

# **R290 Integrated Display Cabinets**

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**euramm<sup>o</sup>n**

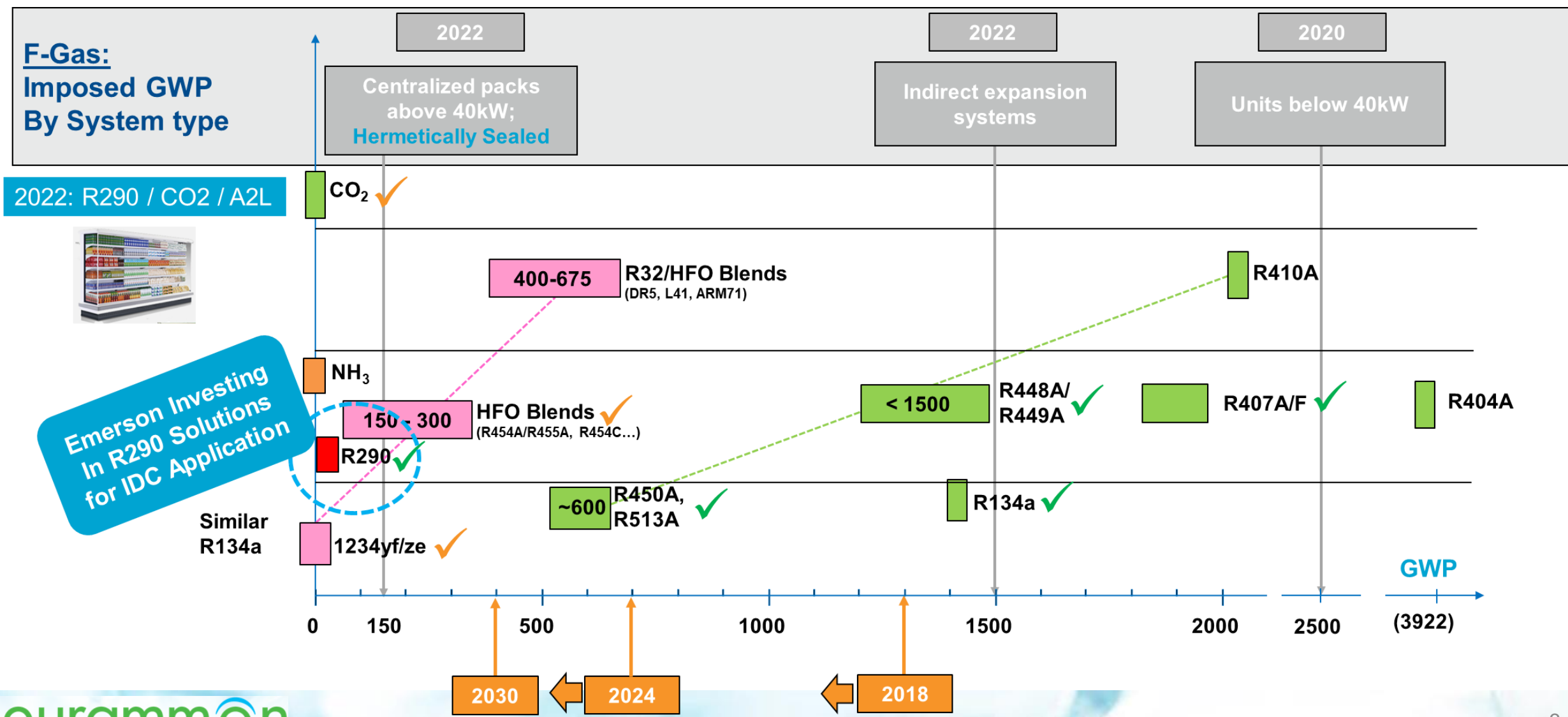
refrigerants delivered by mother nature

# Agenda





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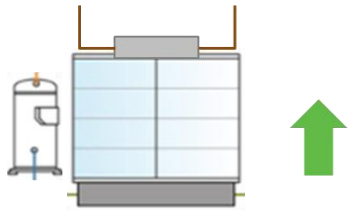



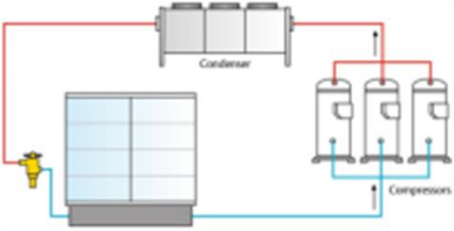


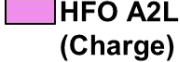

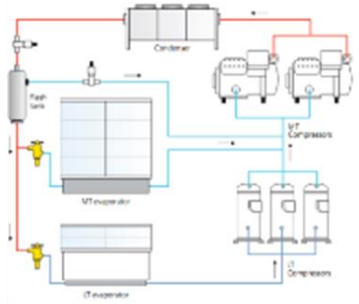








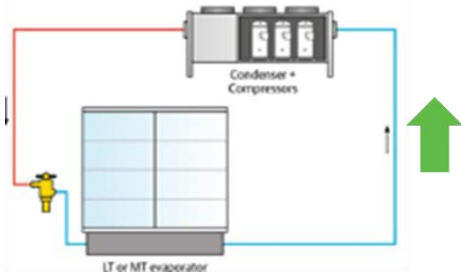




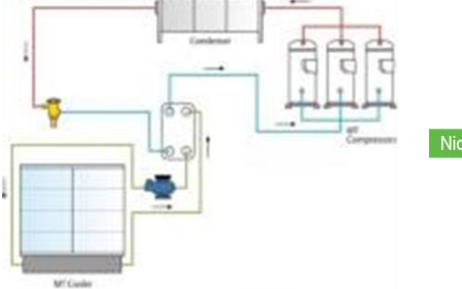




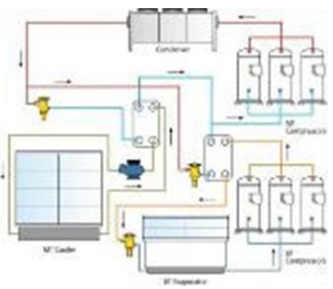







- Supermarket System Architectures and Future Solutions
- ILK Study: Comparison CO<sub>2</sub> vs R290 for Discount Supermarkets
- R290 Variable Speed Solution for Integral Display Cabinets
- Summary

