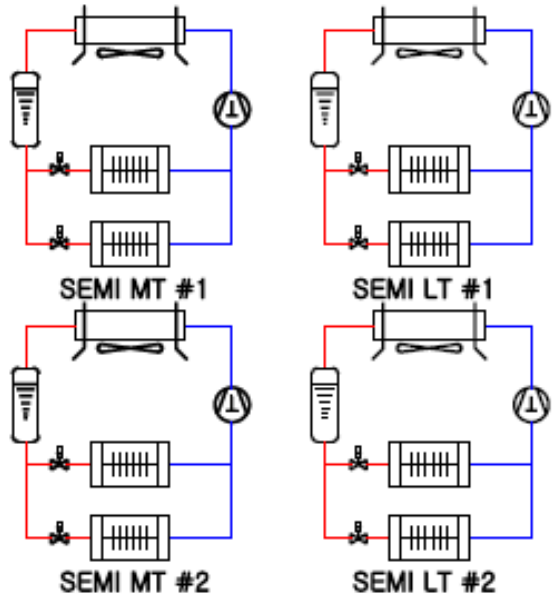
proKlima

Several retailers and forecourt stores confirmed implementation

Small/Medium-Size Supermarkets

Example of System/Architecture

Distributed architecture based on condensing units



Recommended Refrigerant Solution

- **Solstice® L40X (R-455A)**
- **Solstice® N40 (R-448A) / N13 (R-450A)**

Key Benefits System + Refrigerant (R-455A)

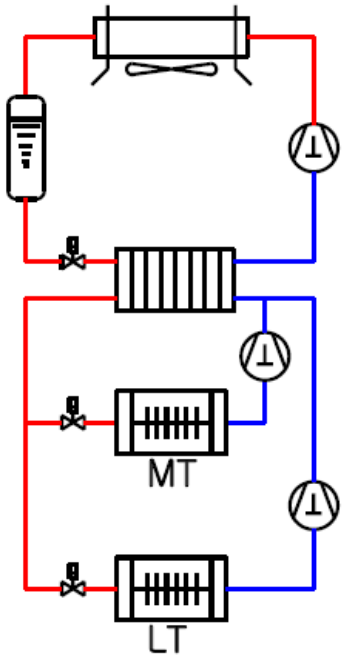
- Covers both low- & medium-temp with GWP<150 (similar to R-448A)
- EN 378: Charge up to 57,7 kg possible in public buildings if outdoor condensing units (min. 625 m^3 room volume) or up to 84 kg per circuit (with 2 additional safety measures) - this reduces the number of circuits to be built (lower CAPEX & OPEX)
- Higher capacity per circuit vs. R-290 and lower safety risk
- Lower cost & higher efficiency vs. centralized R-744 systems (specific set point for each cluster of cabinets allow for optimized working conditions hence efficiency)
- Architecture allows for higher flexibility vs. centralized system architectures (store set-up configuration, replacement of failing units, potential food loss)

Solstice L40X (R-455A) enables optimization of system decentralisation

Large Supermarkets

Recommended System/Architecture

Cascade architecture



Recommended Refrigerant Solution

Solstice® ze & R-744

Key Benefits System + Refrigerant

- Full coverage of refrigeration, heating, AC and hot water through properties of R-1234ze
- R-1234ze: PED Group 2 & higher COP than R-134a
- Better efficiency in medium & high ambient conditions when compared with transcritical R-744 systems
- Subcritial installation: simplicity & lower cost of system construction and maintenance vs. transcritical R-744 systems
- GWP<1, no F-Gas constraints (R-1234ze is not GHG)
- Risk assessments ongoing to determine max. allowed charge of R-1234ze in DX (no charge limitation if in machinery room)

