EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Commercial Refrigeration

30 October 2017 – LeMeridien Dubai

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Event introduction

Mr Brian Suggitt, Eurovent ME Chairman
Managing Director Middle East, Systemair AB

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Thank you to our partners

EU-GCC
Trade and Business Cooperation Facility

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Our media partner

climate control MIDDLE EAST

KEY PERSPECTIVES ON THE REGION'S HVACR INDUSTRY

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Today's workshop agenda

1. International regulatory developments and performance certification in commercial refrigeration and their potential for the Middle
2. Influence of cooler units in preventing moisture and aroma loss in open-shelf products in the cold storages
3. Natural refrigerant systems in warm climates: existing solutions, case studies and future developments for the Middle East
4. Examining the benefits of Air Curtains in Cold Storage applications
5. Open Discussion
6. Closing and buffet dinner

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International regulatory developments and performance certification in commercial refrigeration and their potential for the Middle East

Session 1

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Francesco Scuderi

Deputy Secretary General
Eurovent Association Brussels
CEN/TC44/WG6 Convenor
ISO/TC86/SC7/WG2 Convenor

Roadmap

1. **Commercial refrigeration equipment**
2. European legislation on refrigerants
3. ISO & EN standards: what are they?
4. What is an industry recommendation?
5. Third party certification: what does it mean?
6. ISO/EN Standards on supermarket equipment
7. Eurovent Certita Certification: Certification program for supermaket display cabinets
8. Q&A

Which equipment do fall in the commercial refrigeration family?

Main function: sales & display

- Remote display cabinets
- Plug-in cabinets
- Ice-cream freezers
- Commercial beverage coolers

Main function: storage

- Cold rooms

Which equipment do fall in the commercial refrigeration family? (cont.)

Remote cabinets

Plug-in cabinets

Commercial Beverage Coolers

Ice-Cream Freezer

Cold rooms

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EU F-Gas Regulation

- European Union legislation to control F-Gases, including hydrofluorocarbons HFCs (F-Gas Regulation)
- **Limits the total amount** of most important F-gases sold in the EU from 2015 onwards
- **Bans the use** of F-Gases in many new types of equipment where less harmful alternatives are widely available
- **Preventing emissions** of F-Gases from existing equipment

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Refrigerants tomorrow
F-Gas Regulation timeline

Remote applications

- 1 Jan 2020: GWP<2500

  →R404A phased out

- 1 Jan 2022: GWP<150

  →R134A-R410A-R407C phased out

Refrigerants tomorrow
F-Gas Regulation timeline (cont.)

Plug-in applications

- 1 Jan 2020: GWP<2500

  →R404A phased out

- 1 Jan 2022: GWP<150

  →R134A-R410A-R407C phased out

Refrigerants tomorrow
Results of F-Gas Regulation

- EU F-Gas Regulation pushed issue forward worldwide
- Change in refrigerant usage already visible
- Low-GWP and natural refrigerants at the forefront
- Awareness differs in European Union and Middle East
- **HFC phase down is a reality and return to past very unlikely**

Refrigerants tomorrow
Commercial refrigeration (estimates)

- **Refrigerants**
  - Increasing move towards CO2 (R744) for remote units
    - CO2 Equatorial line is disappearing
  - Propane (R290) for integral units

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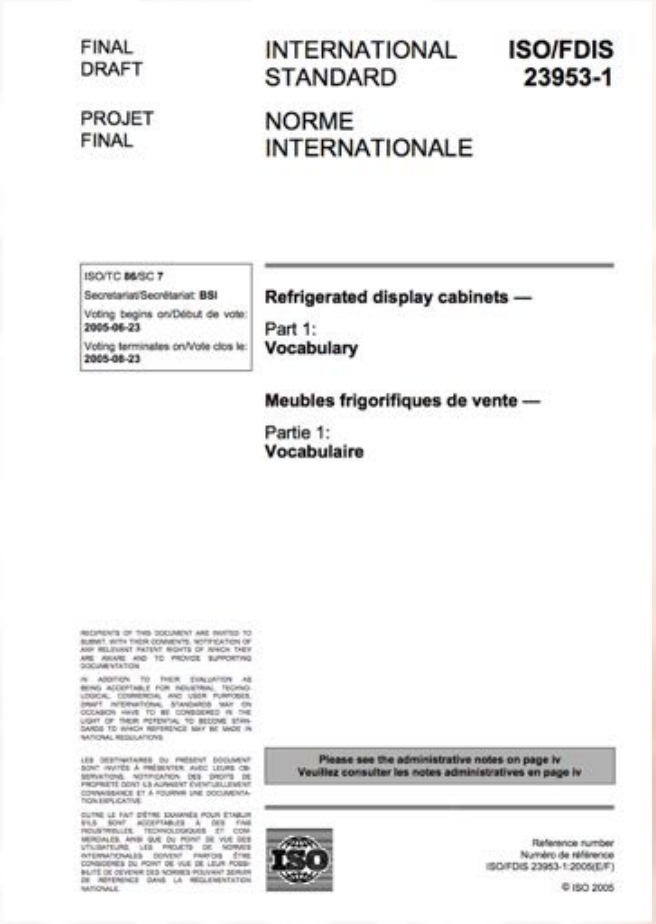
What is a Standard?

- Standard = written document
- **Voluntary** application (non-mandatory)
- Prepared by all **parties involved**
- Reflects **consensus**
- **Approved** by recognized bodies
- Intended for **common and repeated use**
- Based on **"state of the art" technology**
- Accessible to the public



FINAL DRAFT

INTERNATIONAL STANDARD

ISO/FDIS 23953-1

PROJET FINAL

NORME INTERNATIONALE

ISO/TC 86/SC 7
Secretariat/Secrétariat: BSI
Voting begins on/Début de vote: 2005-06-23
Voting terminates on/Vote clos le: 2005-08-23

Refrigerated display cabinets —

Part 1:
Vocabulary

Meubles frigorifiques de vente —

Partie 1:
Vocabulaire

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OUTRE LE FAIT D'ÊTRE EXAMINÉES POUR ÉTABLIR S'ILS SONT ACCEPTABLES À DES FINS INDUSTRIELLES, TECHNOLOGIQUES ET COMMERCIALES, AINSI QUE DU POINT DE VUE DES UTILISATEURS, LES PROJETS DE NORMES INTERNATIONALES DOIVENT PARFOIS ÊTRE CONSIDÉRÉS DU POINT DE VUE DE LEUR POSSIBILITÉ DE DEVENIR DES NORMES POUVANT SERVIR DE RÉFÉRENCE DANS LA RÉGLEMENTATION NATIONALE.

Please see the administrative notes on page iv
Veuillez consulter les notes administratives en page iv

Reference number
Numéro de référence
ISO/FDIS 23953-1:2005(E/F)

What is a Standard?(cont.)
Are the standards mandatory?

- **Voluntary:** In case of disputes, standards are considered as rules of good practice
- **Mandatory** if the application is required by a law or a regulation
- **Mandatory** where there is reference to a specific standard in contractual document

What is a Standard?(cont.)
How the standardisation works

ISO IEC — International level

CEN CENELEC — European Level

UNI ENTE ITALIANO DI NORMAZIONE — COMITATO ELETTROTECNICO ITALIANO — National Level

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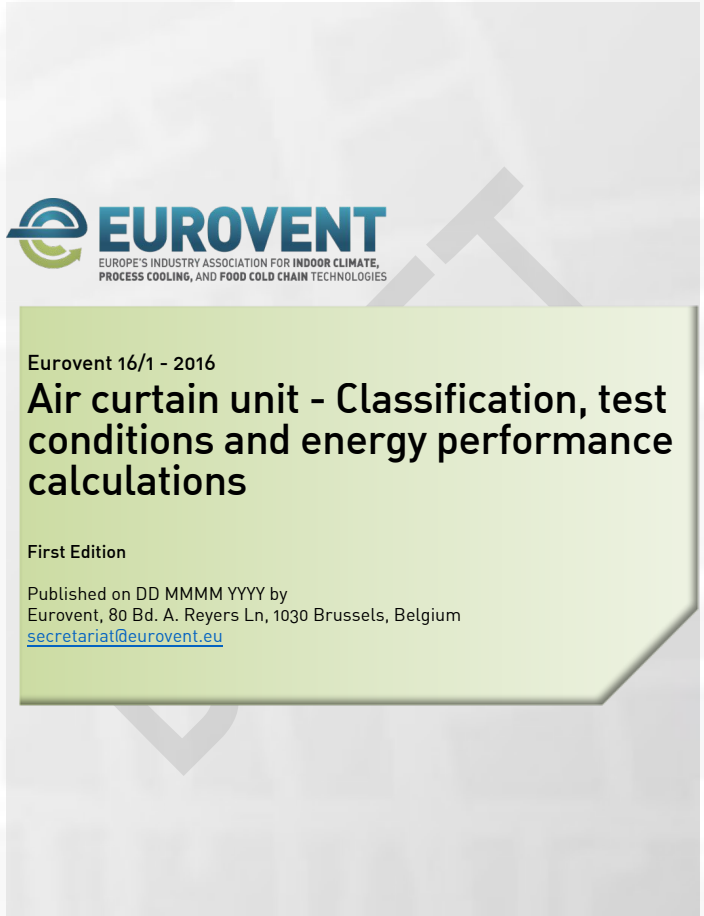
What is an Industry Recommendation?

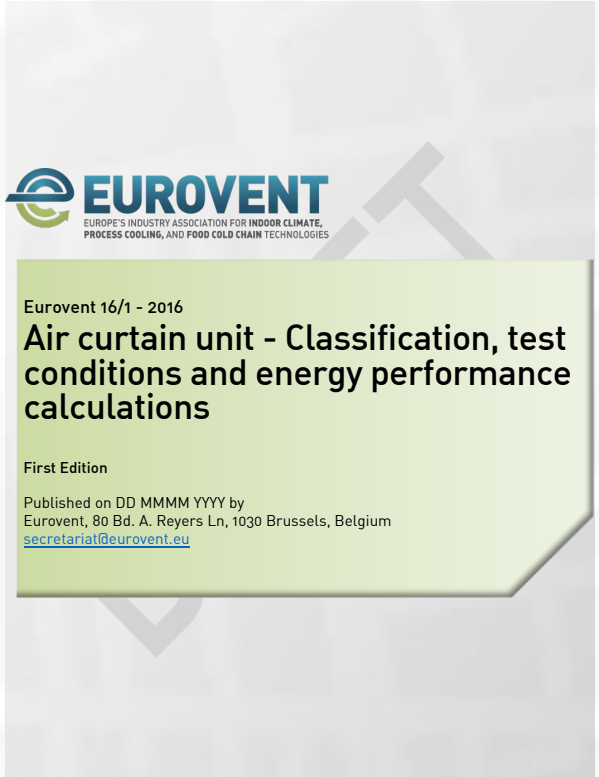
- a set of **written regulations issued by an Industry/Experts association**
- usually prepared in an joint effort by **the major player of the industry**
- a **standardisation preparatory working document**



Eurovent Industry Recommendation on air curtains

Available on Eurovent.eu website:

https://eurovent.eu/?q=content/eurovent-161-2016-air-curtain-unit-classification-test-conditions-and-energy-performance



Eurovent Industry Recommendation
Categories and standard rating conditions

Categories

Air curtain class.	H door [m]	W door [m]	Warm cell temp [°C]	Cold cell temp [°C]	DT [°C]	DP [Pa]	Wind load [m/s]	Climate classes
Commercial/comfort	2.0	1.5	20	2	18	0	2	ACUCC1
Industry	3.0	2.0	15	2	13	0	2	ACUI1
Cold storage	2.0	1.5	20	5	15	0	0	ACUCS1

Std. door dimensions

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Eurovent Industry Recommendation **Heat loss and CSE due temperature difference**

Heat loss through an open door subjected to temperature difference, Q_T

$$Q_{T\ without} = \frac{V \cdot \rho \cdot c_p \cdot (\theta_{0w/o} - \theta_{1w/o})}{T} \quad [kW]$$

$$Q_{T\ with} = \frac{V \cdot \rho \cdot c_p \cdot (\theta_{0w} - \theta_{1w})}{T} \quad [kW]$$

Where:

V = Volume of the warm cell	[m^3]
ρ = Air density of the warm cell	[kg/m^3]
c_p = Specific heat of air	[kJ/kg K]
T = Door opening time	[s]
θ = Average cell temperature	[°C]

Climate Separation Efficiency due to temperature difference:

$$CSE_T = 1 - \frac{Q_{T\ with} + P_e}{Q_{T\ without}} \quad [\%]$$

Where:

P_e = Motor input power	[kW]

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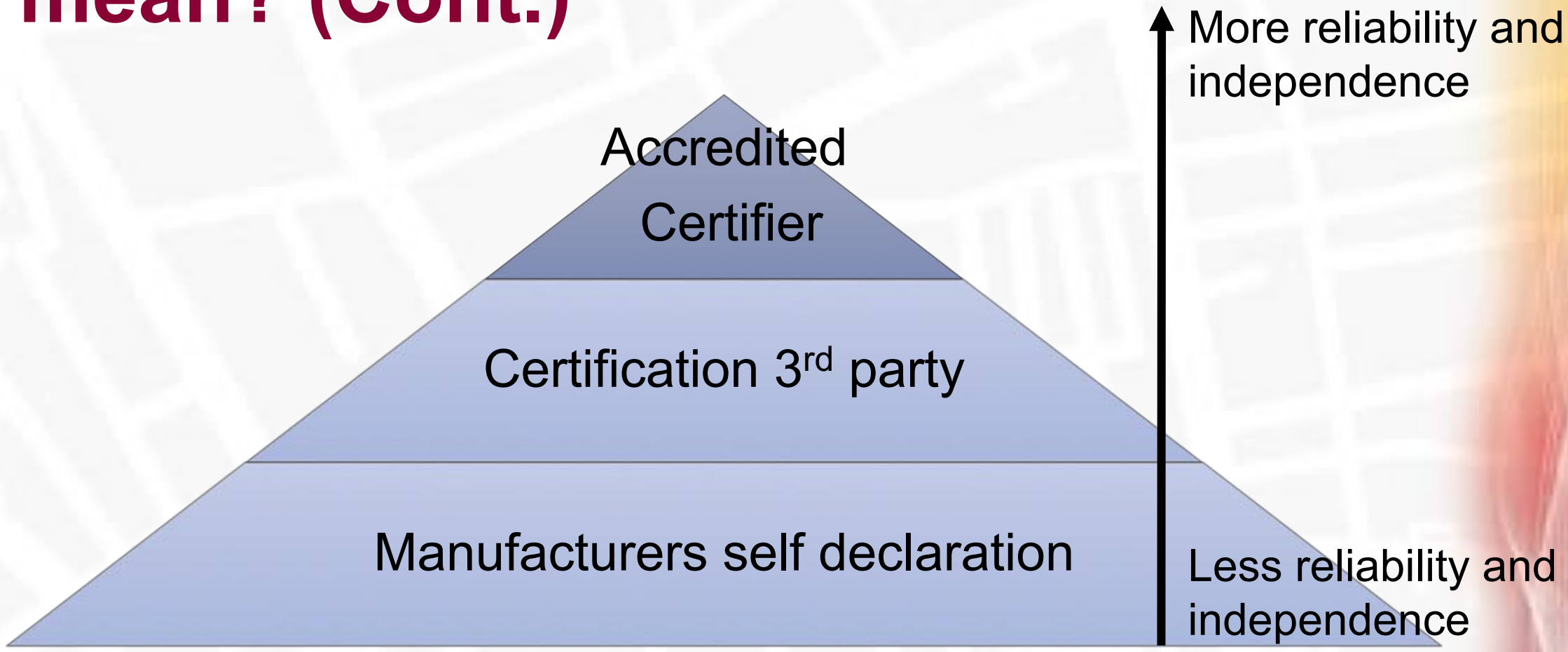
Third party certification: what does it mean?