# F-Gas Allows Refrigerants < 150 GWP For DX Applications From 2022

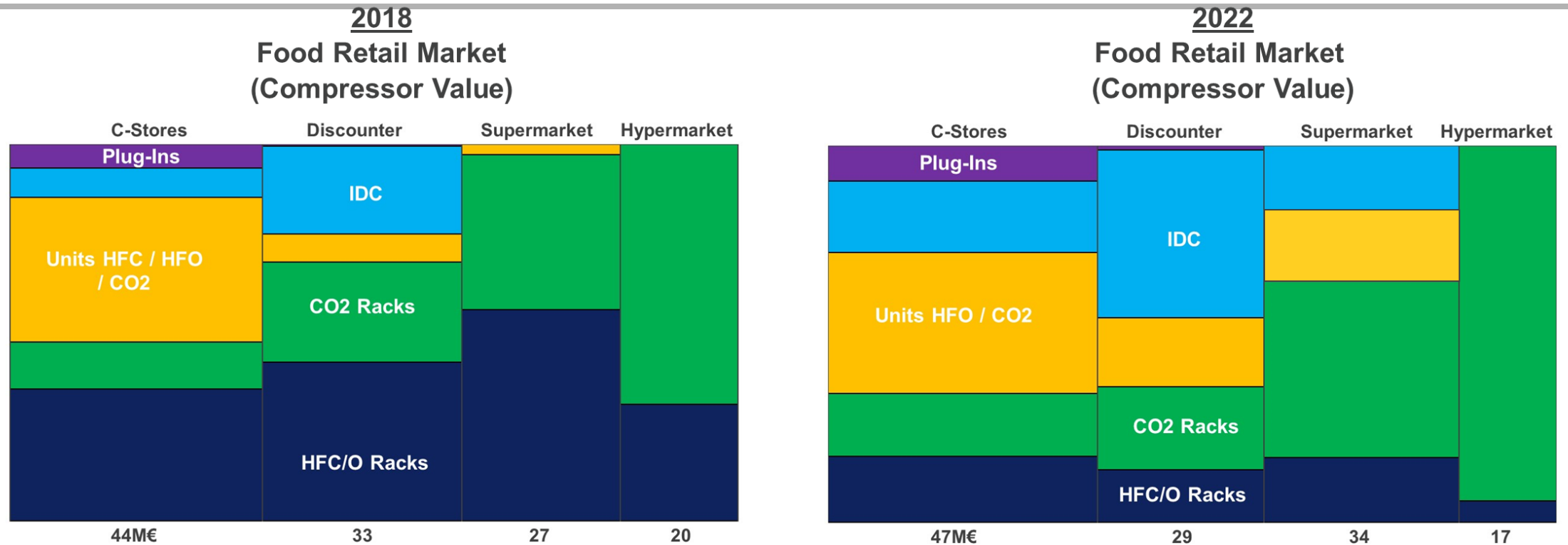


# Refrigerants – System Applications

	A1 Non Flammable		Growing/Decreasing
	A2L Mildly Flammable		
	A3 Flammable		

Food Service / Cold Rooms	Retail - Distributed / De-Centralised	Retail – Centralised Systems	
<p><b>Remote Unit</b></p>  <p> HFC/HFO A1   HFO A2L   CO2</p> <p>GWP 2500</p>	<p><b>Integral Display Cases</b></p>  <p> HFC   R290</p> <p>GWP 150</p>	<p><b>Centralised Packs &gt; 40kW</b></p>  <p> HFC/HFO A1   HFO A2L (Charge)   CO2</p> <p>GWP 150</p>	<p><b>CO2 Booster</b></p>  <p>  CO2</p> <p>GWP 150</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Moving To </p>
<p><b>MonoBlock</b></p>  <p> HFO A1   HFO A2L   R290</p> <p>GWP 2500</p>	<p><b>Units &lt;40kW</b></p>  <p> HFC/ HFO A1   CO2   HFO A2L (Charge)</p> <p>GWP 2500</p>	<p><b>Indirect Systems / Chillers MT</b></p>  <p>  R290   HFO A2L &lt;150</p> <p>GWP 150</p> <p style="text-align: right;">Niche </p>	<p><b>Cascade</b></p>  <p> HFC/HFO A1   HFO A2L   CO2 (LT)   CO2 (LT)</p> <p>GWP 1500</p> <p style="writing-mode: vertical-rl; transform: rotate(180deg);">Moving To </p>

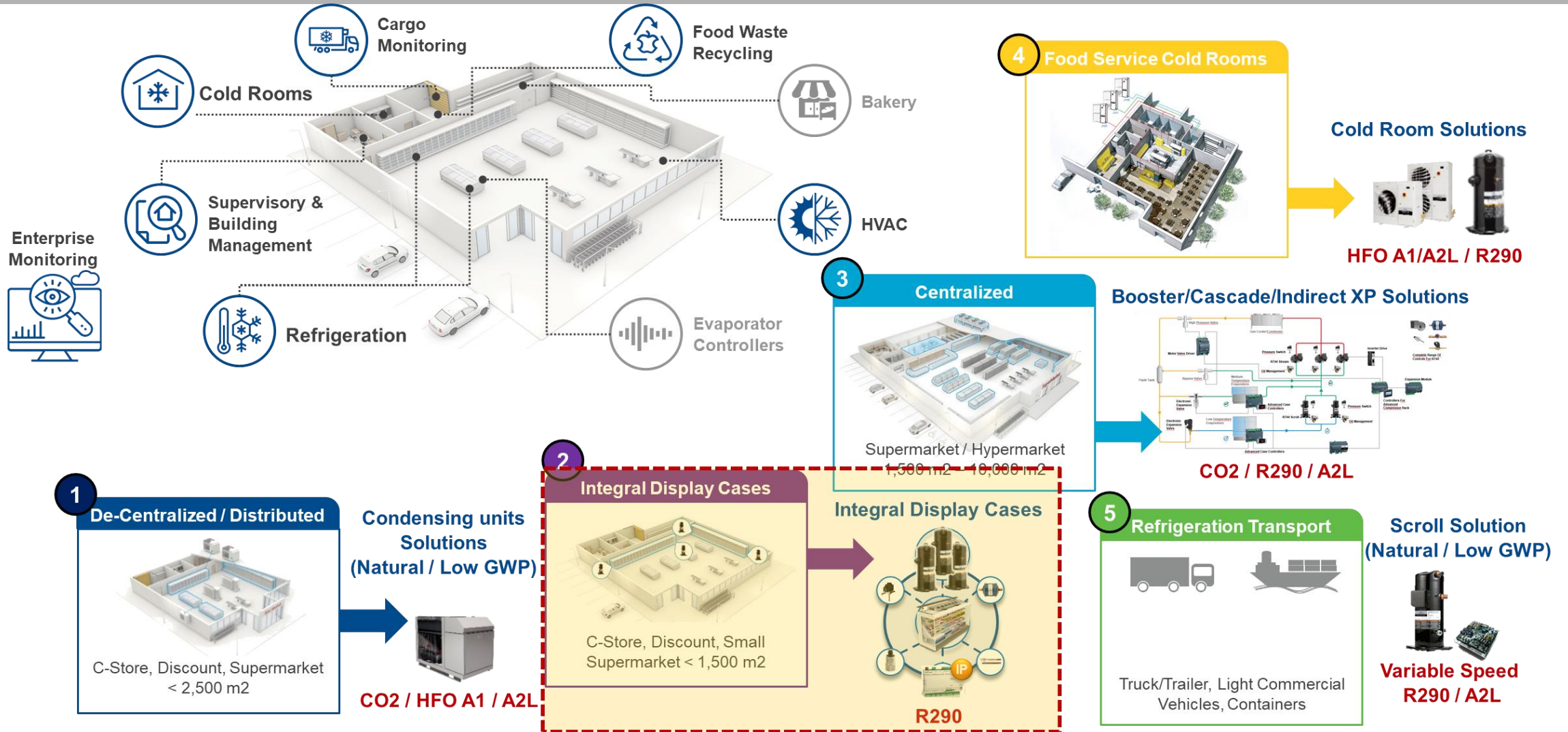
# System Architecture Transition Caused By F-Gas & Recent Ongoing Technology Developments



- Natural Refrigerant based systems participation will increase in the next 4 years
- Adoption of CO2 Boosters will continue in larger formats
- Integral Display Cases (IDC) based on R290 will grow for smaller formats thanks to charge increase
- Small HFO A2L Systems Will Play A Role As An Economical Option To CO2



# Emerson Investing In 4 Different Types Of Refrigeration Solutions



# Natural Refrigerant European Market

Market Surveys – Shecco (shecco.com) & Life Front (www.lifefront.eu)

## CO2



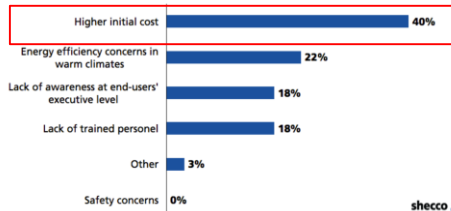
- Trend Started in 2000
- Acceleration in 2008
- 16.000 Stores on CO2
- Less Than 10% - excluding small stores

## Waterloop Systems

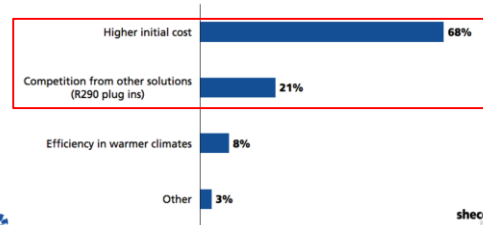


- Trend Started in 2010
- R290 Started in 2016
- 7500 Stores on Water Loop
- 2000 Stores on R290

What do you believe is the major barrier holding back a widespread uptake of CO2 in the supermarkets sector?



