HALL 7A

Chillventa Specialist Forums 2022
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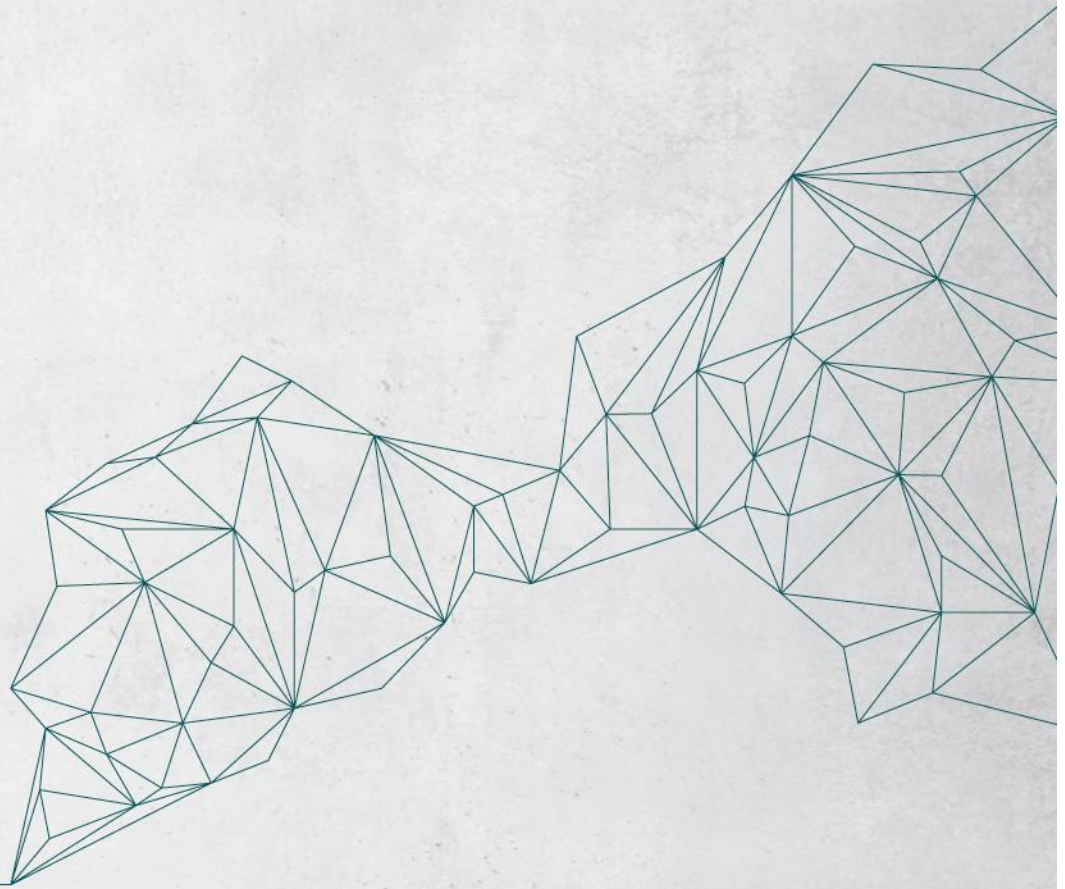
CONNECTING EXPERTS.



BEST REFRIGERANTS VS REFRIGERATION CAPACITY REQUIREMENTS

OCTOBER, 2022

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EUROPE
INTEGRATED PRODUCTS
DIRECTOR