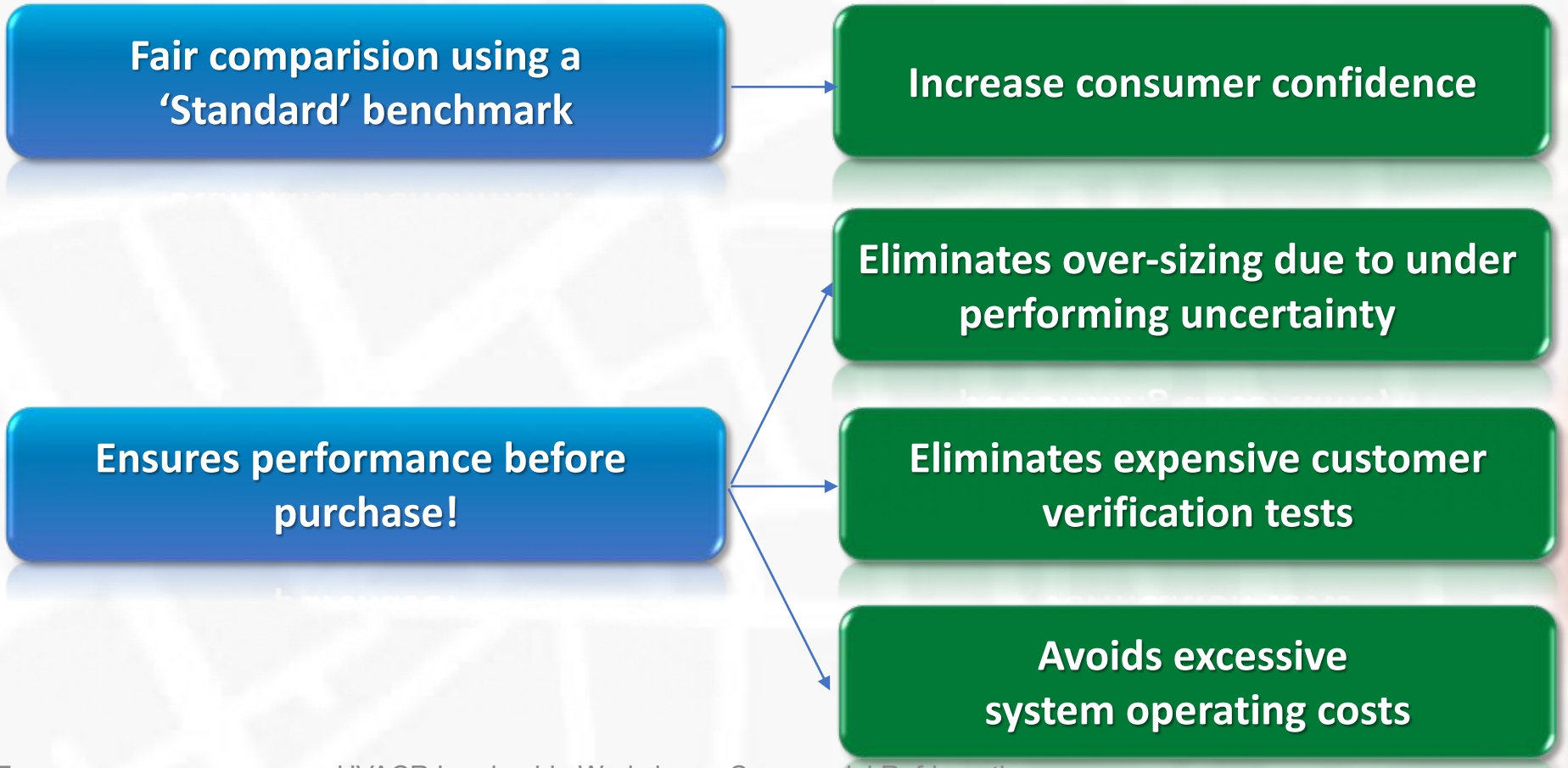
General Purpose:

- The value of 3rd party certification is to build up **customer** confidence by levelling the competitive playing field for all manufacturers and by increasing the integrity and accuracy of the industrial performance ratings
- Encourage honest competition
- **Ensure level playing field**
- Provide the garantee **that equipment** not only complies with the standards but also **performs as claimed**

Third party certification: what does it mean? (Cont.)



Third party certification: (Cont.)



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EN/ISO Standards on supermarket equipment

Refrigerated display cabinets – Cold rooms

- **EN/ISO 23953-1:2015**

Refrigerated Display Cabinets - Part 1: Vocabulary

- **EN/ISO 23953-2:2015**

Refrigerated Display Cabinets - Part 2: Classification, requirements and test conditions

- **EN 16855-1:2017**

Walk-In cold rooms - Definition, thermal insulation, performance and test methods – Part 1: Prefabricated cold room kits

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EN/ISO Standards on supermarket equipment (cont.)

Commercial Beverage Coolers - Ice Cream Freezers

- **EN 16902:2016**

Commercial beverage coolers: Classification, requirements and test conditions

- **EN 16901:2016**

Ice-cream freezers: Classification, requirements and test conditions

Supermarket display cabinet
EN ISO 23953

- Definition of the product family temperature (meat,frozen food, deep frozen food, milk, fruits etc.)
- How to test the temperature performances of a display cabinet
- How to test the energy consumption of a display cabinet
- How to ensure the food safety

Supermarket display cabinet

EN ISO 23953 (cont.)

Different Classes= different performances and different energy consumption

Class	Highest temperature, θ_{ah}, of warmest M-package colder than or equal to[ab]	Lowest temperature, θ_b, of coldest M-package warmer than or equal to [b]	Highest minimum temperature, θ_{al}, of all M-package colder than or equal to[a]
	°C		
L1	−15	—	−18
L2	−12	—	−18
L3	−12	—	−15
M0	+4	−1	—
M*	6	−1	
M1	+5	−1	—
M2	+7	−1	—
H1	+10	+1	—
H2	+10	−1	—
S	Special classification		

L= Frozen foodstuff

M= Chilled foodstuff

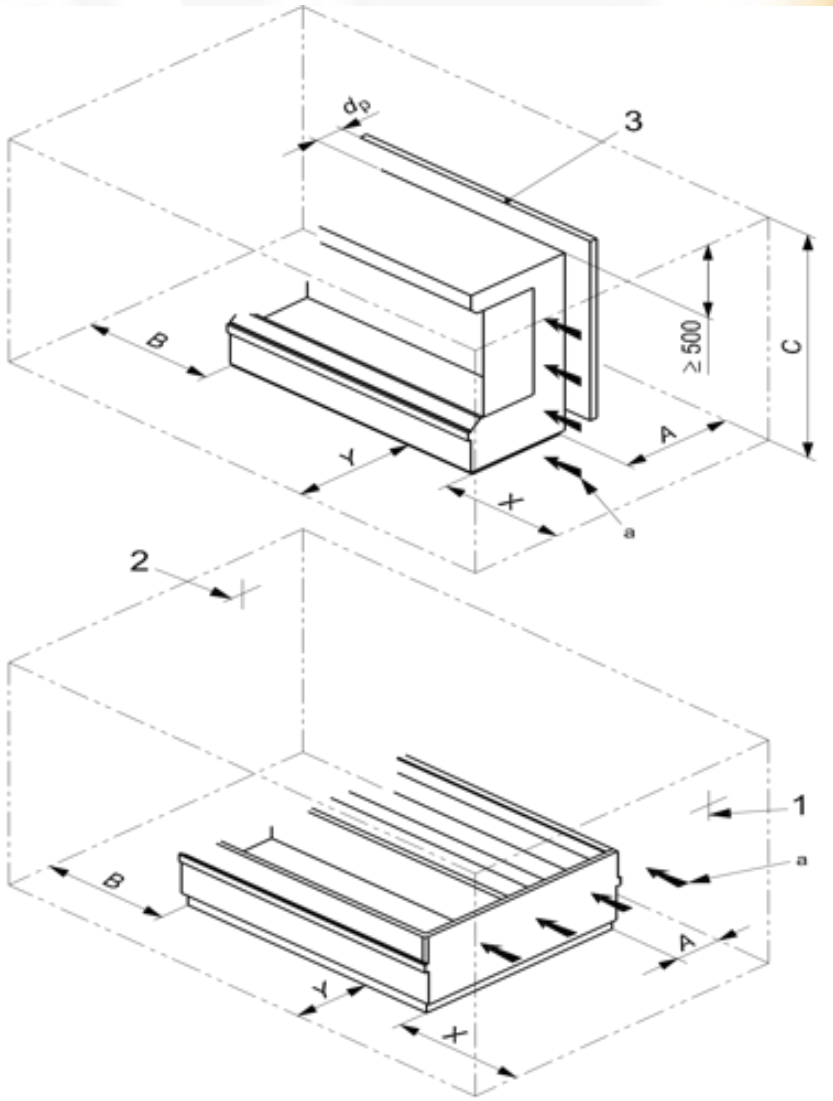
H= fruit

Supermarket display cabinet
EN ISO 23953 (cont.)

Temperature test in the climate chamber

Air flow parallel to the cabinet longitudinal axis

→These are the <u>most severe test conditions (these are addressed only by this standard)</u>

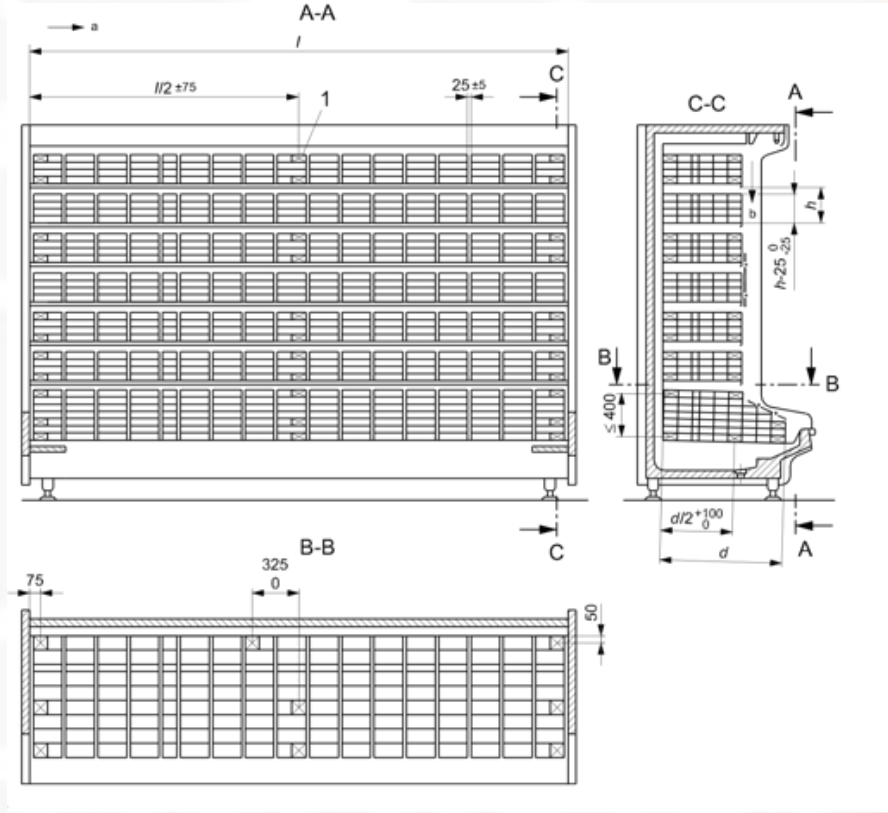


Supermarket display cabinet
EN ISO 23953 (cont.)

Temperature test in the climate chamber (cont.)

Temperature class and energy consumption assessment

→These are the most severe test conditions (these are addressed only by this standard)



Supermarket display cabinet
EN ISO 23953 (cont.)

- It must be noted that the same cabinet could have different energy consumption according to its product temperature

<u>How can we be sure that what is claimed is correct?</u>

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Third party certification for commercial refrigeration equipment

Eurovent Certita Certification is a major European certification body providing **voluntary 3rd party certification** in the field of Heating, Ventilation, Air Conditioning and Refrigeration (HVAC-R)

Eurovent Certita Certification certifies the performance ratings of products, **according to European and International standards,** on the full range of HVAC-R products

Third party certification for commercial refrigeration equipment (cont.)

Eurovent Certita Certification as a certification body accredited by Cofrac – Accreditation 5-5017 –

Eurovent Certita Certification fulfills the requirements of the standards **EN ISO/CEI 17065:2012.**

Third party certification for commercial refrigeration equipment (Cont.)

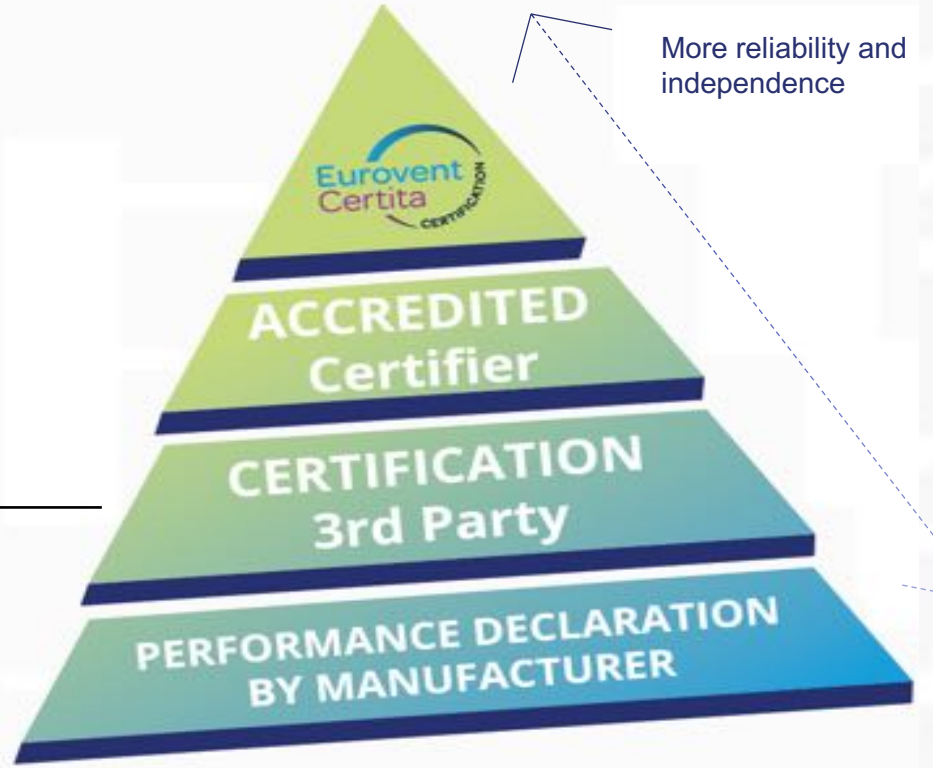
4) PERFORMANCE DECLARATION BY THE MANUFACTURER

- ✓ Self assessment of the products' compliance to the ISO & EN Standards
- ✓ Consumer trust relies on the manufacturers' reputation

Third party certification for commercial refrigeration equipment (Cont.)