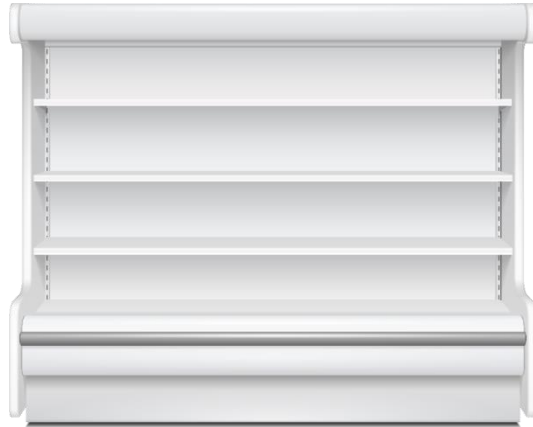
What is the main barrier CO2 technology for small stores needs to overcome?



- **Cost is number one hurdle for CO2** specially in small formats
- Together with **efficiency, awareness** and **technical skills**

- **Current charge limits** in standards restrict the development of R290
- **Higher charge limits** will positively impact adoption, cost & availability

# ILK Study: Discount Supermarket ~1000 m<sup>2</sup> - Cabinets



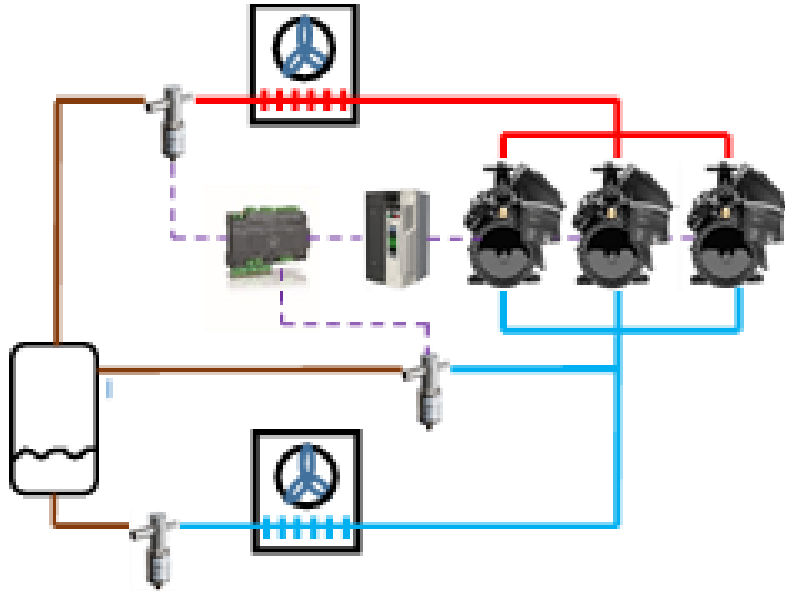
- Total length 31,25 m
- 25 Axes each 1,25 m
- 7 cabinets 3,75 m
- 2 cabinets 2,50 m
- Total Cooling Capacity 50 kW



Integrated Freezer Cabinets with R290 and heat rejection into the market are not considered for the comparison in this study.



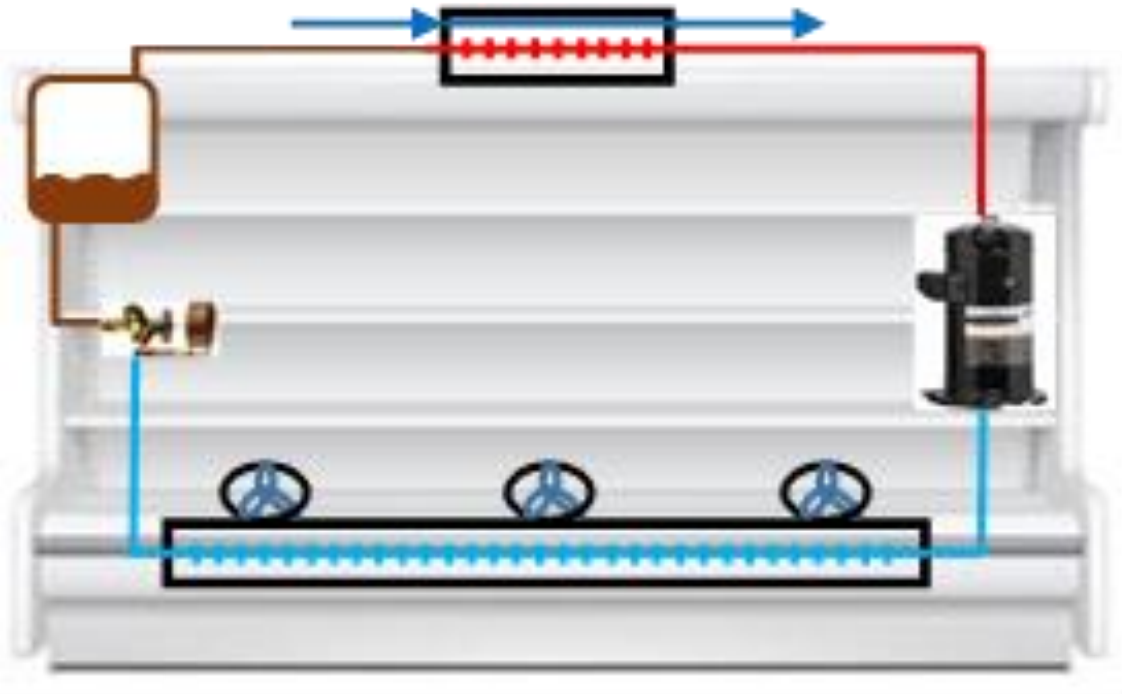
# CO2 Pack System



## CO<sub>2</sub> Compressor Pack

- ❑ 1 4MTL-12X Inverter
  - 28,8 kW @65 Hz
- ❑ 2 4MTL-05X
  - 10,3 kW
- ❑ 38°C Ambient Design Temperatur
- ❑ 22°C ambient -> transcritical control
- ❑ 2K dT to ambient transcritical
- ❑ Subcooling sub-crit.=f( $t_{\text{ambient}}$ )
- ❑ Güntner GGHC CD063.1
- ❑ 10°C min. condensation temp.