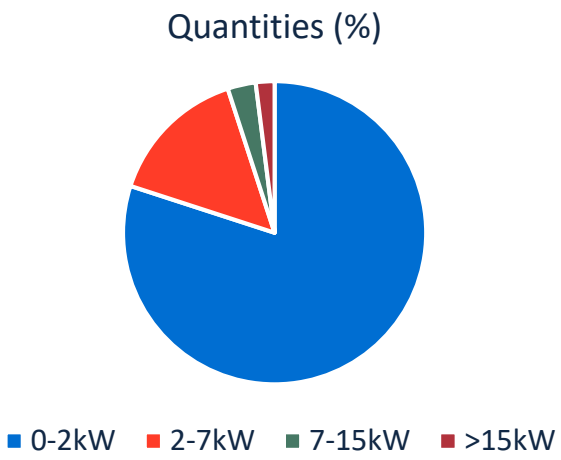
Cooling for a Better Tomorrow™

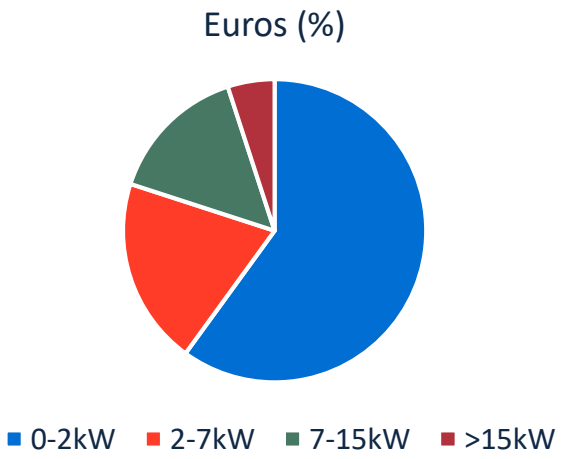
AGENDA

1. Discussion Scope
2. Directives and Regulation Situation
3. Standards Situation
4. Refrigerant Road Map
5. Sub 150 solutions
6. Case Studies
7. Summary

DISCUSSION SCOPE : 0 – 10KW

- **Market data**





- **Applications**

Reach in Coolers

Prep Tables / Back Bar

Bottle Coolers

Display Cases

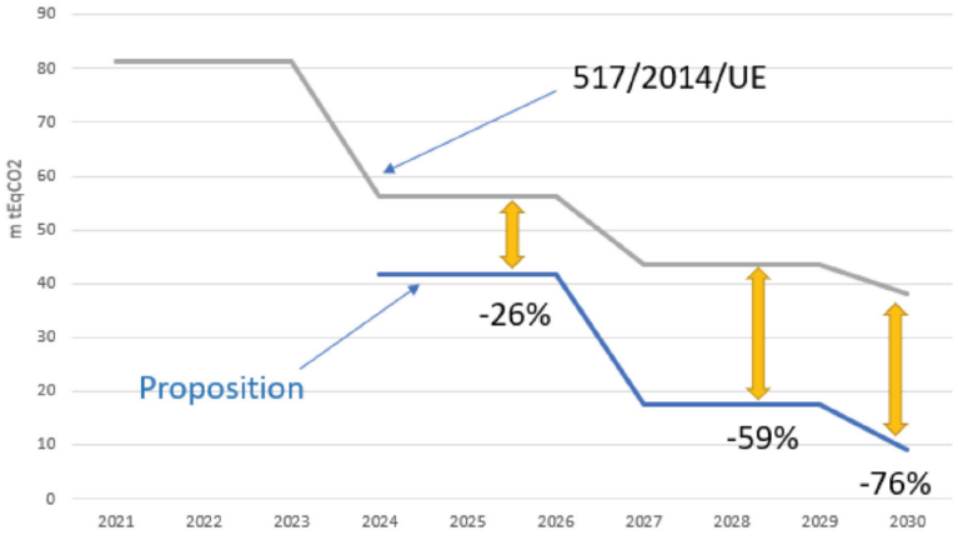
Walk In Cold rooms

Ice Machines

- À-10kW : High proportion of the Commercial Refrigeration Market - Many types of applications
- “Simple and Small” Units – Direct Expansion system – Remote or Stand alone – Low Maintenance – Cost sensitive

DIRECTIVES & REGULATION SITUATION

- **Europe: New F-Gas**
  - New Proposal released
    - With increased Phase down quota
    - With new bans for Jan, 2025
  - It's a **HFC Phase OUT** by 2027
  - 2023 EU Parliament discussion for future adoption



- **EU Green Deal – Fit for 55**
- Climate targets (Paris Agreement), the EU aims to make Europe the first climate-neutral continent by 2050.
- July 2021: "Fit for 55" (policy proposals)
  -55% Green house gases by 2030

- **REpowerEU**
- In response to the difficulties and global energy market disruption caused by Russia's invasion of Ukraine, the EU Commission presented the REPowerEU Plan (saving energy, producing clean energy, diversifying our energy supplies)

Low GWP driven – HFC Phase down acceleration – Energy Saving prioritized
Low GWP - Speed – Energy Saving