3) CERTIFICATION – 3RD PARTY

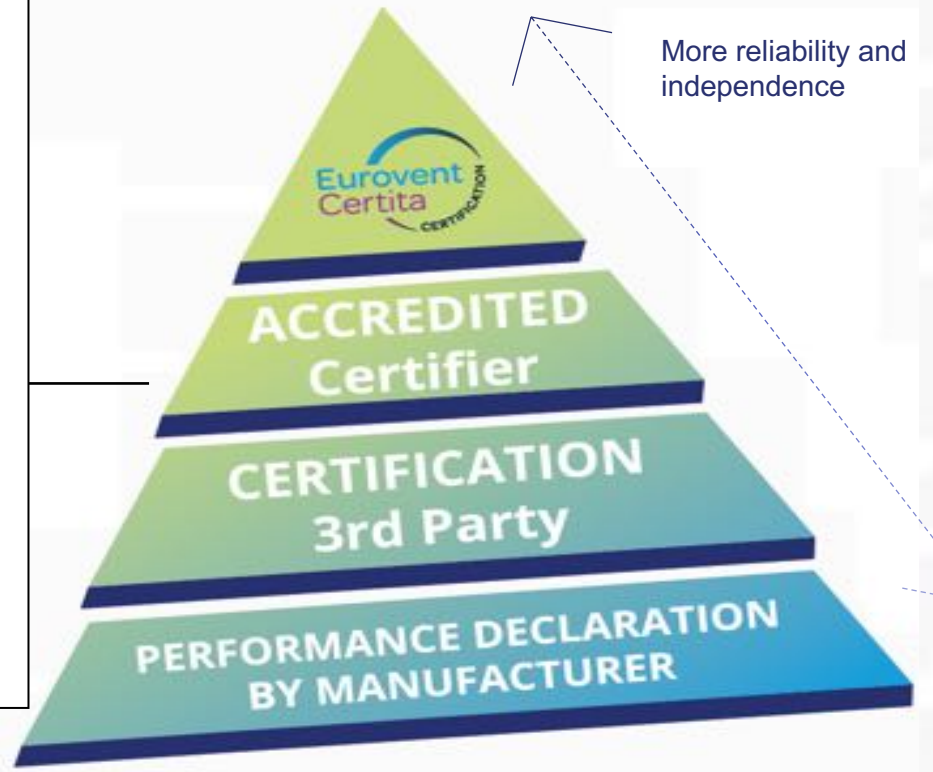
- ✓ Complies to test & Certification protocols approved by an independent body
- ✓ Consumers and authorities are part of validation



Third party certification for commercial refrigeration equipment (Cont.)

2) ACCREDITED CERTIFICATION BODY

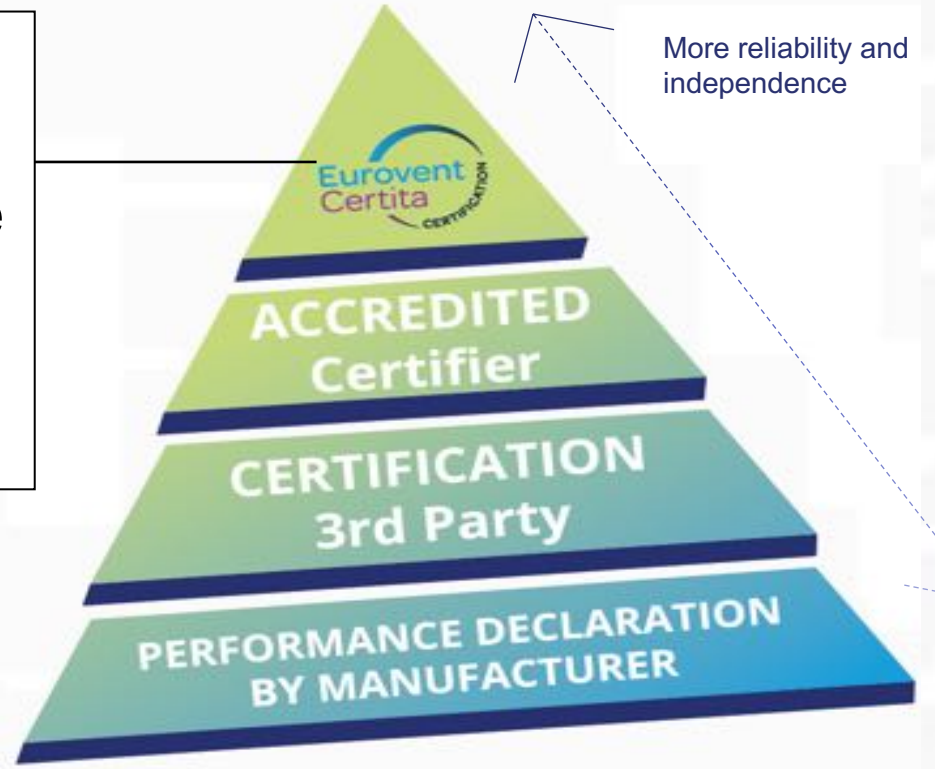
- ✓ Certification protocols are verified & accredited
- ✓ Certificate No 5-0517 scope available on www.cofrac.fr
- ✓ Consumer trust relies on independence



Third party certification for commercial refrigeration equipment (Cont.)

1) CERTIFICATION – 3rd PARTY

- ✓ Over 600 manufacturers worldwide
- ✓ 38 Certification programmes
- ✓ 66% of HVAC-R products sold in Europe are ECP certified



Third party certification for commercial refrigeration equipment (cont.)

The Eurovent Certified Performance energy efficiency label to make the right choice

Energy efficiency classes:

- From A+ (= highest energy efficiency)
- To E (= lowest energy efficiency)

Third party certification for commercial refrigeration equipment (Cont.)

ECC RDC program

Testing **of 2 cabinets** per year in accordance with EN/ISO 23953:2015 Standard

ECC RDC program

A continuous verification process

Comparison between the measured values and the declared values

Production sites **audits**

Product performance testing in an **independent laboratory**

Corrective actions progress assessment (if any)

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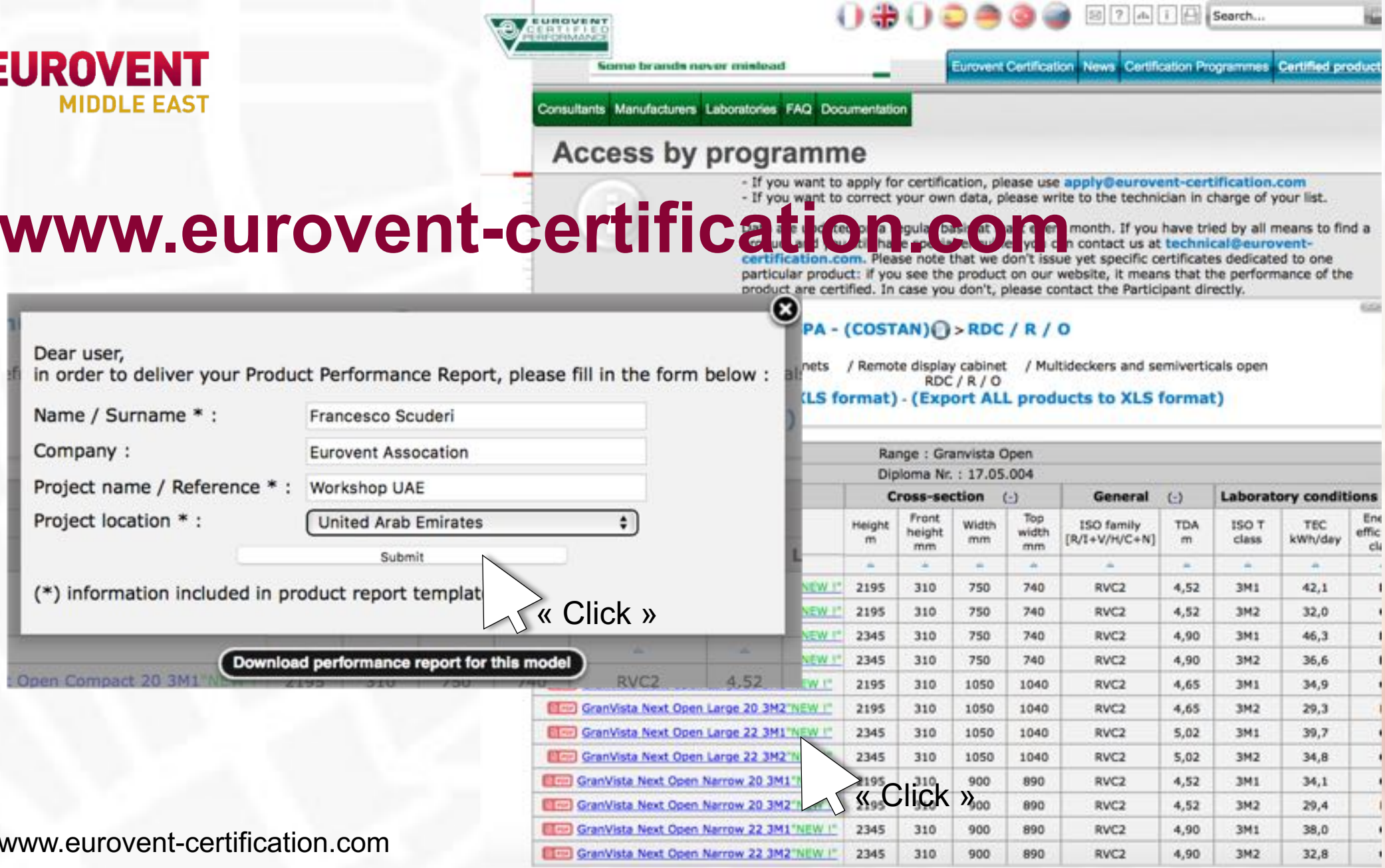
www.eurovent-certification.com



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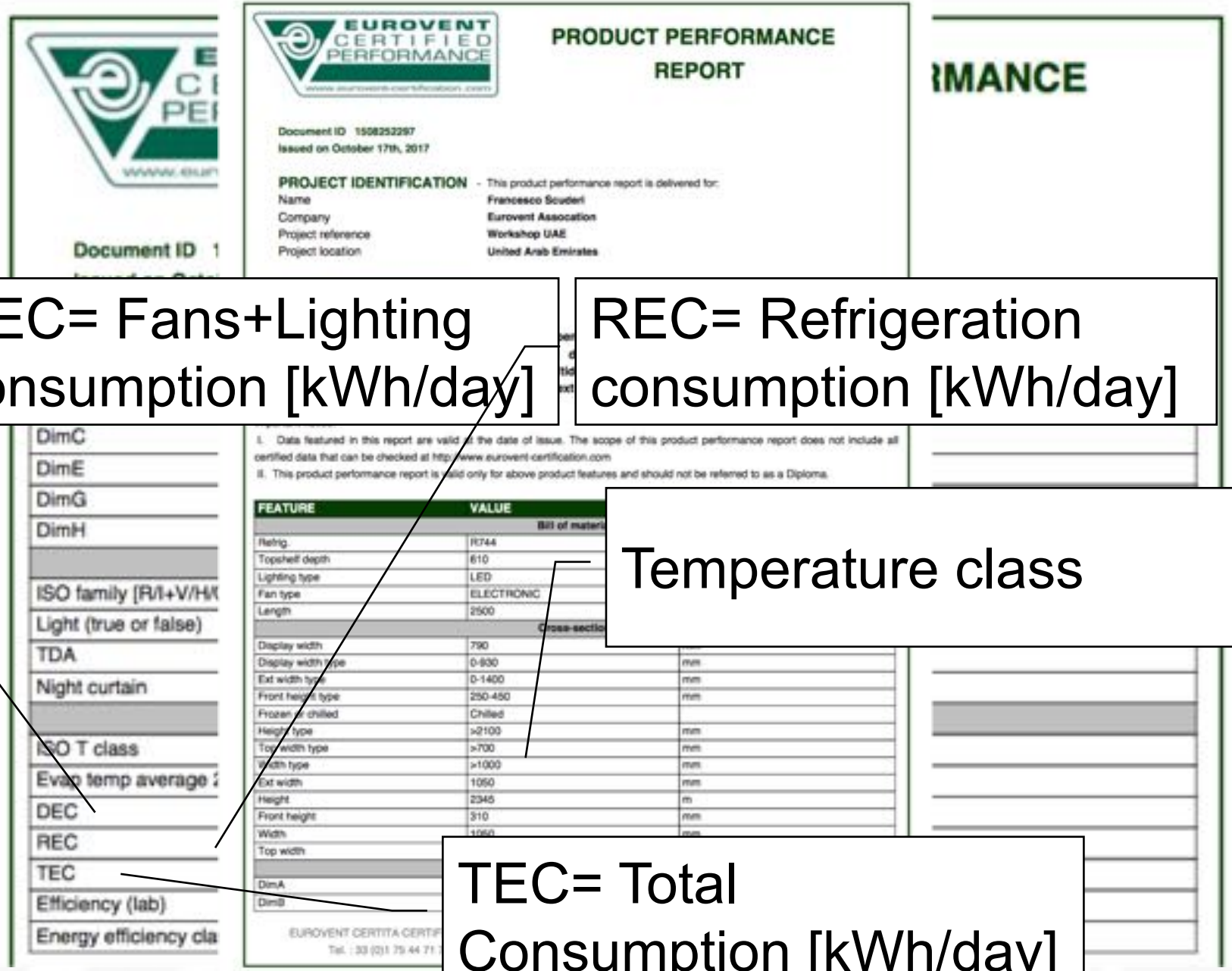