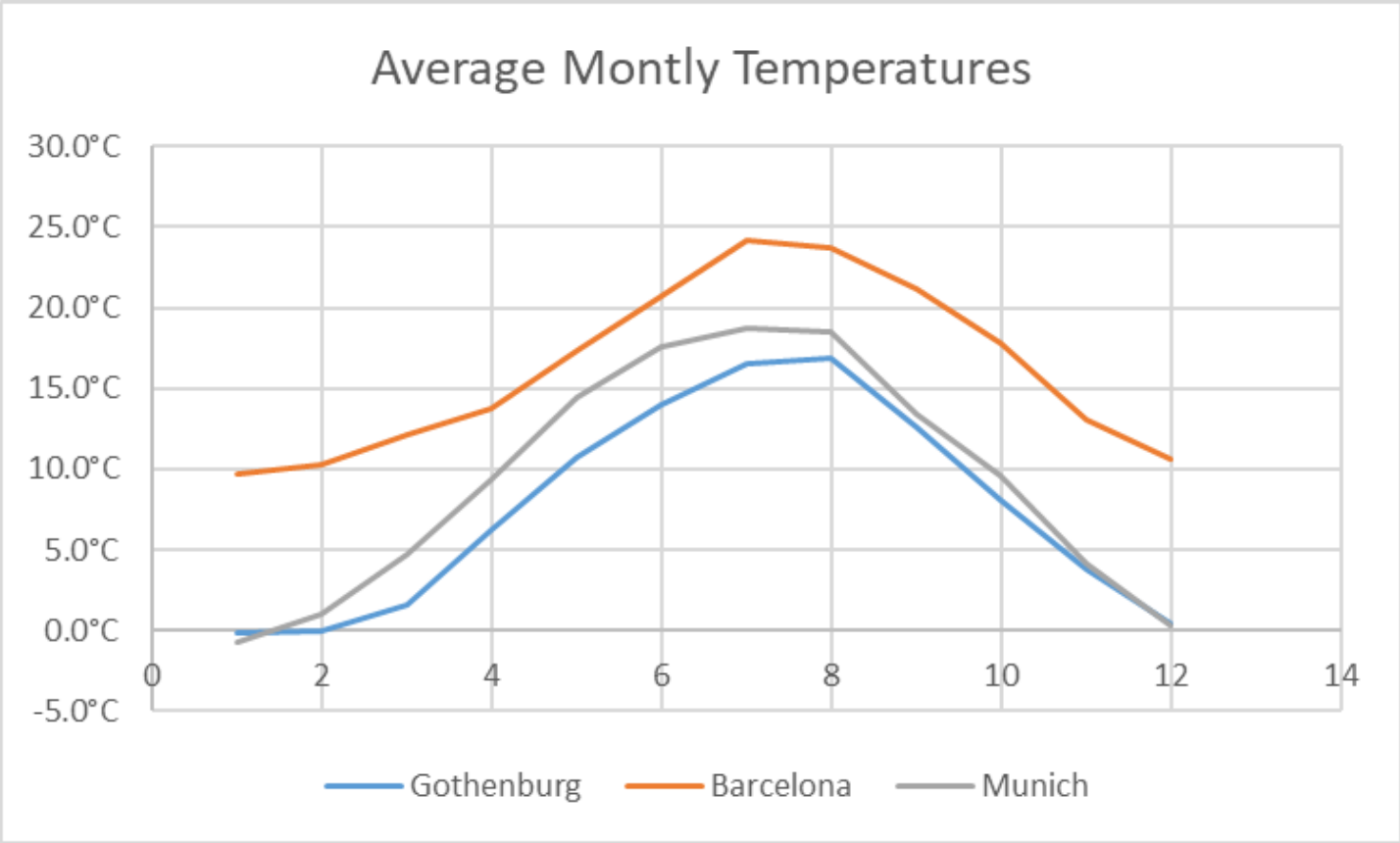
# Integrated Display Cabinets (IDC)



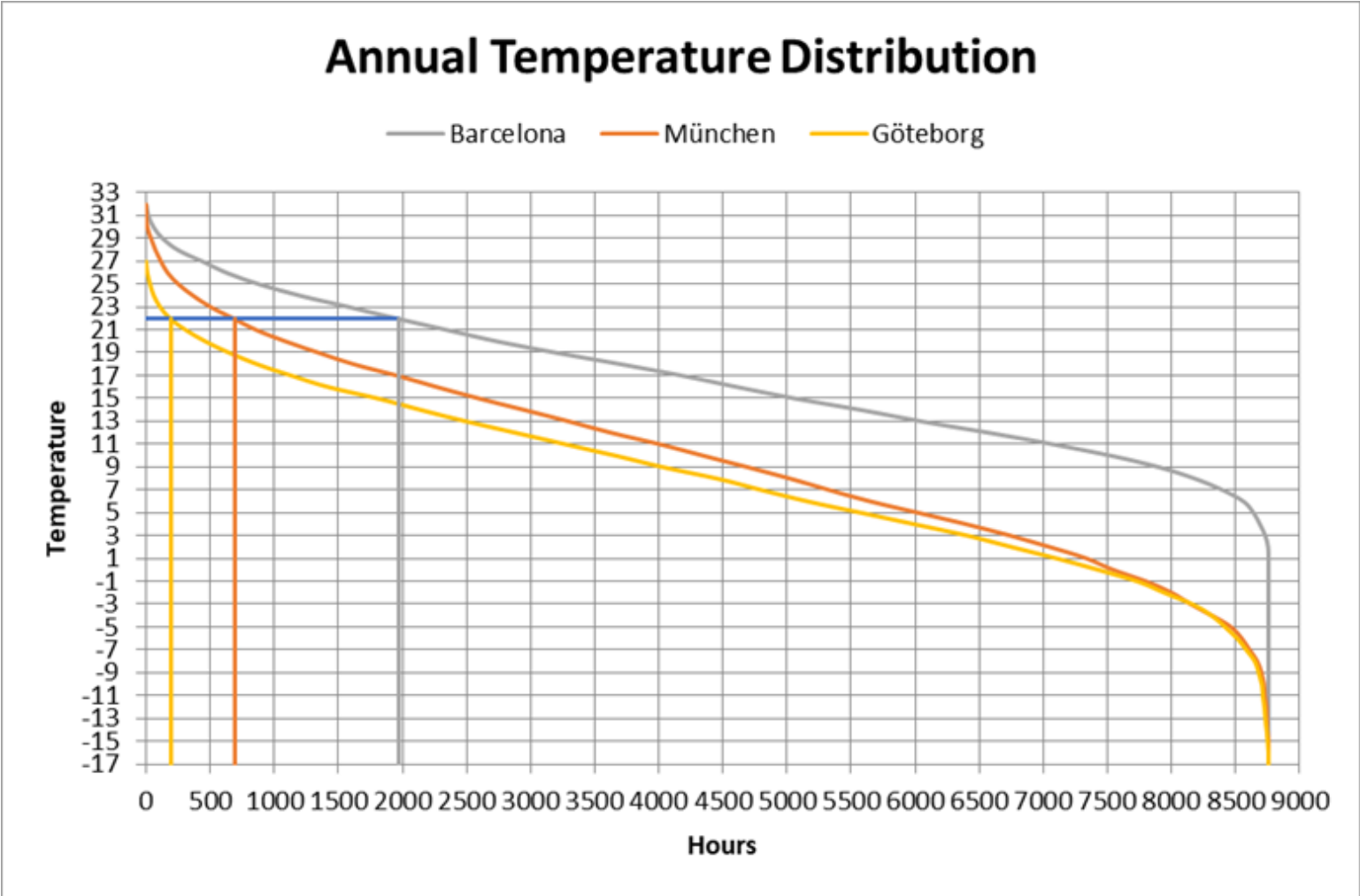
## R290

- 7 ZB20KCU
  - 5,89 kW
- 2 ZB17KCU
  - 4,68 kW
- Brine Cooler Design for 43°C
- 5K dT brine controlled
- Güntner GFW 090.1 Heat Exchanger
- Propylen Glycol 38%
- Min temperaure difference 3,2 K