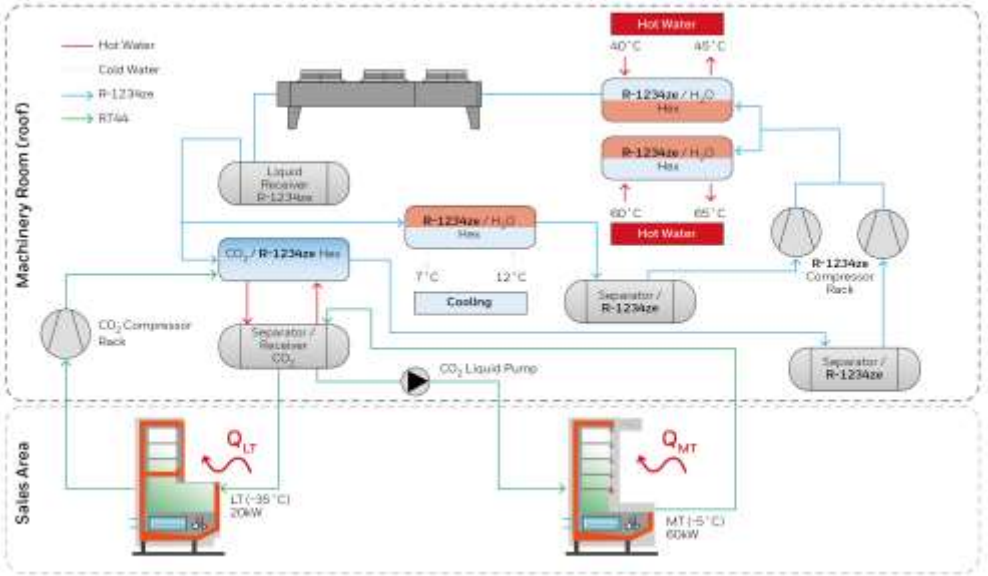
Simplicity and maximum efficiency for large centralized systems

Large Supermarkets

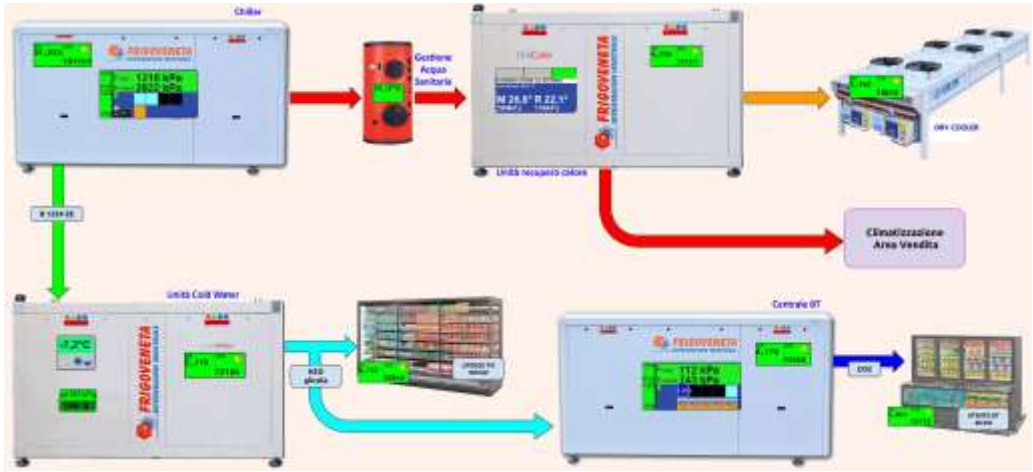
References

- **U2/UNES Supermarket (Parma, Italy)**
  - Commissioned Dec 2014
  - Operating & maintenance costs reduced by ~15,000 €/year *
  - Energy consumption reduced by ~35% *
  - Compact system design: Increase sales floor area

  * *When compared to standard 3-system architecture (Ref DX + HVAC + Gas HW)*



- **Famila & Mega Supermarkets (Italy)**
  - 4 stores commissioned in Sep 2018 by Frigoveneta
  - Chiller R-1234ze (ca. 80 kg)
  - Glycol for medium-temp (180 kW) / R-744 for low-temp (40 kW)
  - Energy consumption optimization thru :
    - Recovery of waste heat from cooling (AC + sanitary hot water)
    - Central regulation of all HVAC loads (heat pump, air treatment, fans)
    - Central management of lighting loads & FM