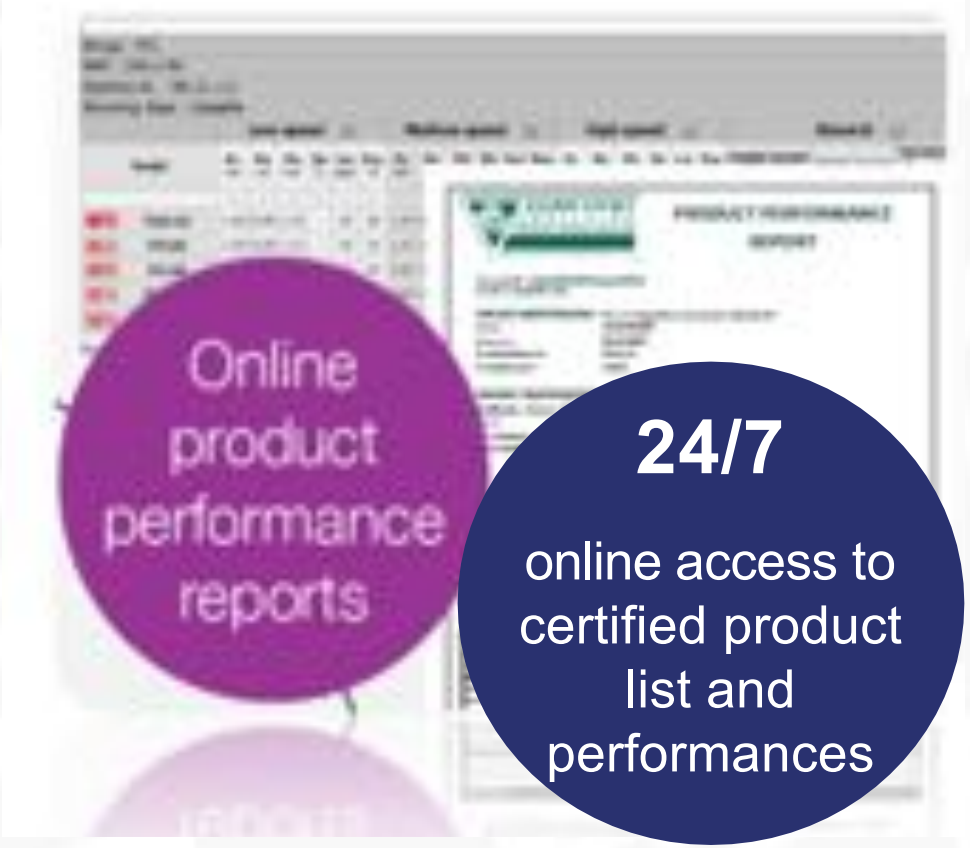
DEC= Fans+Lighting consumption [kWh/day]

REC= Refrigeration consumption [kWh/day]

Temperature class

TEC= Total Consumption [kWh/day]

ECC RDC program



- Temperature class (performances)
- REC→easy to dimension the total cooling demand
- DEC→Easy to dimension the electrical capacity
- REC and DEC according to the temperature class

ECC RDC program

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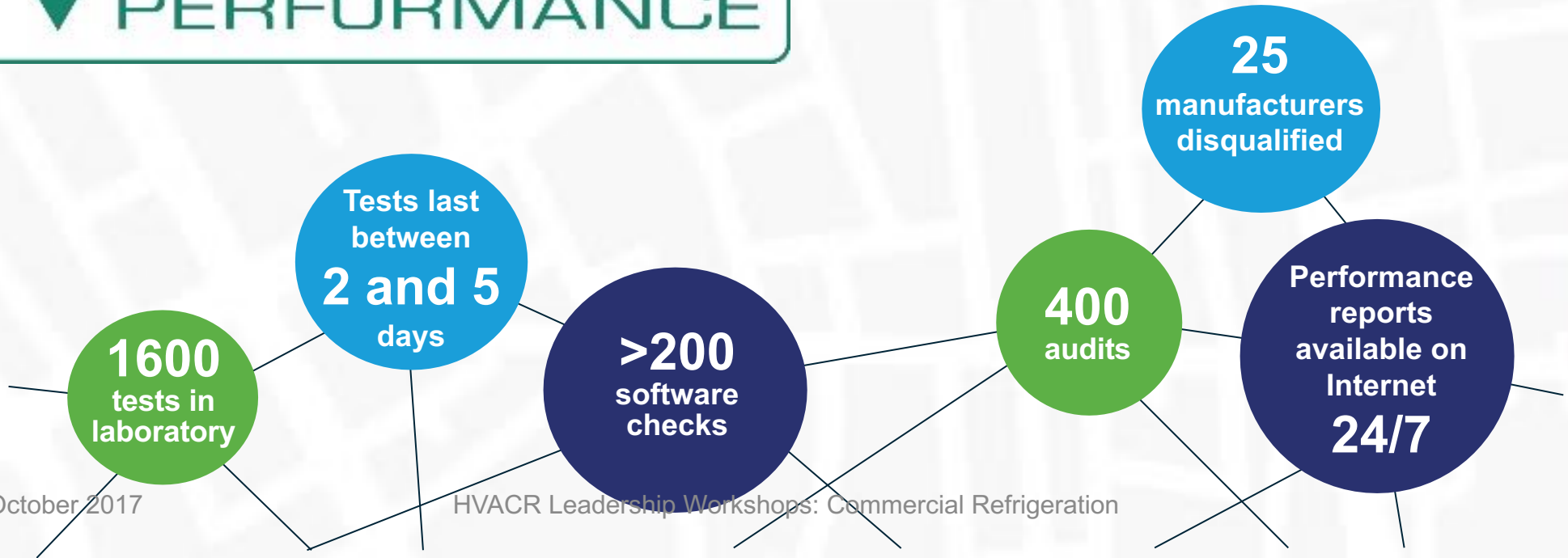
Some brands never mislead!



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Thank You!

Q&A

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Influence of cooler units in preventing moisture and aroma loss in open-shelf products in the cold storages

Session 2

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Serdar Tumen

Business Development Manager

Friterm A.S., Turkey

Cold storage & protection methodology

I. COLD PROTECTION

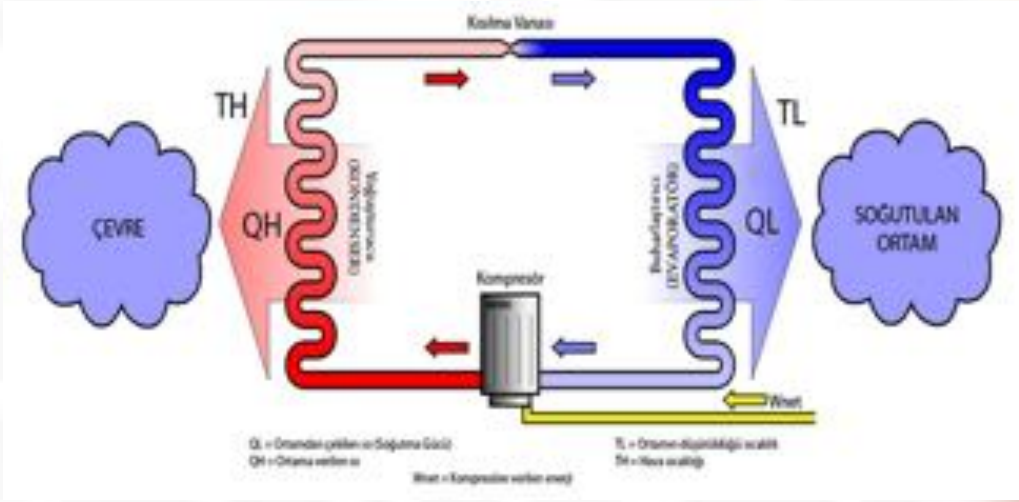
II. FROZEN PROTECTION

How does a condenser work?

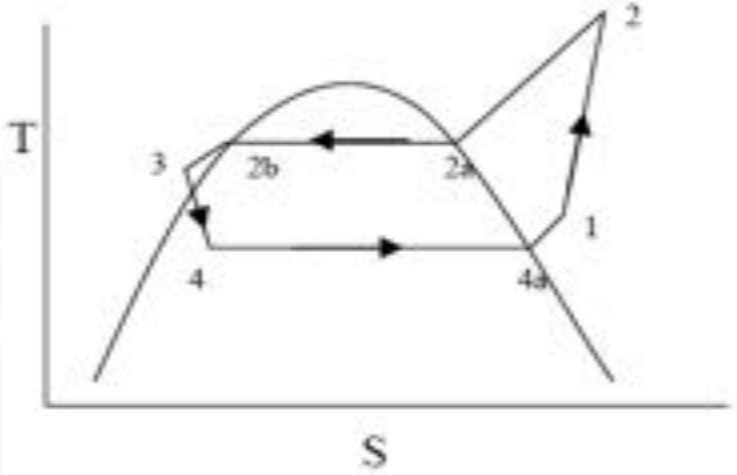
In the refrigeration system, the refrigerant gets heat from the evaporator and gets heat from the compressor which occur during the compressor suction work additionally. Right this point, Condensers involves in to the system, evacuates the heat from the system and condensing the refrigerant.

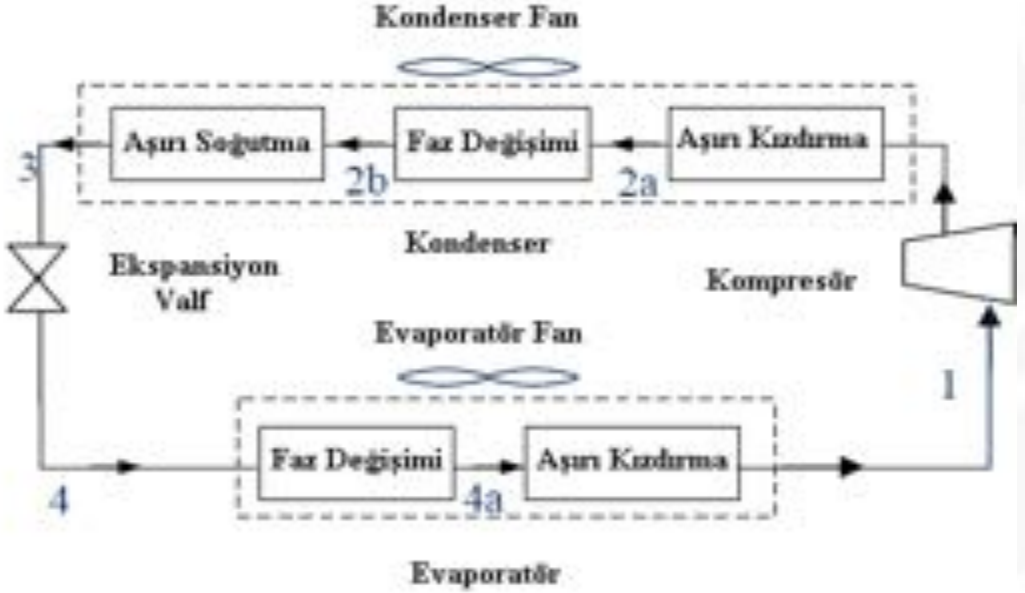
On this way, System's pressure drops as well as refrigerant changes its character as fluid again to get heat from evaporator to continue its circle.

Condenser Capacity= Compressor Cooling Capacity + Compressor Power



How does a condenser work?(Cont.)





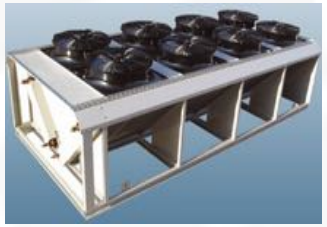
3 steps of heat exchanges in the Condenser:

1. Condensing the Refrigerant
2. Decreasing the Pre heating
3. Subcooling

The main work of Condenser Area:
% 85 Condensing the refrigerant which is the main duty of condenser.
% 5 app. Decreasing the pre heating
% 10 serves to subcooling

Family of condensers available in the market

1. Water cooled (shell&tube)



2. Air-cooled

3. Adiabatic

Outdoor temperature: influence on the condensing capacity

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PROJELENDİRME İÇİN ŞEHİRLERİN DIŞ HAVA SICAKLIKLARI

OUTSIDE AIR TEMPERATURES OF CITIES IN TURKEY IN SUMMER FOR DESIGN

Şehir adı / City	Kış sıcaklığı / Winter Temp. (°C)	Yaz kuru term. sıcaklığı / Summer Dry Bulb Temp. (°C)	Yaz yaş term. sıcaklığı / Summer Wet Bulb Temp. (°C)
Adana	0	38	26
Adıyaman	-9	38	22
Afyon	-12	34	21
Ağrı	-24	34	25
Amasya	-12	31	21
Ankara	-12	35	21
Antalya	+3	39	28
Artvin	-3	30	26
Aydın	-3	39	26
Balıkesir	-3	38	27
Bilecik	-9	34	23
Bingöl	-18	33	21
Bitlis	-15	34	22
Bolu	-15	34	24
Burdur	-9	36	21
Bursa	-6	37	25
Çanakkale	-3	34	25
Çankırı	-15	34	25
Çorum	-15	29	19
Denizli	-6	38	24
Diyarbakır	-9	42	23
Edirne	-9	36	25
Elazığ	-12	38	21

Şehir adı / City	Kış sıcaklığı / Winter Temp. (°C)	Yaz kuru term. sıcaklığı / Summer Dry Bulb Temp. (°C)	Yaz yaş term. sıcaklığı / Summer Wet Bulb Temp. (°C)
Erzincan	-18	36	22
Erzurum	-21	31	23
Eskişehir	-12	34	24
Gaziantep	-9	39	23
Giresun	-3	29	25
Gümüşhane	-12	33	23
Hakkari	-24	34	20
Hatay	0	37	28
İskenderun	+3	37	29
Isparta	-9	34	21
İçel	+3	35	29
İstanbul	-3	33	24
İzmir	0	37	25
Kars	-27	30	20
Kastamonu	-12	34	22
Kayseri	-15	36	23
Kırklareli	-9	35	25
Kırşehir	-12	35	21
Kocaeli	-3	36	25
Konya	-12	34	22
Kütahya	-12	33	21
Malatya	-12	38	21
Manisa	-3	40	26

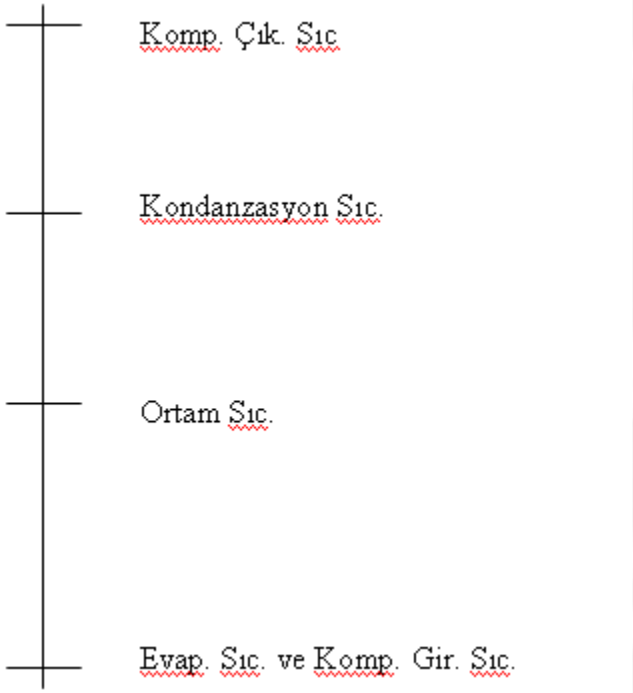
Şehir adı / City	Kış sıcaklığı / Winter Temp. (°C)	Yaz kuru term. sıcaklığı / Summer Dry Bulb Temp. (°C)	Yaz yaş term. sıcaklığı / Summer Wet Bulb Temp. (°C)
K.Maraş	3	36	22
Mardin	-6	38	23
Muğla	-3	37	22
Muş	-18	32	20
Nevşehir	-15	28	17
Niğde	-15	34	20
Ordu	-3	30	22
Rize	-3	30	26
Sakarya	-3	35	25
Samsun	-3	32	25
Siirt	-9	40	23
Sinop	-3	30	25
Siirt	-9	40	23
Sinop	-3	30	25
Sivas	-18	33	20
Tekirdağ	-6	33	25
Tokat	-15	29	20
Trabzon	-3	31	25
Tunceli	-18	37	22
Şanlıurfa	-6	43	24
Uşak	-9	35	22
Van	-15	33	21
Yozgat	-15	32	20
Zonguldak	-3	32	25

Ambient temprature of the cities for the projects in Turkey

Condenser air inlet temperature can be considered as the region summer time dry thermometer temperature for the outside use of the buildings

In order to define the condenser capacity, we need to know the temperature of the place and the heat exchange of the place to other places.