# Weather Data for the Comparison



# Weather Data (Meteonorm) for the Comparison



# Comparison Energy Consumption

Table 4: Results for the Electric Energy Consumption for Munich

Electric Energy Requirement	CO <sub>2</sub> -Compressor Pack	R 290-IDC
Compressor	48,003 kWh/a	46,949 kWh/a
Display Cabinet	7,381 kWh/a	7,381 kWh/a
Gascooler/Condensor / Brine Cooler + Brine Pump	4,461 kWh/a	6,011 kWh/a
Auxiliary Power Supply	0,394 kWh/a	0,394 kWh/a
<b>Sum</b>	<b>60,239 kWh/a</b>	<b>60,735 kWh/a</b>
	<b>100%</b>	<b>101%</b>

Table 5: Results for the Electric Energy Consumption for Barcelona

Electric Energy Requirement	CO <sub>2</sub> -Compressor Pack	R 290-IDC
Compressor	63,169 kWh/a	54,734 kWh/a
Display Cabinet	7,381 kWh/a	7,381 kWh/a
Gascooler/Condensor / Brine Cooler + Brine Pump	5,647 kWh/a	6,329 kWh/a
Auxiliary Power Supply	0,394 kWh/a	0,394 kWh/a
<b>Sum</b>	<b>76,591 kWh/a</b>	<b>68,838 kWh/a</b>
	<b>100%</b>	<b>90%</b>

Table 6: Results for the Electric Energy Consumption for Gothenburg

Electric Energy Requirement	CO <sub>2</sub> -Compressor Pack	R 290-IDC
Compressor	43,489 kWh/a	44,471 kWh/a
Display Cabinet	7,381 kWh/a	7,381 kWh/a
Gascooler/Condensor / Brine Cooler + Brine Pump	4,428 kWh/a	5,940 kWh/a
Auxiliary Power Supply	0,394 kWh/a	0,394 kWh/a
<b>Sum</b>	<b>55,692 kWh/a</b>	<b>58,186 kWh/a</b>
	<b>100%</b>	<b>104%</b>

CO<sub>2</sub> vs R290

+1% Munich

-10% Barcelona

+4% Gothenburg



# Electrical Energy Consumption & TEWI for Munich

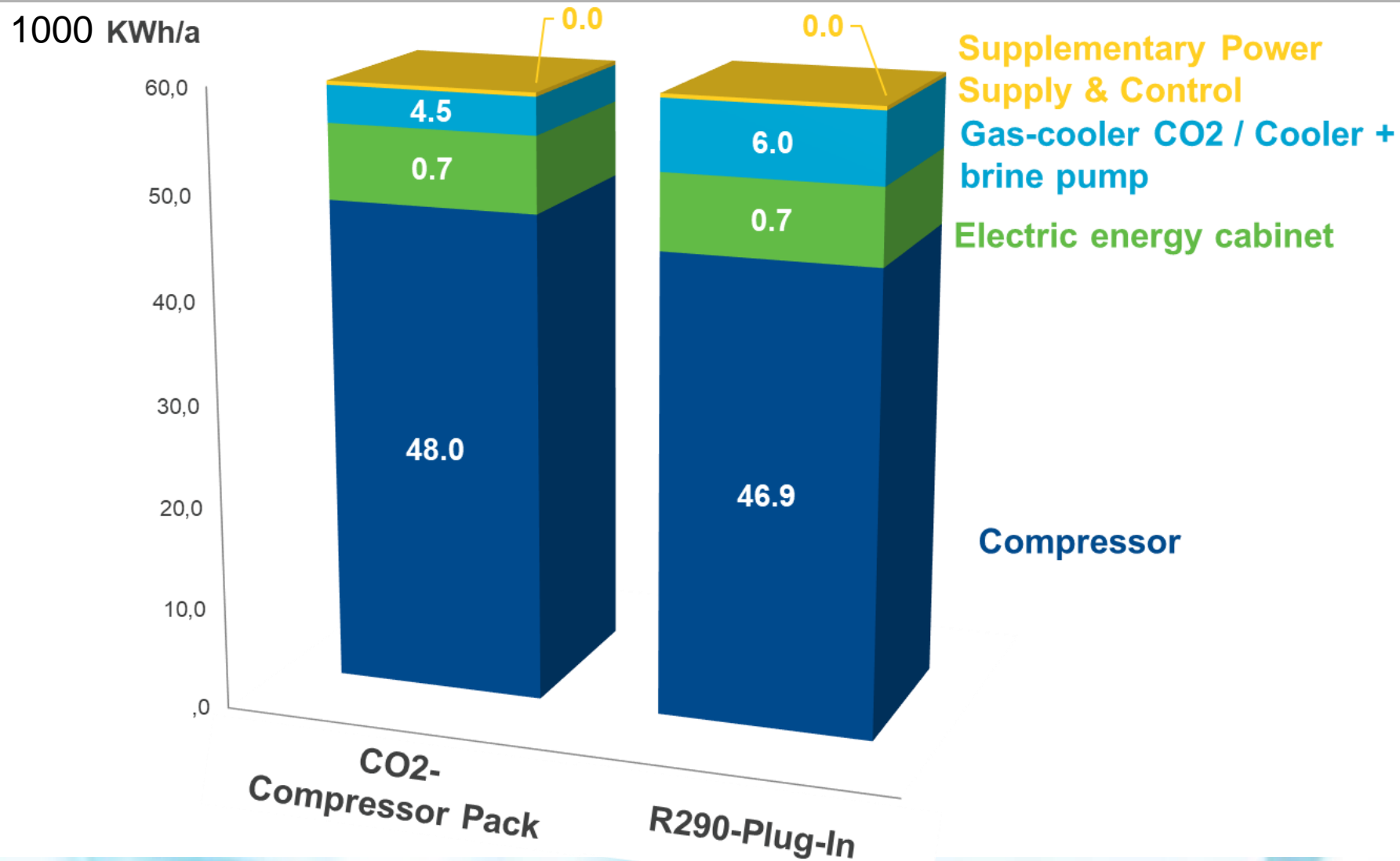
Calculated Energy Consumption:

Electrical Energy Consumption	CO2-Compressor Pack	R 290- Plug-In
<b>Sum:</b>	60.239 kWh/a 100%	60.735 kWh/a 101%

TEWI-Calculation:

TEWI Calculation	CO2-Compressor Pack	R 290- Plug-In
<b>Leckage rate</b>	5%/a	1%/a
<b>Total Emissions in kg CO<sub>2</sub> äqu.</b>	322.3 t 100%	324.9 t 101%