ALFA PROJEKT

FRIGOVENETA REFRIGERAZIONE INDUSTRIALE

Solstice® L40X (R-455A): Further Commercial References

Self-Contained Integral Systems

- ES System K / Genfrost

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Waterloop Systems

- Ostrov
- Alecto/Hawco

hawco

Food Service & Collective Kitchen

- Tournus Equipement

Large DX Industrial Systems

- Quercy Refrigeration

Be the next to convert and create your competitive advantage

Industry

Example of System/Architecture

Process Chiller

Recommended Refrigerant Solution

Solstice® ze

Key Benefits System + Refrigerant

- More compact system design vs. R-717 chillers: Lighter & lower CAPEX
- Simplicity & lower cost of system construction, operation and maintenance
- Efficiency comparable with R-717 systems
- Lower safety risk vs. R-717 chillers
- GWP<1, no F-Gas constraints (R-1234ze is not GHG), PED group 2
- EN 378: No charge limitations in most cases (room occupancy/access & system location)

HFO refrigerants offer more options for industrial applications

Industry

References

- **Zimavi Vegetable Processing (Alicante, Spain)**
  - 2 cold rooms (@1ºC) + 1 refrigeration tunnel (from 25ºC to 2ºC) / 250 kW
  - Chiller R-1234ze from Geoclima + heat transfer fluid Temper
  - Consultancy/Contracting: Frimavi
  - 20% lower investment & 70% lower operation cost than for a corresponding R-717 installation
  - COP similar to corresponding R-717 installation (similar operating conditions)

- **Quercy Refrigeration (South-West France)**
  - Fruit storage & processing
  - COP higher than for the R-717 chillers, through the use of air-cooled DX condensers (upwards waste heat recovery)
  - 50% lower CAPEX vs. similar R-717 chillers
  - Lower noise level
  - Compressors for R-1234ze are tight compared with compressors for R-717 systems

Lower safety risk and costs with long-term refrigerant solution

Honeywell Refrigerant Solutions for New Systems

<table>
<tr><th colspan="2"></th><th>Food Service, Cold Rooms</th><th>Convenience & Forecourt Stores</th><th>Small/Medium-Size Supermarkets</th><th>Large Supermarkets</th><th>Large Industrial</th><th>Refrigerated Transport</th></tr>
<tr><td colspan="2">Self-contained, integral systems Low- & Medium-Temp (Plug-ins)</td><td colspan="4">Solstice® L40X (R-455A)</td><td></td><td></td></tr>
<tr><td rowspan="3">Condensing Units</td><td>Compressor below 2 HP</td><td colspan="2">Solstice® L40X</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Compressor between 2 and 10 HP</td><td></td><td colspan="2">Solstice® L40X
(if charge size allowed by EN378 and/or risk assessment)
Otherwise: Solstice® N40 or Solstice® N13</td><td></td><td>Solstice® L40X</td><td></td></tr>
<tr><td>Compressor above 10 HP</td><td></td><td></td><td></td><td></td><td>Solstice® L40X</td><td></td></tr>
<tr><td colspan="2">Waterloop Systems</td><td></td><td colspan="2">Solstice® L40X</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Monoblock Systems</td><td colspan="2">Solstice® L40X</td><td></td><td></td><td>Solstice® L40X</td><td>Solstice® L40X</td></tr>
<tr><td>Centralized systems</td><td>System cooling capacity above 40 kW</td><td></td><td></td><td colspan="2">Today: cascade
Solstice® ze/R-744
Tomorrow: “Solstice® zd loop / Solstice® L40X”</td><td>Process chillers:
Solstice® ze/zd</td><td></td></tr>
</table>

Solstice refrigerants for all systems and segments

Summary

- HFO solutions represent an optimum in terms of efficiency (TEWI), capacity, safety risk & total cost of ownership in many applications and systems
- Honeywell has developed long-term refrigerants which can cover most systems and applications
- **Solstice® L40X (R-455A):** F-Gas compliant refrigerant for Low-, Medium- & High-Temp in refrigeration, heat pumps and chillers
  - Already several key references in the market: food service, self-contained display cases, waterloop, condensing units, industrial racks
  - Its extremely low flammability is a key differentiator vs. hydrocarbons
  - The high LFL enables higher max. charges according to EN 378 and is a key differentiator vs. other A2L's
  - Its high efficiency in Medium- & Low-Temp, also in small capacities, is a key differentiator vs. R-744
  - CAPEX and OPEX of systems are comparable with traditional R-134a/R-404A systems
- **Solstice ze & Solstice zd:**
  - Widely used in chiller applications today
  - Optimal & safe solutions for cascade architectures in retail & industrial refrigeration

Solstice refrigerants with GWP<150: the future of refrigeration… now!

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