Temperature difference effect

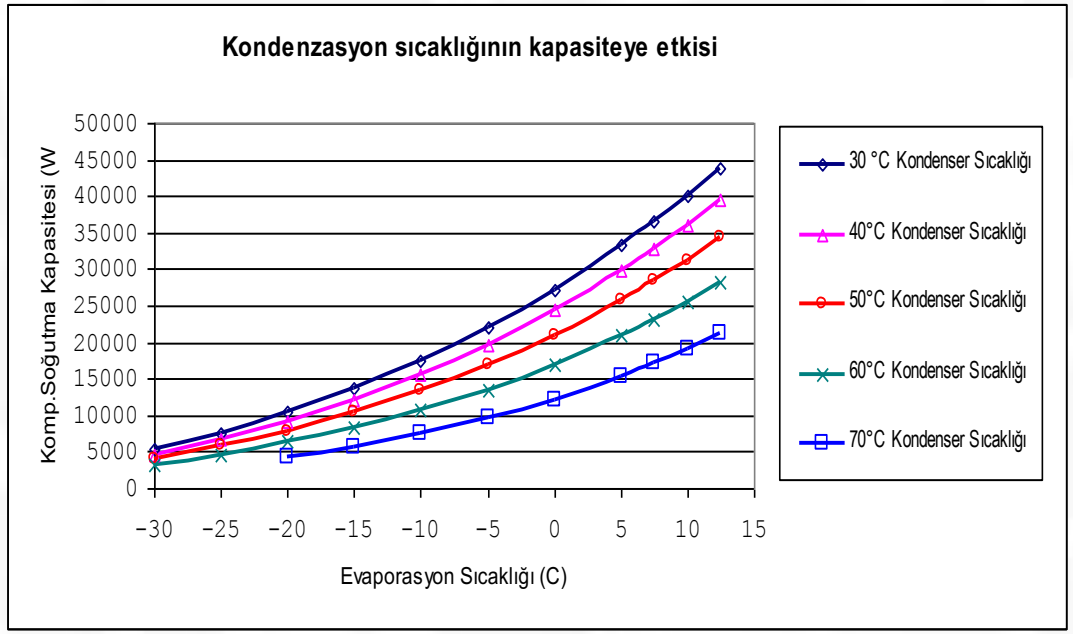


The most important factor to choose the right condenser is, the difference between Condensing temperature and Condenser inlet air temprature.

Condensing temperature is the 1:1 load for the compressor and therefore this load may turn into extra condenser capacity for us; We have to consider low condensing temperature in the designs..

In the applications; Condensing temperature should be considered over 5-15 ^{o}C than air inlet temperature. Condensing temperature should be decided regarding to ambient temperature where to system work

Coolong capcity and condensing temperature



Cooling Capacity changes under different condensing temperature

Considering the Condensation temperature between 60-30 °C due to ambient temperature, thermo physical characteristic of refrigerant (there is no condensation on certain temperature depends on refrigerants) and selected compressors's characters are the criterias.

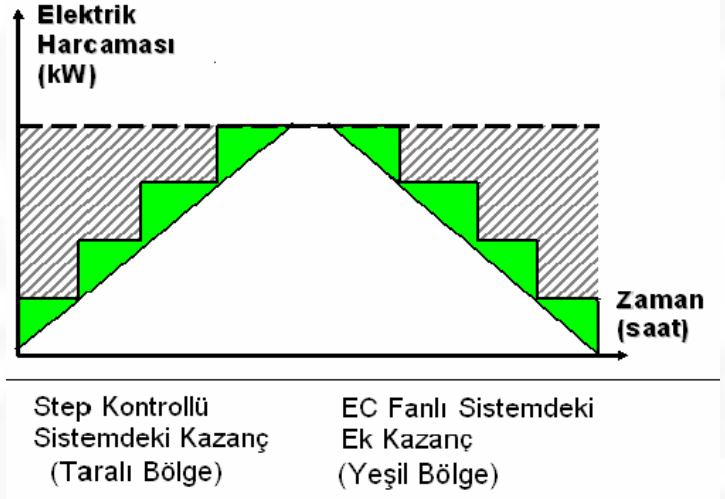
ΔT should be lower if the ambient temperature high.

For Instance; If the project here in Dubai, ΔT should be chosen between 5-7.

Fans and energy productivity

- Standard AC Fans
- Double Speed AC Fans
- Step / Fan Speed Control Unit
- EC Fans
- Special Low Noise Fans (Owl Wings Fans)

In Cold Storage warehousing, Double speed fans could decrease the loss of products and provide energy productivity.



Air cooled condensers: Energy efficiecny class

*ENERJİ VERİMLİLİĞİ SINIFI		
Class	Energy Consumption	Energy Rate (R)*
A	Extremely low	R > =110
B	Very low	70 =< R < 110
C	Low	45 =< R < 70
D	Medium	30 =< R < 45
E	High	R < 30

R= Energy rate

R= Product standard capacity/Fans electrical consumptionsdivided fan motors total energy consumption

Energy Efficiency calculated according to the Eurovent Certita Certification Rating standard manual

Condensers: Fin selectios

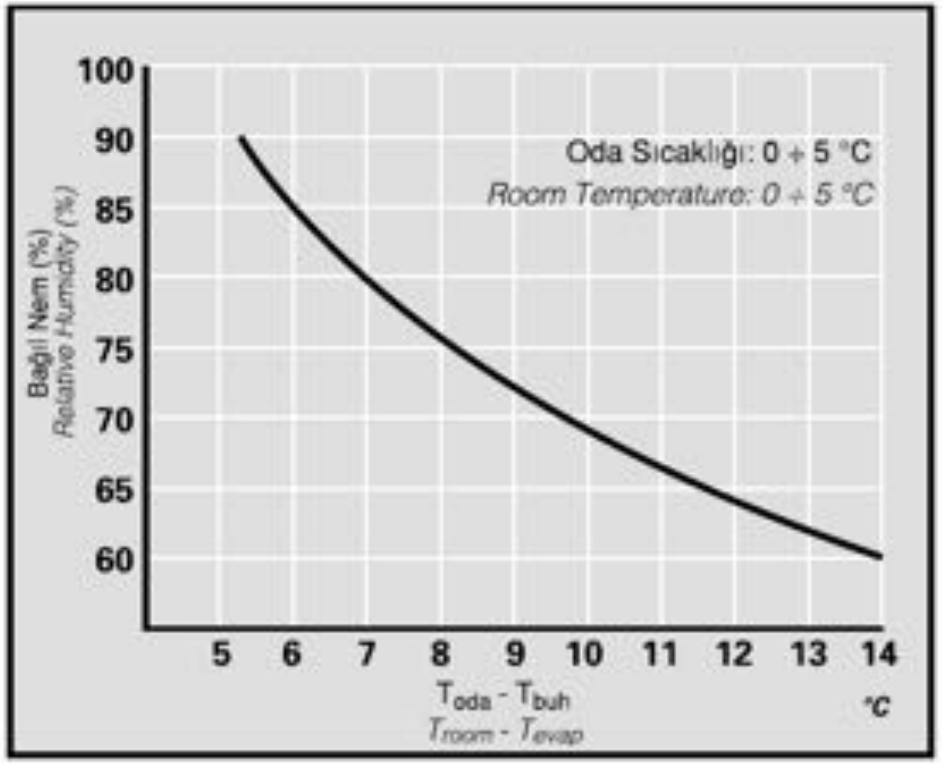
MATERIAL	Where to use
Normal Al Fin (Al 1100/ 8006/ 8011)	• Normal Conditions (Not High Corrosive places)
Epoxy Coated Fin	• Ideal for General Use • Sea Side and Vessels • Water Defrost Systems
Whole Epoxy Coated Coils	• Hygenic storages • Corrosive places
Hydrophilic Coated Fin	• Hygenic Conditions • No Ice demanded places • Display Cabinets
Cupper Fin	• Sea Side and vessels • Long material life • High Corrosive condioned places

Condensers: Casing material selection

Casing Material	Where to Use
Magnezed metal sheet (Electro Static Painting coated - ESPC)	General Appl. (Epoxy based coating on Processed galvanized metal for food and variety storaged product)
Stainless Steel	General Appl., Eshtetic places, Dairy products Hygen needed places
Magnezium Alloy Al (AlMg) (ESPC)	Genel Appl., Eshtetic Places Light weight needed places Dairy Products

System efficiency and energy saving

- Humid and Aroma loss can be prevented by decreasing the temperature differences between room and refrigerant's temperature for the long cold storage products.
- As this will make the compressor works on the higher evaporation temperature, C.O.P will increase and extra energy savings provided.



The change graph because of Evaporation temperature and Room temperature with relative humidity difference.

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How to design a Cooling system

BAZI GIDA MADDELERİNİN ISIL KARAKTERİSTİKLERİ VE DEPOLAMA KOŞULLARI
THERMAL CHARACTERISTICS AND STORAGE CONDITIONS OF VARIOUS FOODS

Malın Cinsi *Type of the Good*	Muhafaza Şartları *Storage Conditions*		Yaklaşık Depolama Ömrü *Approximate Storage Life*	Su Oranı *Water Ratio* %	Donma Başlangıcı Sıcaklığı *Highest Freezing Point* °C	Donma Öncesi Özgül Isısı *Specific Heat Above Freezing* kJ/(kg·K)	Donma Sonrası Özgül Isısı *Specific Heat Below Freezing* kJ/(kg·K)	Donma Isısı *Latent Heat* kJ/kg
	Sıcaklık *Temperature* °C	Nem Oranı *Rel. Humidity* %						
Enginar / *Artichokes*	0	95-100	2 H *(W)*	84	-1,2	3,65	1,89	280
Yerelması *Jerusalem artichokes*	0	90-95	4-5 A *(M)*	80	-2,2	3,47	1,84	267
Kuşkonmaz / *Asparagus*	0 ÷ 2	95-100	2-3 H *(W)*	93	-0,6	3,95	2	310
Yeşil fasulye *Beans, snap*	4 ÷ 7	90-95	7-10 G *(D)*	89	-0,7	3,82	1,95	297
Pancar (yaprağı) *Beets, topped*	0	95	10-14 G *(D)*		-0,4			
Brüksel lahanası *Brussels sprouts*	0	95-100	3-4 H *(W)*	85	-0,8	3,68	1,90	284
Lahana / *Cabbage*	0	98-100	5-6 A *(M)*	92	-0,9	3,92	1,99	307
Havuç / *Carrots, topped*	0	98-100	4-6 H *(W)*	88	-1,4	3,78	1,94	294
Karnabahar / *Cauliflower*	0	95-98	3-4 H *(W)*	92	-0,8	3,92	1,99	307
Kereviz / *Celery*	0	98-100	2-3 A *(M)*	94	-0,5	3,98	2,02	314
Mısır / *Corn, sweet*	0	95-98	4-8 G *(D)*	74	-0,6	3,31	1,76	247
Salatalık / *Cucumbers*	7 ÷ 13	95	10-14 G *(D)*	96	-0,5	4,05	2,04	320
Donmuş sebzeler *Frozen vegetables*	-23, -18		6-12 A *(M)*	61				
Sarımsak (kuru) *Garlic, dry*	0	65-70	6-7 A *(M)*	61	-0,8	2,88	1,60	203
Sarımsak (yeşil) *Garlic, leafy*	0	95-100	10-14 G *(D)*	93	-0,3	3,95	2,0	310
Pırasa / *Leek*	0	95-100	2-3 A *(M)*	85	-0,7	3,68	1,90	284
Mantar / *Mushrooms*	0	95	3-4 G *(D)*	91	-0,9	3,88	1,98	304
Soğan (yeşil) *Onions, green*	0	95-100	3-4 H *(W)*	89	-0,9	3,82	1,95	297
Bezelye (yeşil) *Peas, green*	0	95-98	1-2 H *(W)*	74	-0,6	3,32	1,77	247
Biber (tatlı) *Peppers, sweet*	7 ÷ 13	90-95	2-3 H *(W)*	92	-0,7	3,92	1,99	307
Patates / *Potatoes*	3 ÷ 4	90-95	4-5 A *(M)*	81	-0,6	3,55	1,85	270
Turp / *Radishes*	0	95-100	3-4 H *(W)*	95	-0,7	4,02	2,03	317
Ispanak / *Spinach*	0	95-98	10-14 G *(D)*	93		3,95	2,0	310
Balkabağı / *Pumpkins*	10 ÷ 13	70-75	2-3 A *(M)*	91	-0,8	3,89	1,98	304
Kabak / *Summer squash*	0 ÷ 10	85-90	5-14 G *(D)*	94	-0,5	3,99	2,02	314
Domates (yeşil) *Tomatoes, mature green*	13 ÷ 21	90-95	1-3 H *(W)*	93	-0,6	3,95	2,0	310
Domates (kırmızı) *Tomatoes, firm ripe*	7 ÷ 10	85-90	4-7 G *(D)*	94	-0,5	3,98	2,02	313
Şalgam / *Turnips*	0	95	4-5 A *(M)*	92	-1,1	3,92	1,99	307
Suteresi / *Watercress*	0	95-100	3-4 H *(W)*	93	-0,3	3,95	2,0	310
Marul / *Lettuce*	0 ÷ 1	95-100	2-3 H *(W)*	95	-0,2	4,02	2,03	317