# Energy energy demand of the main components



# Life Cycle Cost Analysis - Munich

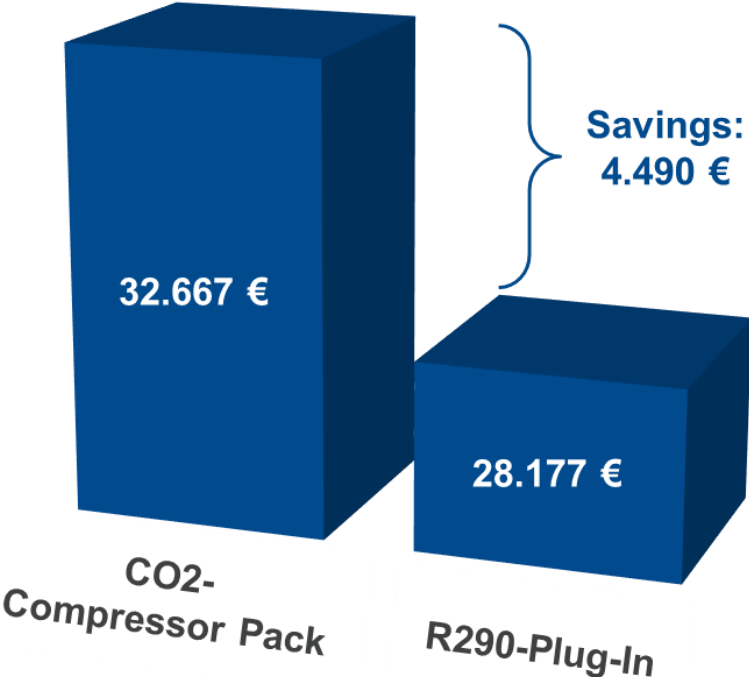
		CO2-Compressor Pack	R 290- Plug-In
<b>Planning / Invest Cost</b>	€	121.674	96.615
<b>Energy Cost</b>	€/a	18.403	16.851
<b>Disposal</b>	€	6.190	4.210

Average annual cost and total cost including disposal costs over 10 years

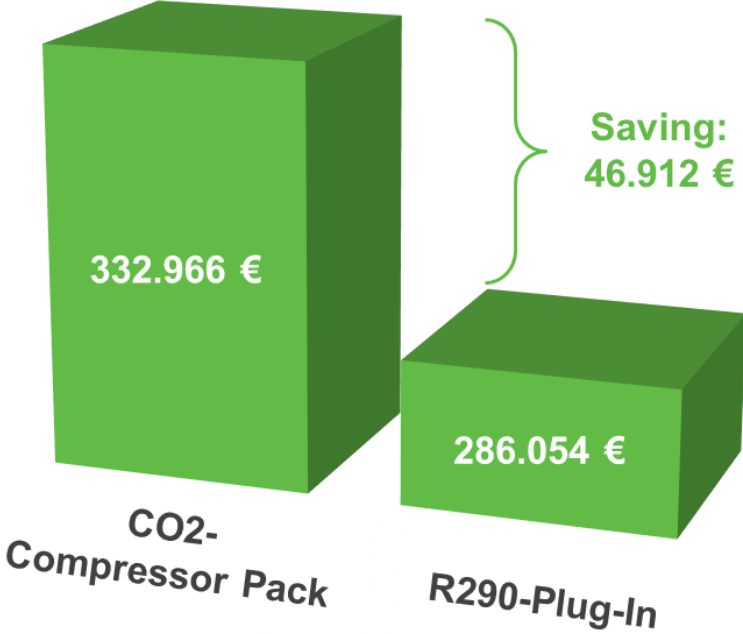
CO2-Compressor Pack		R 290- Plug-In	
Annual Cost	Total Cost	Annual Cost	Total Cost
32.667€	332.966€	28.177€	286.054€
100%		86%	86%

# Average Annual Cost and Total Cost incl. disposal 10 Years - Munich

## Annual Cost



## Total Cost for 10 years



# IEC Standard 60335-2-89 for 500g R290 is published June 2019

## Types of equipment

Out of scope

Investigated

Airflow to be considered  
May be mounted  
tabletop or under  
counter



Beer cellar coolers



Walk-in display cooler



Walk-in coldstore



Draft beer coolers



Ice makers



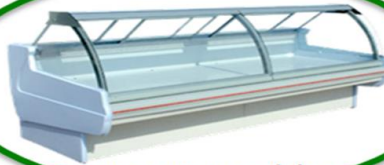
Ice-cream dispensers



Reach-in cabinets



Ice cream freezer



Serve-over cabinets



Multi-deck cabinets



Gelato counters



Preparation counters



Gondola cabinets



Condensing units



Blast freezers



Water coolers



Bottle coolers

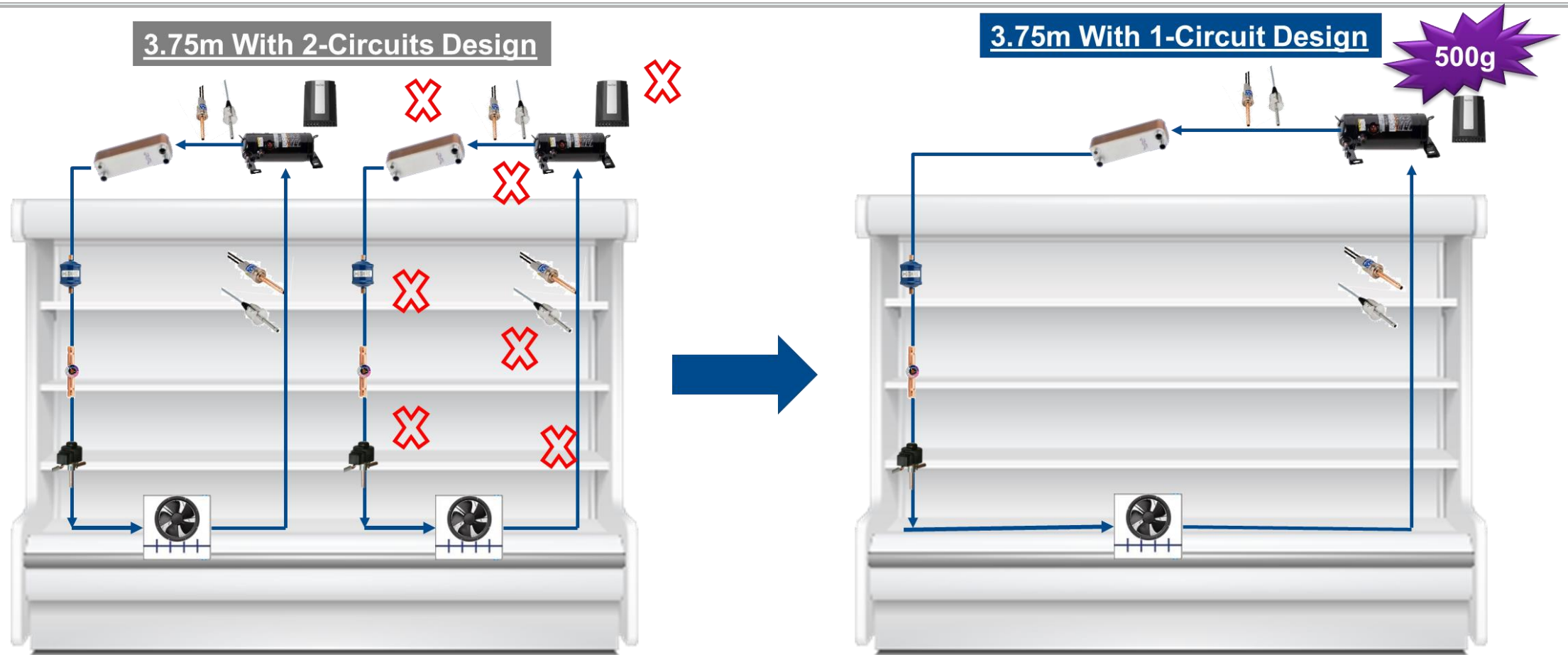


Chilled produce retail areas

Different rooms to be considered  
Only considered if it is used in factory sealed systems.