STANDARDS SITUATION

EN378 – Generic standard, wider scope

Cold rooms

Industrial systems

EN 60335-2-89
Particular requirements for commercial appliances

EN60335-2-89 – Oct 2022

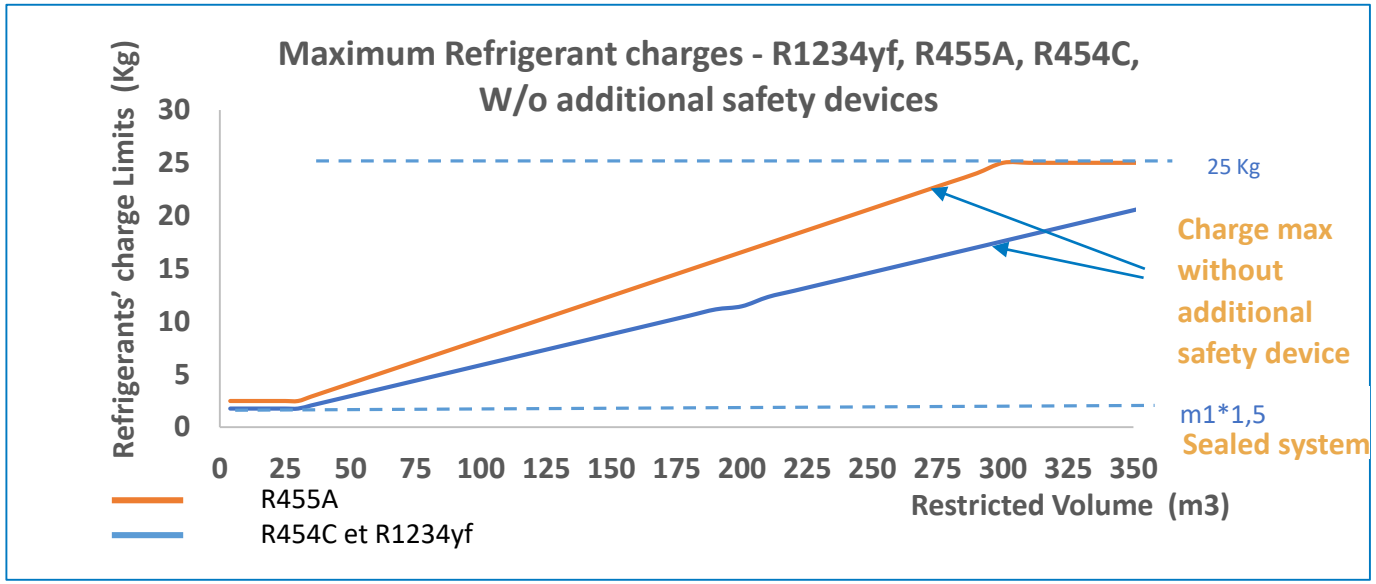
R-1234yf : LII = 0,289 Kg/m3
Charge max => 1,2kg