G = Gün, H = Hafta, A = Ay
D = Day, W = Week, M = Month

NOT / *NOTE*: **1 kcal/kg = 4,18 kJ/kg**
Ref: Ashrae Refrigeration 1998

Malın Cinsi *Type of the Good*	Muhafaza Şartları *Storage Conditions*		Yaklaşık Depolama Ömrü *Approximate Storage Life*	Su Oranı *Water Ratio* %	Donma Başlangıcı Sıcaklığı *Highest Freezing Point* °C	Donma Öncesi Özgül Isısı *Specific Heat Above Freezing* kJ/(kg·K)	Donma Sonrası Özgül Isısı *Specific Heat Below Freezing* kJ/(kg·K)	Donma Isısı *Latent Heat* kJ/kg
	Sıcaklık *Temperature* °C	Nem Oranı *Rel. Humidity* %						
Elma / *Apple*	0 ÷ 3	90-95	8-9 A *(M)*	84	-1,1	3,65	1,89	280
Kayısı / *Apricot*	0 ÷ 1	90-95	1-3 H *(W)*	85	-1,1	3,68	1,90	284
Avokado / *Avocado*	3 ÷ 4	85-90	2-8 A *(M)*	65	-0,3	3,01	1,67	253
Muz / *Bananas*	13 ÷ 14	85-95	-	75	-0,8	3,39	1,78	250
Böğürtlen / *Blackberry*	-0,5 ÷ 0	90-95	3 G *(D)*	85	-0,8	3,68	1,90	284
Ufak kavun / *Cantaloupes*	2 ÷ 4	95	5-15 G *(D)*	92	-1,2	3,92	1,99	307
Vişne / *Sour cherry*	0	90-95	3-7 G *(D)*	84	-1,7	3,58	1,89	280
Kiraz / *Cherry*	-1 ÷ -0,5	90-95	2-3 H *(W)*	80	-1,8	3,51	1,84	267
Hindistan cevizi / *Coconut*	0 ÷ 1	90-95	3-5 A *(M)*	82	-0,8	3,58	1,87	274
Kuş üzümü / *Currant*	-5 ÷ 0	90-95	1-4 H *(W)*	85	-1	3,68	1,90	284
Hurma / *Dates, cured*	-18 ÷ 0	75	6-12 A *(M)*	20	-16	1,59	1,09	67
İncir (taze) / *Fig, fresh*	-1 ÷ 0	85-90	7-10 G *(D)*	78	-2,4	3,45	1,81	260
Donmuş meyveler / *Frozen fruits*	-24 ÷ -18	90-95	18-24 A *(M)*					
Kivi / *Kiwi*	0	90-95	3-5 A *(M)*	82	-1,7	3,58	1,87	273
Limon / *Lemon*	11 ÷ 12	85-90	1-4 A *(M)*	89	-1,4	3,82	1,95	297
Malta eriği / *Loquat*	0	90	3 H *(W)*	87		3,75	1,93	290
Yeşil zeytin / *Olives, fresh*	7 ÷ 10	85-90	4-6 H *(W)*	75	-1,4	3,35	1,78	250
Portakal / *Orange*	3 ÷ 9	85-90	3-6 H *(W)*	86	-1,3	3,72	1,92	287
Şeftali / *Peaches*	-5 ÷ 0	90-95	2-4 H *(W)*	89	-0,9	3,82	1,95	297
Armut / *Pears*	-1,6 ÷ -0,5	90-95	2-7 A *(M)*	83	-1,6	3,61	1,88	277
Erik / *Plum*	-1 ÷ 0	90-95	2-4 H *(W)*	86	-0,8	3,72	1,92	287
Nar / *Pomegranate*	4	90-95	2-3 A *(M)*	82	-3	3,58	1,86	274
Ayva / *Quinces*	-1 ÷ 0	90	2-3 A *(M)*	85	-2	3,68	1,90	284
Ahududu / *Raspberries*	-5 ÷ 0	90-95	2-3 G *(D)*	81	-1,1	3,55	1,85	270
Çilek / *Strawberries*	-5 ÷ 0	90-95	5-7 G *(D)*	90	-0,8	3,85	1,97	300
Mandalina / *Tangerine*	4	90-95	2-4 H *(W)*	87	-1,1	3,75	1,93	290
Karpuz / *Watermelon*	4 ÷ 10	90	2-3 H *(W)*	93	-0,4	3,95	2,0	310
BALIKLAR - ETLER - KÜMES HAYVANLARI / *FISHES - MEAT -POULTRY PRODUCTS*								
Kalkan / *Turbot*	-1 ÷ 1	95-100	18 G *(D)*	75	-2,2	3,35	1,78	250
Ringa / *Herring*	0 ÷ 2	80-90	10 G *(D)*	61	-2,2	2,88	1,60	203
Uskumru / *Mackerel*	0 ÷ 1	95-100	6-8 G *(D)*	65	-2,2	3,01	1,65	217
Somon / *Salmon*	-1 ÷ 1	95-100	18 G *(D)*	64	-2,2	2,98	1,64	213
Tuna / *Tuna fish*	0 ÷ 2	95-100	14 G *(D)*	70	-2,2	3,18	1,71	233
Donmuş balık / *Frozen fish*	-29 ÷ -18	90-95	6-12 A *(M)*					
Sığır (taze) / *Beef, fresh*	0 ÷ 1	88-92	1-6 H *(W)*	62÷77	-2,2 ÷ -1,7	2,91 ÷ 3,43	1,62 ÷ 1,80	207÷257
Sığır (donmuş) / *Beef, frozen*	-23 ÷ -18	90-95	9-12 A *(M)*					
Kuzu (taze) / *Lamb, fresh*	0 ÷ 1	85-90	5-12 G *(D)*	60÷70	-2,2 ÷ -1,7	2,85 ÷ 3,18	1,59 ÷ 1,72	200÷233
Kuzu (dnm.) / *Lamb, froz.*	-23 ÷ -18	90-95	8-10 A *(M)*					
Kümes H. (tz.) / *Poultry, fresh*	0	85-90	1 H *(W)*	74	-2,8	3,32	1,77	247
Kümes H. (dnm.) / *Poultry, froz.*	-23 ÷ -18	90-95	8-12 A *(M)*					

G = Gün, H = Hafta, A = Ay
D = Day, W = Week, M = Month

NOT / *NOTE*: **1 kcal/kg = 4,18 kJ/kg**
Ref: Ashrae Refrigeration 1998

How to design a Cooling system (Cont.)

1. It must be indicated cold room temperature and relative humidity depending on chosen refrigerant
2. Room size must be decided regarding to product capacity and stored product.
3. Floor, side and roof temperature will be decided.
4. Room wall construction and Isolation material – thickness should be decided in terms of outside&Inside environmental conditions.
5. Heat recovery should be calculated (Fans' heat also seperately considered while calculating the heat recovery. In some shock systems' applications; this circumstances effects the total capacity around %30 & plus.)

How to design a Cooling system (Cont.)

6. Refrigerant must be decided regarding tp capacity and the stored product.
7. Evaporator, condenser and compressor capacity should be decided.
8. Condenser cooling circut must be decided whether using air or water. (That depends on system closure to source of the water, condenser capacity, and air & water temperature which will condensate the refrigerant in the condenser.)
9. Needs to be controled Evaporator's fans' capacity.
10. Pipe diameter calculated in the Installation

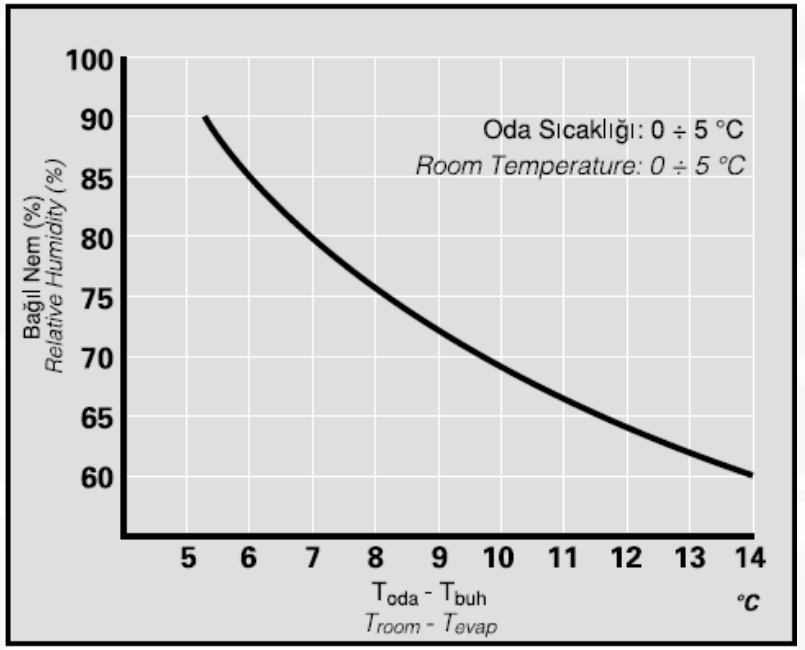
How to calculate the cooler capacity

Necessary Information to make selection of Coolers:

- Room Temperature and relative humidity level
- Difference of Room temperature – evaporation temperature (In terms of stored product)
- Room size / Blowing distance
- Necessary air flow

Specifically for the food cooling, room relative humidity wanted to be on the proper conditions. Room's relative humidity is the function of difference between cold store temperature and evaporation's temperature.

To provide necessary relative humidity for the 0-5 °C cold rooms, ΔT can be decided from the beside graph for the right evaparator selection.



Cooler selection

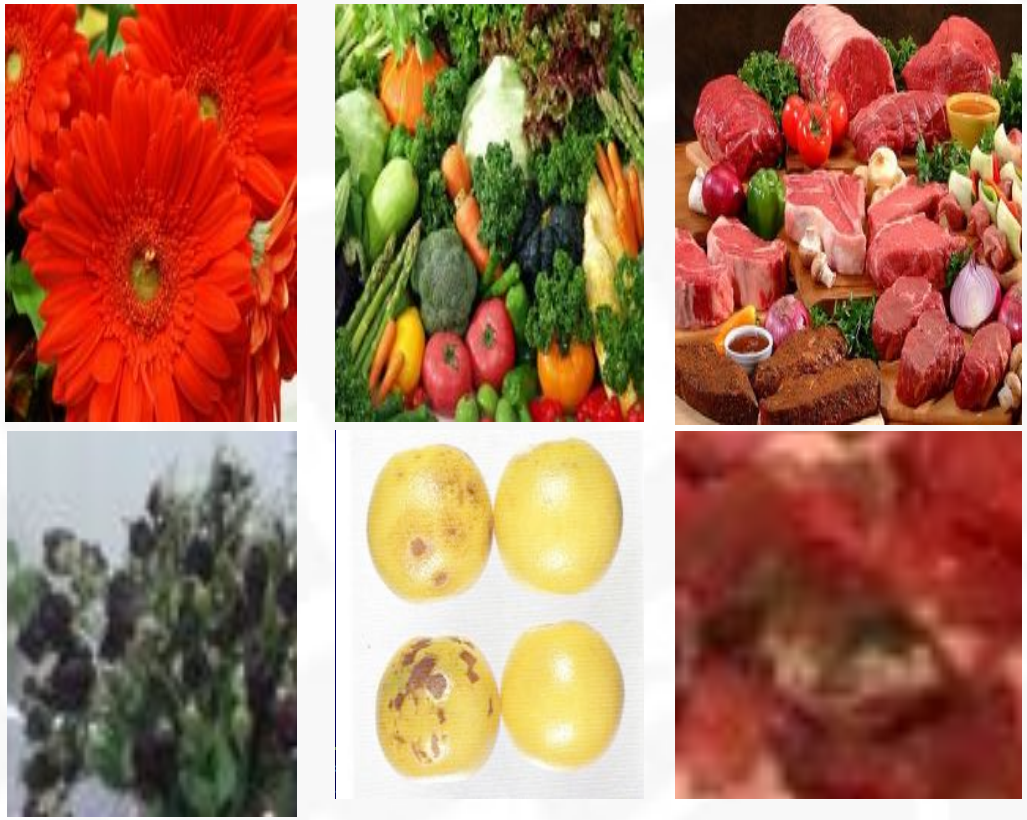
Air Speed : **2,5-3,7 m/sn** (Mid Speed)
FES TYPE

- **WIDE RANGE USE FOR GENERAL COOLING APPLICATIONS**
- **WIDE CAPACITY & VARIETY OF PITCH CHOICE**

Air Speed: **1,5-3,5 m/sn** (Mid Speed)
FEDD TYPE

- **GOOD FOR LOW TOP**
- **COLD AIR NOT ON PRODUCT**
- **COOLING FROM TOP TO BOTTOM HOMOGEN COOLING IN THE ROOM**

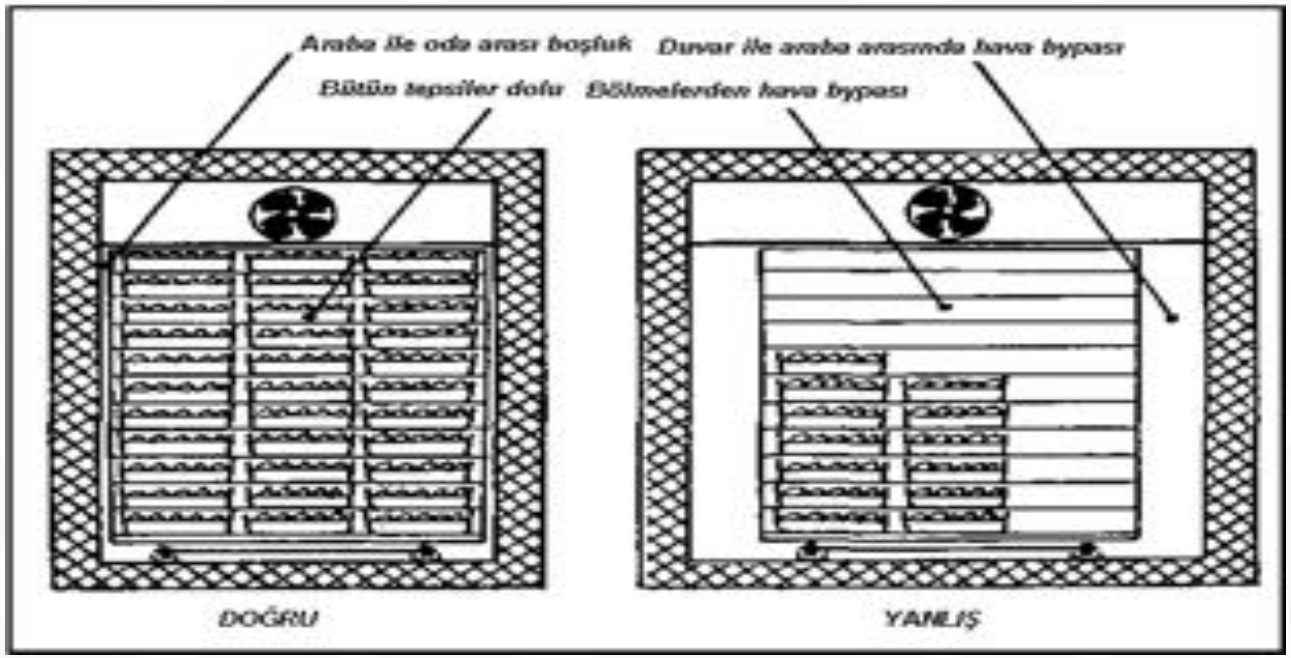
Influence of air speed on cooling



- Freezing time shorter when the air speed increased.
- When the refrigerant speed increases, heat transfer coefficiency and therefore K total heat transfer coefficieny might be increased. However, In this case, either Refrigerant neither cold storage load loss increases, beside evaporation increases specifically on the food which has humidity. On those products, it can be seen crackings because of dried and weight loss. Especially flowers and vegs, sliced meats are more sensitive against the high speed air flow. They quickly perished.

Importance of air circulation

Air speed on the stored product must be the equal in the tunnel in a good design and processed shock freezers. This way, All the stored products would be frozen equally. Tunnel design construction is very important due to providing the equal air flow all around the room surface and defeating the air resistance of products. Spcaes must be equal between trays, all the trolleys bottom, side and top should be reduced with min space. Otherwise, Air always prefers to easy way and not hit the products and freezing will not be fulfilled.



Packaging effect of the product

Each type of packaging and rolling the product will extend the freezing time. This extension is not only about packaging material isolation, it is also the air between product and package which makes extra isolation.