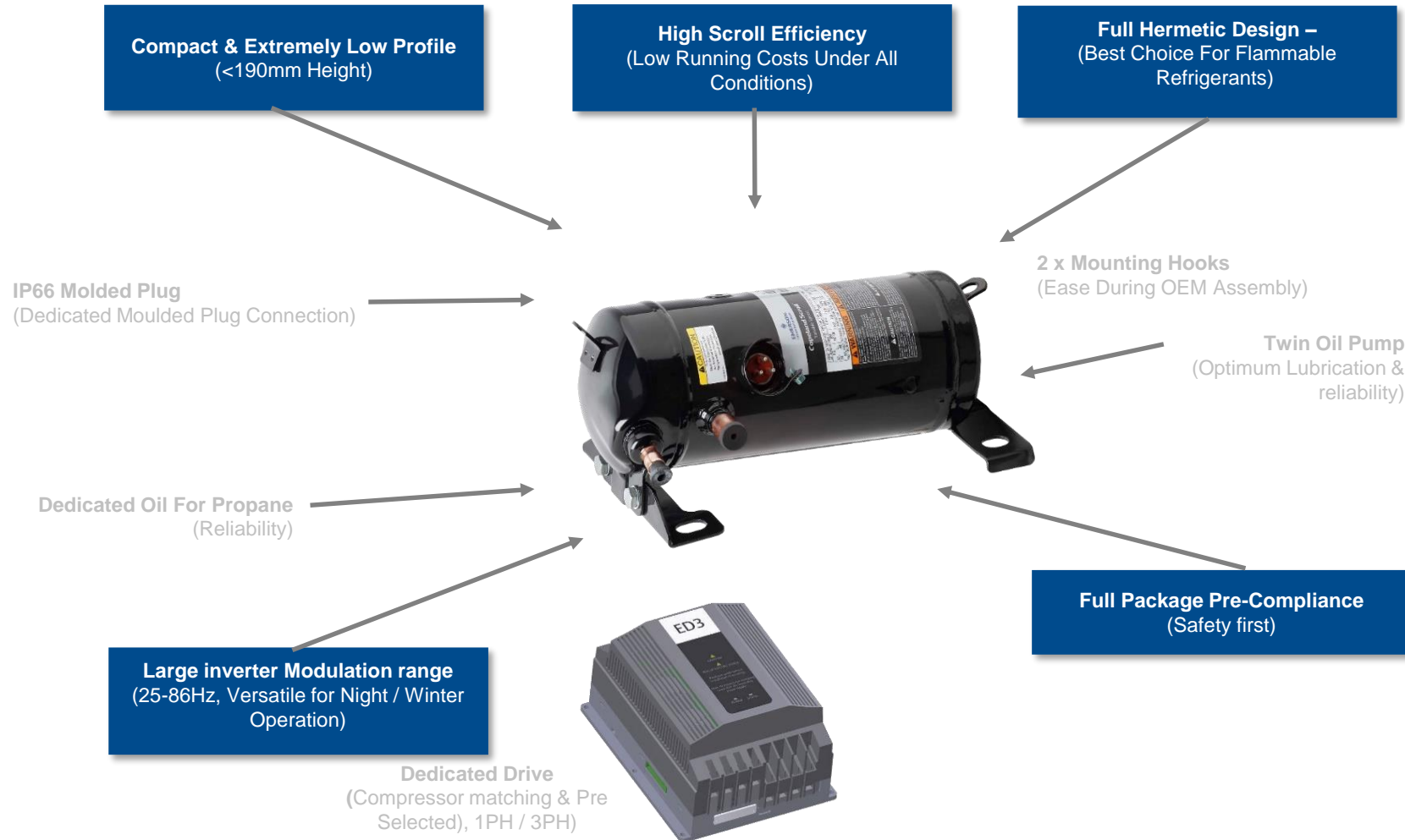


# New IEC 60335-2-89 Standard & Charge Increase will cause IDC Design to move from multiple to one circuit design



Applied Cost Saving Benefits: Less Number of Components and Reduced Manufacturing Complexity and Time

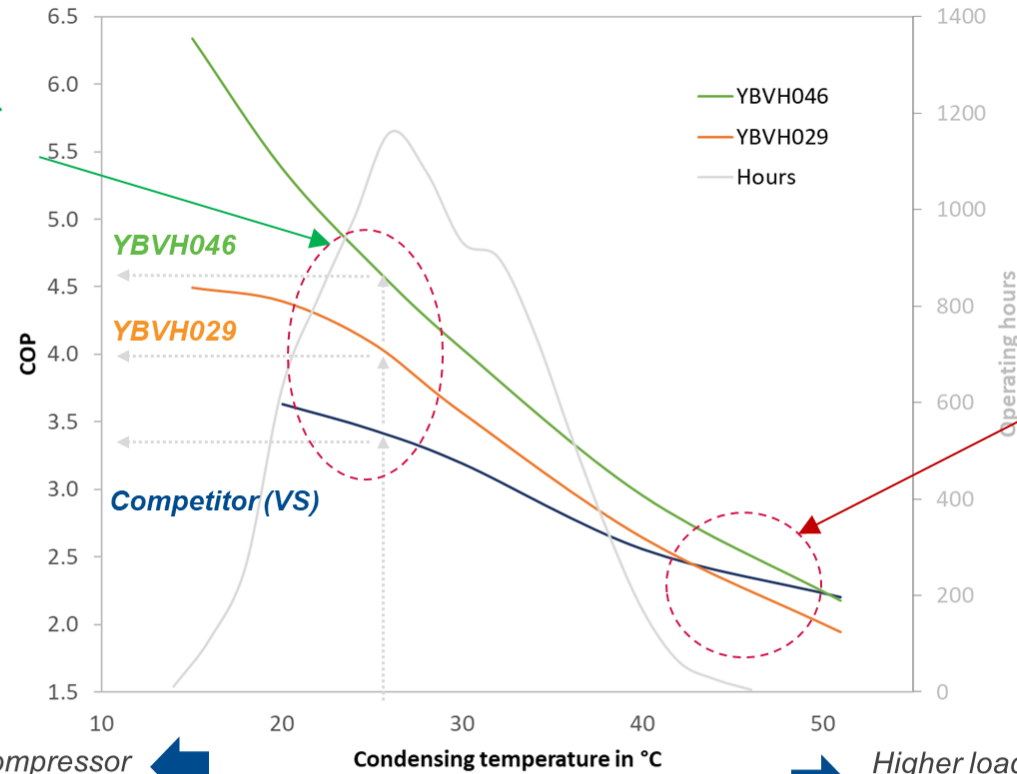
# Horizontal Scroll Variable Speed Overview



# Optimizing Scroll Design To Maximize System Seasonal Performance

Interpolation for speed required at different condensing temperatures

Emerson compressors have higher COP (up to +30%) at part load (=majority of operating hours)



All compressors deliver similar efficiency levels at full load (=few operating hours per year)