R454C : LII = 0,289 Kg/m3
Charge max => 1,2kg

R-455A : LII = 0,431 Kg/m3
Charge max => 1,2kg

R290 : LII = 0,038 Kg/m3
Charge max = 13x0,038 = 494gr

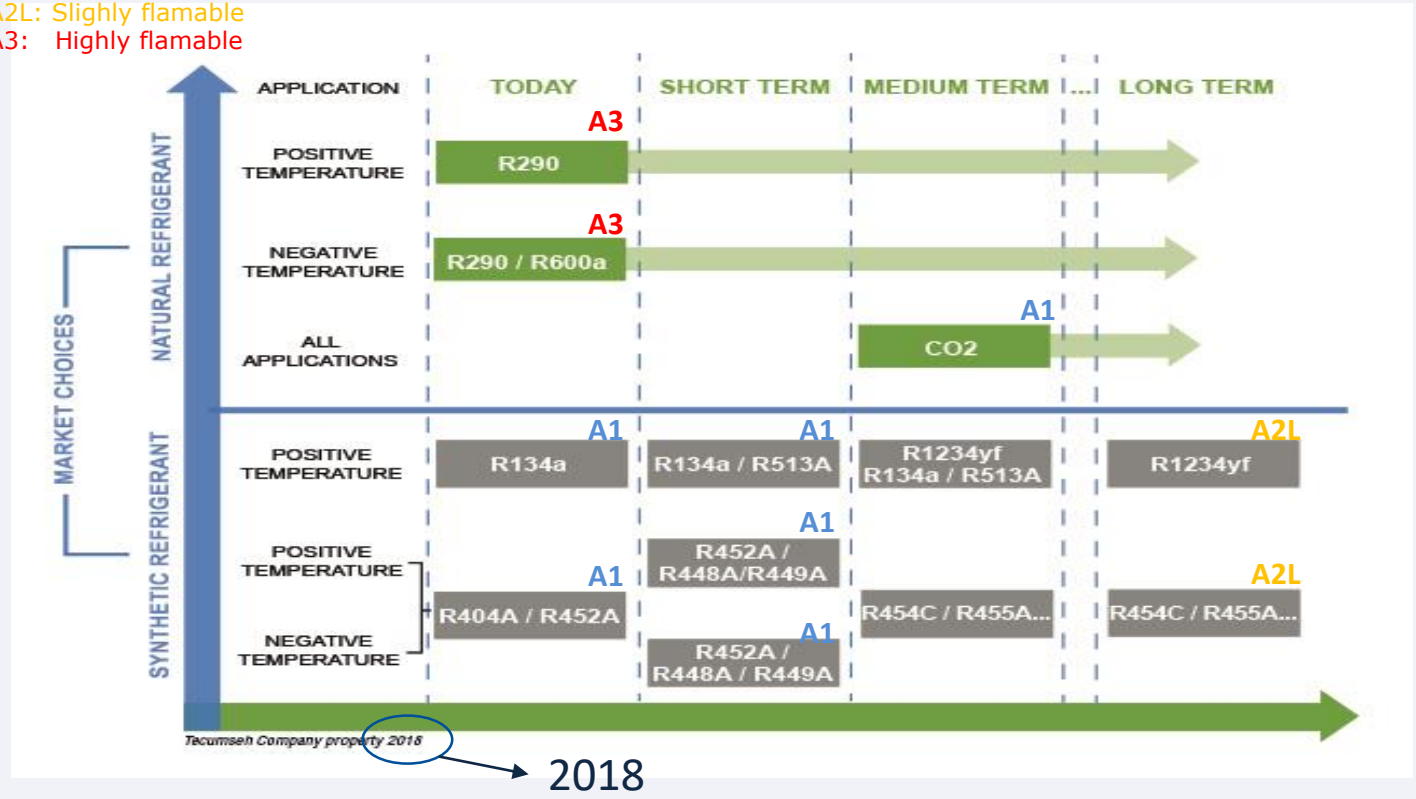
EN378



EN 2-89 is applicable to commercial appliances. EN 378 defines the safety rules for other applications.
Updated Standards give possibilities to use flammable refrigerants

REFRIGERANT ROAD MAP

A1: Non Flamable
A2L: Slighly flamable
A3: Highly flamable



- **Efficiency:** R290 > A2L
- **System Simplicity (DX):** R290 ~ A2L
- **Flammability (Charge):** R290 < A2L

- **Refrigerant Target:**
- Stand alone / Small and medium size (up to the Max charge limit): **R290**
- Remote (as R290 (>150g) forbidden) / Medium and Large units : **A2L**

A robust Refrigerant Roadmap Visible and Officially Announced in 2018 and still accurate:
R290 on Small and Medium cooling capacity size / on Indoor System
A2L: on Medium and Large cooling capacity size / on Remote System

SUB 150 SOLUTIONS

From Light commercial to Commercial and Industrial Applications








DX HCs R600a - R290

DX HFOs R1234yf, R455A, R454C

Brine - Chiller R290

DX R744








Cooling capacity

0 100 1000 10 000 20 000 Watt








TC AE² ALX RG AJ² FH² AG SH

FREEZING REMOTE SYSTEM: A2L CHARGE LIMIT CALCULATION

Application		**Freezing Temperature**	
Refrigerant		**R455A/R454C**	
Cooling capacity		**3,5 kW**	
Cooled building volume	85 m^3	Access category	Supervised occupancy (b)
Mounted condensing unit	SILAG2525P	Location category	CU in the open air (II)
Refrigeration system charge	**4,5 kg**		
Permitted charge	R455A	7,19 kg ✓	
	R454C	4,62 kg ✓	

SIL AG 2525 P

CHILLING REMOTE SYSTEM: A2L CHARGE LIMIT CALCULATION

Application		**Chilling Temperature**	
Refrigerant		**R455A/R454C, R1234yf**	
Cooling capacity		**8,5 kW**	
Cooled building volume	170 m^3	Access category	Supervised occupancy (b)
Mounted condensing unit	SILAG4573P	Location category	CU in the open air (II)
Refrigeration system charge R455A/R454C	5,5 kg		
Refrigeration system charge R1234yf	6,2 kg		
Permitted charge	R455A	14,4 kg	✓
	R454C	9,25 kg	✓
	R1234yf	9,83 kg	✓