Packaging Type	Freeze Time - Hour
Wooden Box, Paper rolled, cover closed	17 – 9
Wooden box, folio rolled, cover closed	17 – 2
Wooden box, paper rolled, no cover	16 – 3
Wooden box, folio rolled, no cover	16 – 2
Wooden box, no rolled , cover closed	14 – 7
Wooden box, no rolled, no cover	8 – 0

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Thank You!

Q&A

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Today's workshop agenda

1. International regulatory developments and performance certification in commercial refrigeration and their potential for the Middle
2. Influence of cooler units in preventing moisture and aroma loss in open-shelf products in the cold storages
3. **Natural refrigerant systems in warm climates: existing solutions, case studies and future developments for the Middle East**
4. Examining the benefits of Air Curtains in Cold Storage applications
5. Open Discussion
6. Closing and buffet dinner

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Natural refrigerant systems in warm climates: existing solutions, case studies and future developments for the Middle East

Session 3

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Andrea Cavalet

After Sales Director

EPTA Middle East

F-GAS EFFECT: HFC REFRIGERANT PRICES in Europe

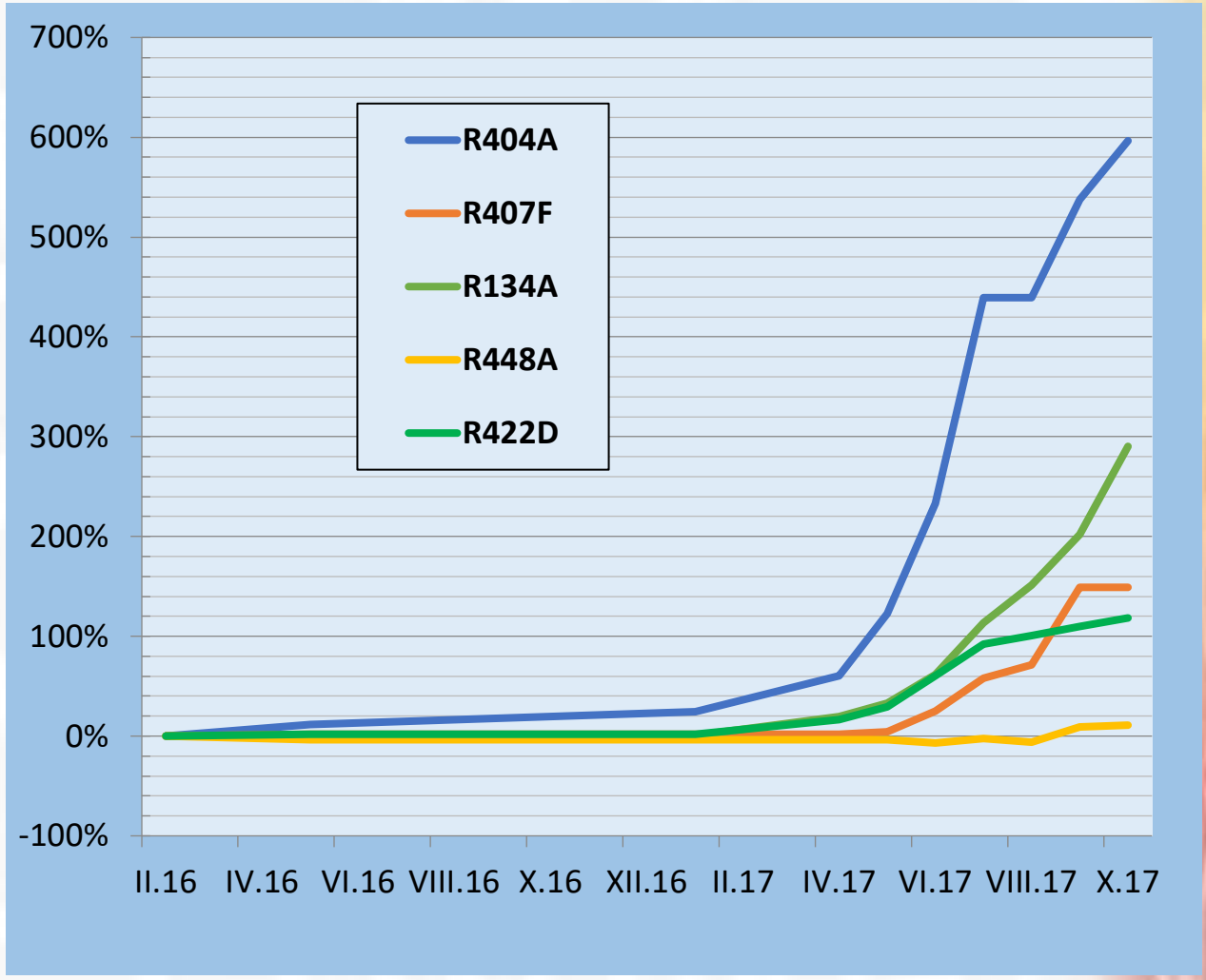
•Ban Mechanism (2020) and Quota Mechanism (2017)

• **F-Gas HIGH impact on market prices and availability**

• **Stop production of R404A – Jan 2018**

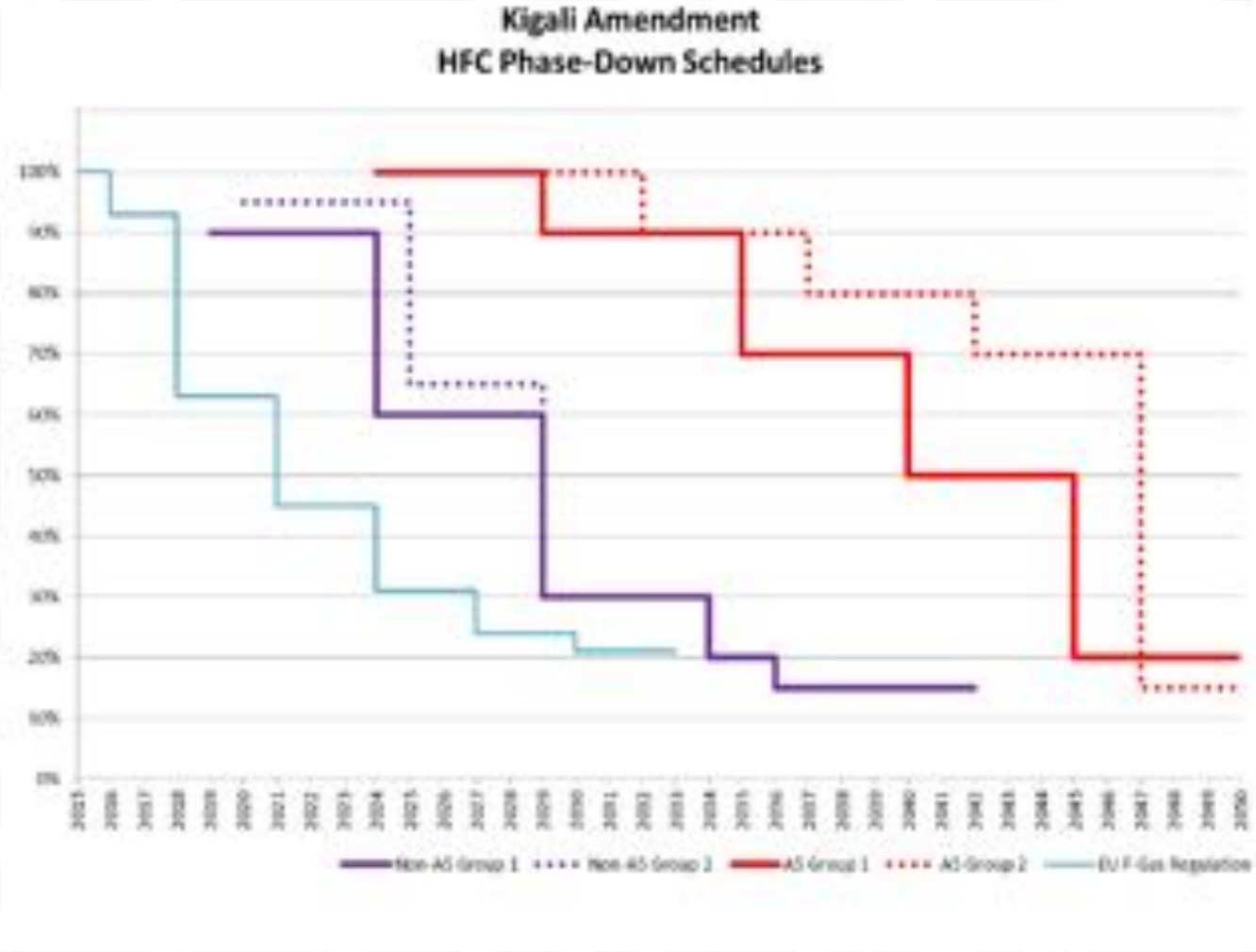
• HFC (R407A/C/F, R134a, R410A) are increasing in price

• HFO refrigerants are stable



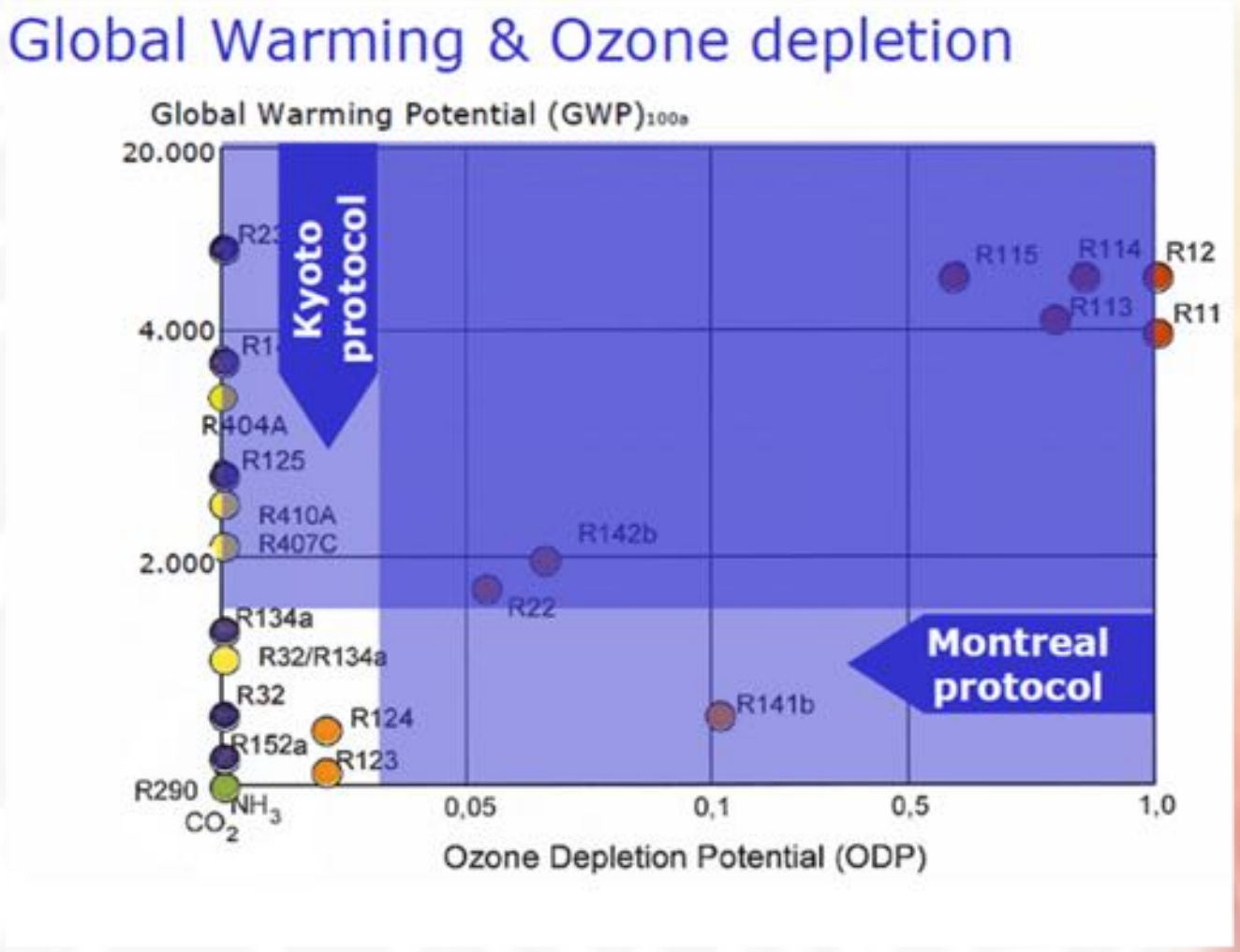
Kigali Amendment – Montreal Protocol

- October 2016
- Step forward to reduce global warming
- **Quota Mechanism**: Global phase-down of HFCs on CO2e basis
- Can be strengthened over time
- Energy efficiency gains could significantly increase climate impact
- Non A5 Group (USA and others)
- A5 Group 1 (China and Africa)
- **A5 Group 2 (Middle East)**

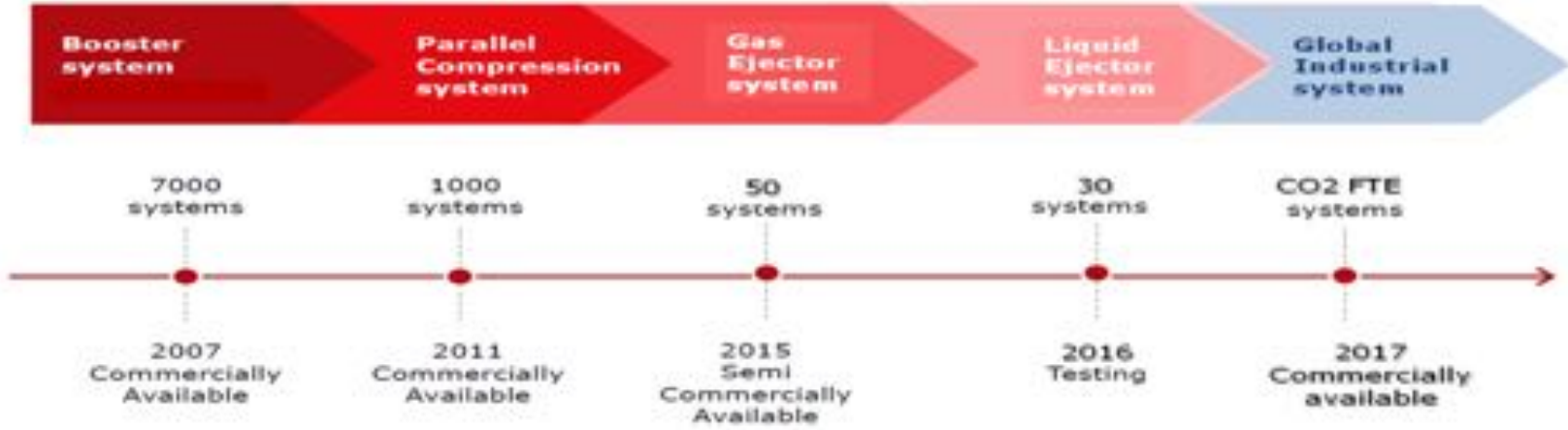


Why CO_2

- **Environmental friendly**
- **ODP = 0**
- **GWP = 1**
- Excellent heat transfer capability
- High cooling capacity compared to traditional refrigerants
- **Not flammable**
- Stable substance: not decompose
- **Low and stable price**



Warm climates available solutions



- **Parallel compression system :** a dedicated VSD compressor removes the flash gas from the liquid
- **Gas ejector system:** device that pumps the vapor exiting from MT evaporators back to the liquid receiver.
- **Liquid ejector system:** device that pumps the liquid exiting from MT flooded evaporators from a low pressure receiver back to the intermediate pressure receiver.