Lower load, compressor running at low speed

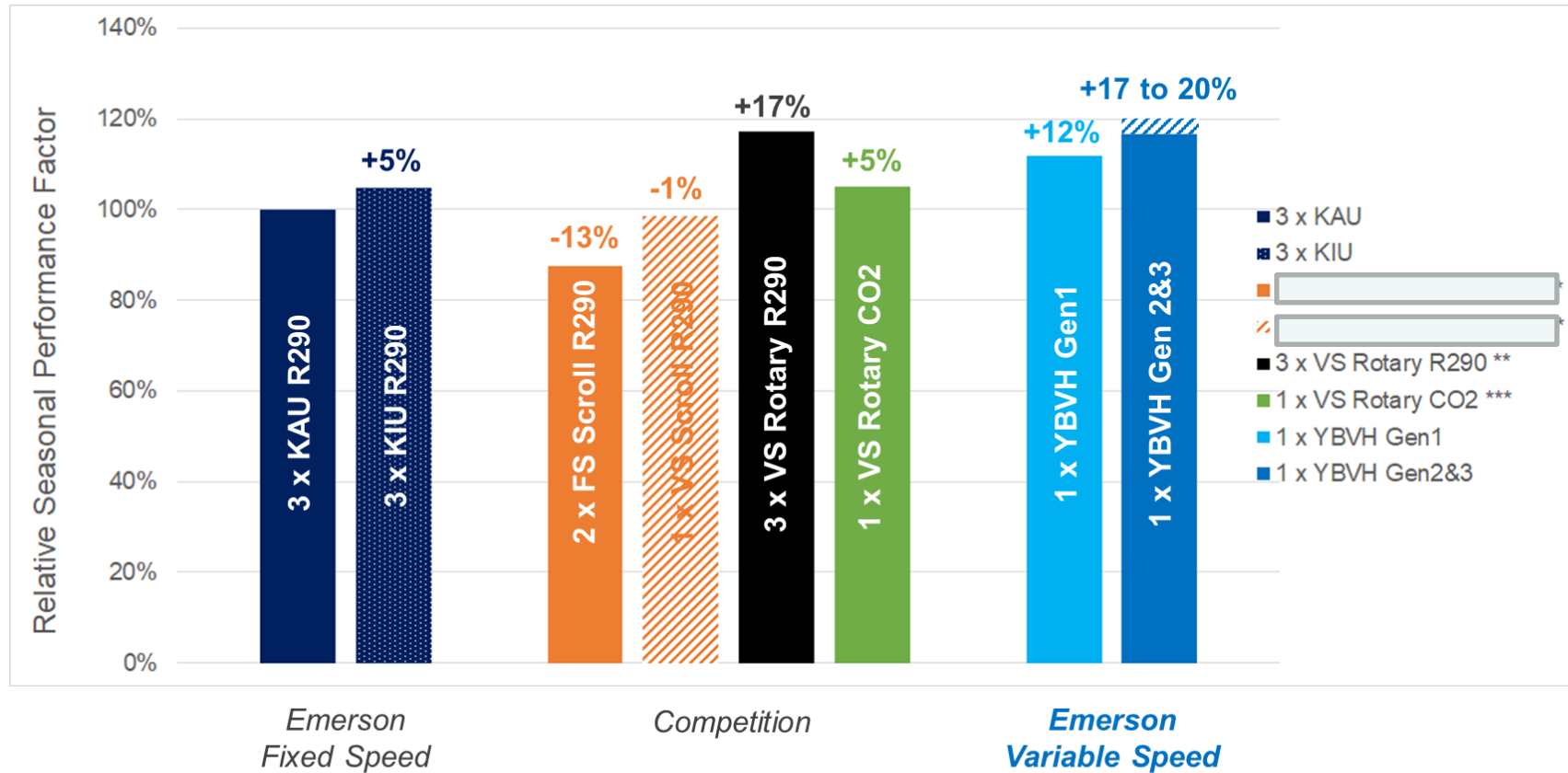
Condensing temperature in °C

Higher load, compressor running at high speed

Most operating hours

# Seasonal Performance Results For 3.75m Open Case

## The Best Single Circuit Solution On The Market



\* linear interpolation of measurement results, evap. Temp. Characteristic from available coefficients

\*\* linear interpolation of measurement results @ -6 °C evap., no evap. Temp. Dependency

\*\*\* based on performance curve published in Diego Malimpensa, 2018, *Natural solutions for semi-plug-in showcases*, Atmosphere Conference 2018

# Emerson Integral Display Case Solution – R290 > 150g

## Ready To Use

- Native compatibility with supermarket management system

## Case Management Electronics

- Temperature control
- Lights & Fans Management
- Case safety & protection
- **VDE & UL** ready design
- User *Display*

## R290 Ready Flow Controls

- **Safety compliant** sensors & switches
- Optimized **expansion valves**



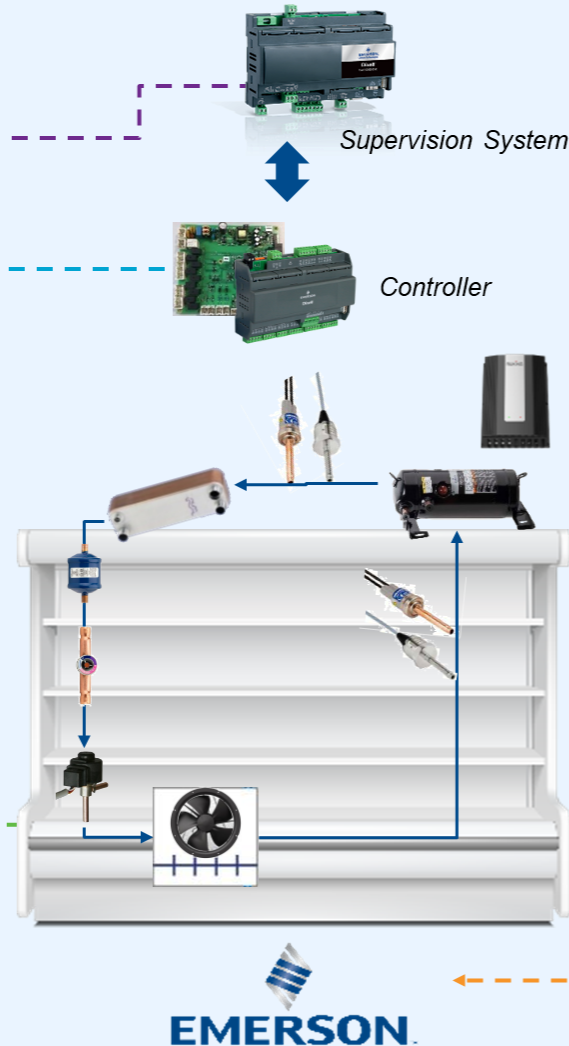
## Horizontal Scroll

- **3 models for medium temp**
- **Horizontal profile for compactness**
- **Suitable for cabinets of all standard sizes w/ and w/o doors**
- **Reduced applied costs**
- **Operational costs reduction with variable speed modulation**



## Solution Provider

- **Application & Engineering Experts** Team
- Full **Technical Support** during development
- Pre-Defined **Solution Kits**



**EMERSON**  
Holistic Emerson Design Approach To Serve Customer Needs:

Time To Market  
Cut Cost  
No Leakages  
Maintenance Cost Reduction  
Refrigeration Reliability  
Optimized To Operate Together



# Summary R290

## R290 Self-contained Systems with Water Loop vs CO<sub>2</sub> Remote Systems

- 15% annual lifecycle costs
- 20% Planning & Investment costs
- 10% operating costs (incl. service)
- 32% decommissioning costs
- Reduces refrigerant leak-rates from >5% down to <<1%

## Emerson's Solution for R290

- Solution „pre-compliant“ to various standards for easy and fast development
- Full range of certified compressors and controls
- Drive & compressor matching (Variable Speed Solution)
- Emerson's range of Copeland Scroll compressors, Dixell electronics and controls components are fully released and certified for use in ATEX (flammable) environments
- Emerson offers a complete range of R290 compressors, covering all needs and sizes of integrated display cases
- Since April 2019 these systems are covered by BAFA funding in Germany.

**eurammon is always available as sparring partner for questions on refrigeration with natural refrigerants.**

Contact:

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**eurammon**

refrigerants delivered by mother nature