SIL AG 4573 P

ICE-MAKER HFC TO R290

Component	Baseline	Development
Refrigerant	R-404A	R-290
Charge	125 g	73 g
Condenser	LU-VE 1 row / 12 tubes	LU-VE 1 row / 12 tubes
Capillary tube	Dia. 0.8 mm x 2.160 m Air flow: 90 cm^3/s @ 5 bar	Dia. 0.78 mm x 2,700 m Air flow: 49 cm^3/s @ 5bar
Evaporator	19 fingers Dia. 10 mm	19 fingers Dia. 10 mm
Accumulator	Dia. 35 mm x H 125 mm	Dia. 35 mm x H 125 mm

		Baseline (R404A)		Development (R290)	
Ambient air temp.	°C	15	30	15	30
Water supply temp.	°C	10	15	10	15
Ice production rate	kg/day	20.3	15.1	21.2 *(+4.4%)*	16.0 *(+6.0%)*
Power consumption	Wh/kg	231	351	223 *(-3.5%)*	337 *(-4.0%)*

PROOFING CABINET : R290 VERSUS A2L

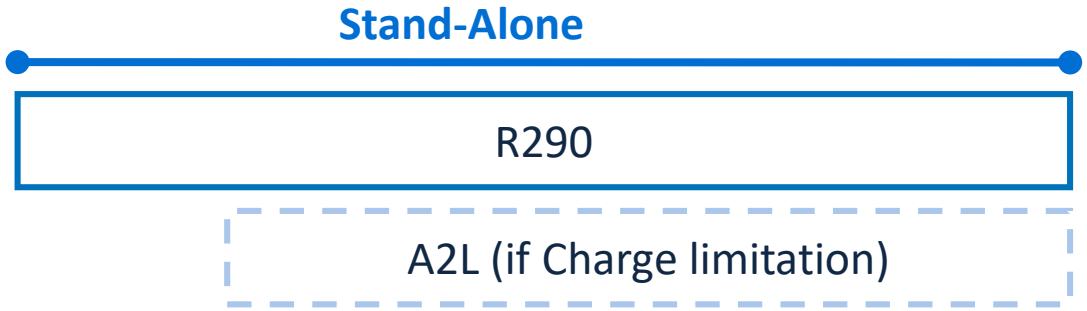
Component	R-290 development	A2L development	
Refrigerant	R-290	R-455A	R-454C
Charge	230 g	620 g	650 g
Compressor	Tecumseh AEX433U-FZ (15,09 cm^3)	Tecumseh AE44070Z-FZ (12 cm^3)	
HP Switch	Danfoss ACB 061F6325 Cut-out: 21,4 barg Cut-in: 16,6 barg	Danfoss ACB 061F8173 Cut-out: 29,5 barg Cut-in: 22,7 barg	
Receiver	None	0,75 L	
TXV	Danfoss 068U3735 Orifice #4	Danfoss 068U2835 Orifice #5	
Filter-Drier	Carly DCY032S	Danfoss DML052S	
Condenser	Luvata Ref. TE: 338221	Luvata Ref. TE: 338221	
Evaporator	Prototype 4 circuits 8 rows 7 tubes/row Volume: 1,1 L	Lloyd Coils Europe 1 circuit 4 rows 7 tubes/row Volume: 1,9 L	

Endurance run (+30°C ambient air / +2°C cabinet air temp.)

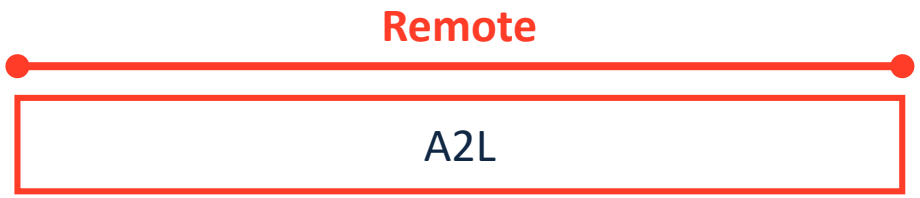
		R-290 (baseline)	R-455A	R-454C
Cooling capacity	W	991	822 *(-17%)*	790 *(-20%)*
EER	W/W	1,58	1,27 *(-0,31)*	1,29 *(-0,29)*

SUMMARY

- **Scope:** 0 – 10kW
- **Priorities:**
  - Low GWP
  - Simplicity – Speed
  - Energy Saving



- **R290:**
  - Efficient solution, limited in the range. Use linked to high flammability.
  - Forbidden in DX remote system (>150g)
- **A2L:**
  - GWP<150 and slightly flammable. Could be used in almost all systems.



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