- **Above solutions are limited by:**

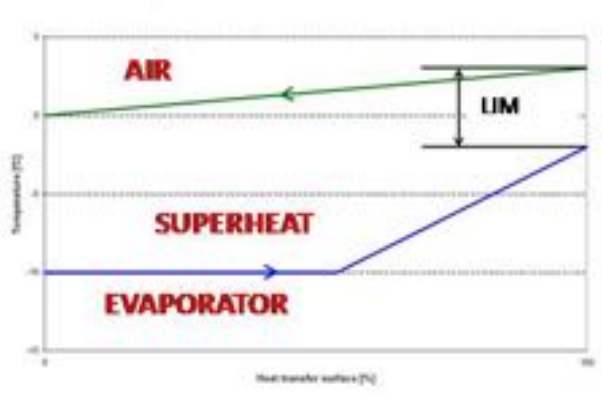
- **COMPLEXITY**
- **HIGH COST OF COMPONENTS NOT COMMERCIALLY AVAILABLE**
- **NEED TO HAVE HIGHLY QUALIFIED STAFF TO COMMISSION AND OPTIMIZE THE SYSTEM**

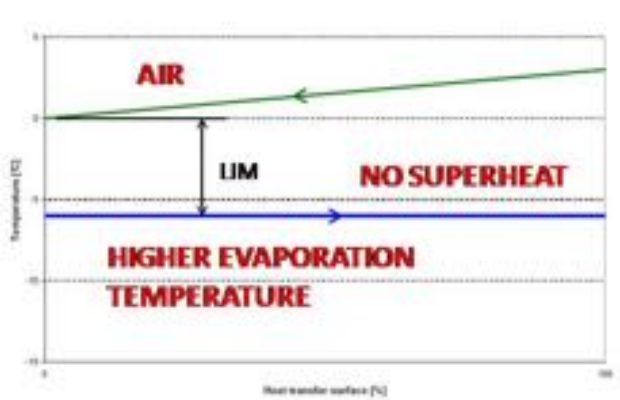
How to find a solution for warm climates that combines

- CO2 transcritical
- Low cost
- Energy saving
- **Reliability**
- **Simplicity** ?

CO2 FTE System

Overfeeding of the evaporators





» **What is the superheat?** The amount of heat added to the refrigerant after its complete evaporation.

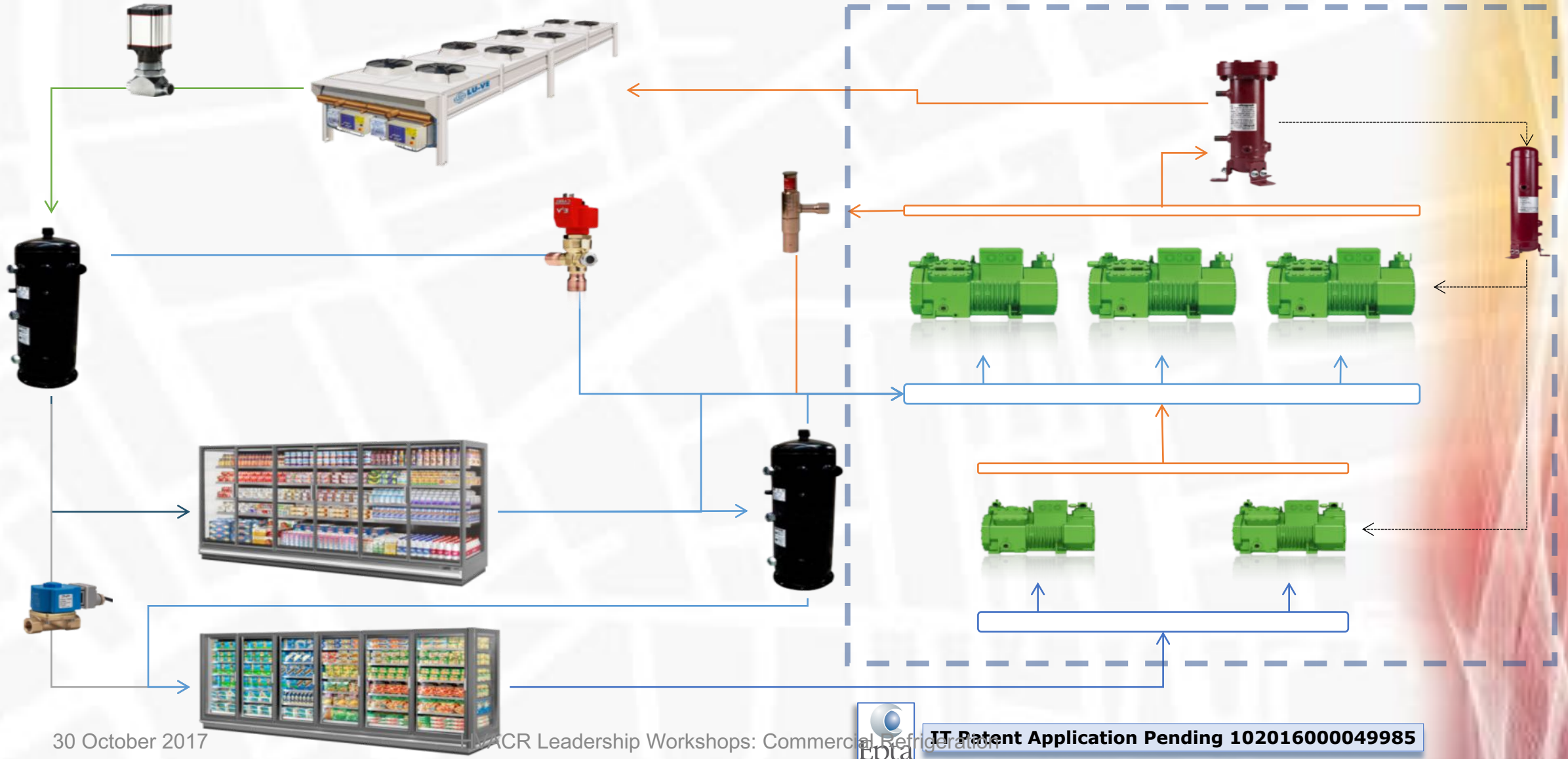
The superheat is necessary to have only vapor at the evaporator outlet, but it also introduces a significant energy waste and higher compression work.

» **Superheat and Evaporating Temperature** The maximum evaporating temperature is limited by the approach between the air inlet temperature and the refrigerant temperature at evaporator outlet.

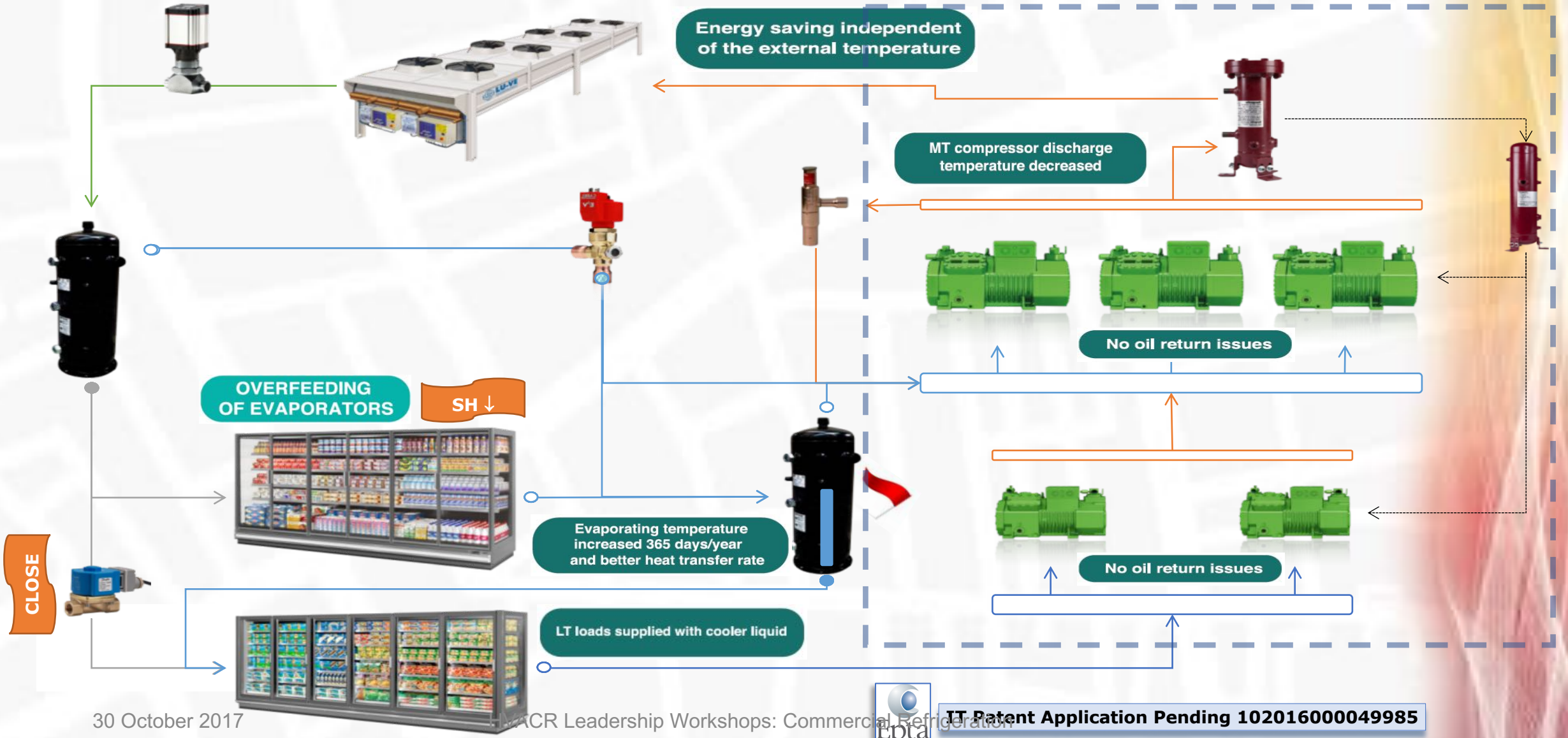
Superheat causes lower evaporation temperature and hence higher energy consumption.

» **ZERO superheat : overfeeding of evaporators** Superheat is completely eliminated, liquid refrigerant is mostly used at the evaporator, liquid and vapor are present at the MT evaporator outlet

» **Advantages of evaporators overfeeding** Higher evaporation temperature (up to 6K), liquid refrigerant ensures excellent heat transfer



IT Patent Application Pending 102016000049985



IT Patent Application Pending 102016000049985

FTE Advantages

1. **Evaporating temperature increased 365day/year**

   The efficiency of the CO_2 FTE SYSTEM is given by the MT cabinets operating with flooded (overfeeding) evaporators without superheat

   Evaporation temperature is increased up to 6K (2.5-3% energy saving per K)

2. **Energy saving is independent of the external temperature**

   Unlike ejector technology, the FTE system works in energy saving mode with flooded evaporators all year long

3. **Optimal performance at EVERY temperature**

   The absence of superheat decreases the discharge temperature of the compressors considerably, making it the ideal system for every climate.

4. **LT loads supplied with cooler liquid**

   Liquid to the LT freezers is subcooled after MT cabinets

5. **No oil return issues**

   Perfect lubrication is ensured as the oil circuit is uninterrupted

FTE Key features

SIMPLE

because it does not need ejectors or sophisticated components, it is as simple as a standard basic CO2 booster system

Mechanically the FTE system operates with the same components as the basic CO_2 transcritical system, plus the FTE multilevel liquid receiver.

Key features

RELIABLE

as it is a modular solution based on standard components produced on a large scale: standard CO_2 cabinets and freezers, standard basic CO_2 booster system, the heart of the system is the FTE module, an intelligent standard multi-level liquid receiver.

EPTA numbers:

- 2000 CO2 system
- 100 CO2 with FTE

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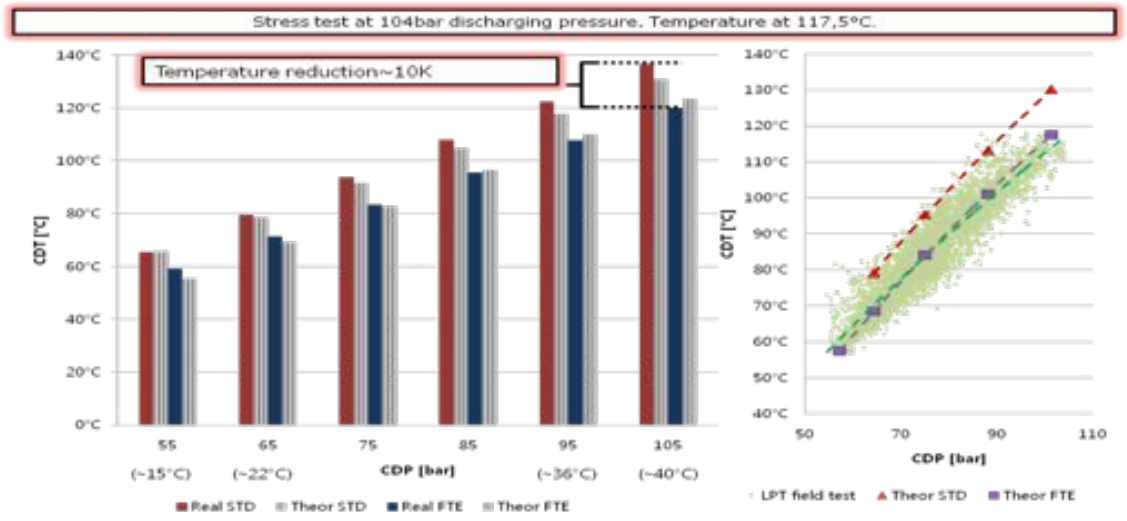
FTE

Key features

RELIABLE

a CO_2 booster system solution more safe and robust than ever: FTE system **reduces the compressor discharge temperature** and ensures **perfect oil circulation** providing better lubrication.

MT compressor discharge temperature decreased



FTE is a new business model :

- **INDUSTRIALIZABLE**
- **RELIABLE**
- **EFFICIENT**

The future of natural refrigeration depends on systems that **combine cost, energy saving and reliability in a simple design.**

With CO2 FTE SYSTEM the cost, performance and reliability gaps can finally be seen to be bridged.

FTE gives a significant contribution to break down the barriers to a natural future in refrigeration.

Natural refrigerant systems

Complete EPTA Catalogue with Natural Refrigerants

F-GAS POLICIES WORK WELL

- CO2 emissions reduced
- Energy consumption is key target
- Natural refrigeration products and systems are available on the market
- **The F-Gas in Europe and the Kigali amendment applied at national level are essential to effectively fight global warming**

System Recovery – HFO blend RETROFIT R404A/R22

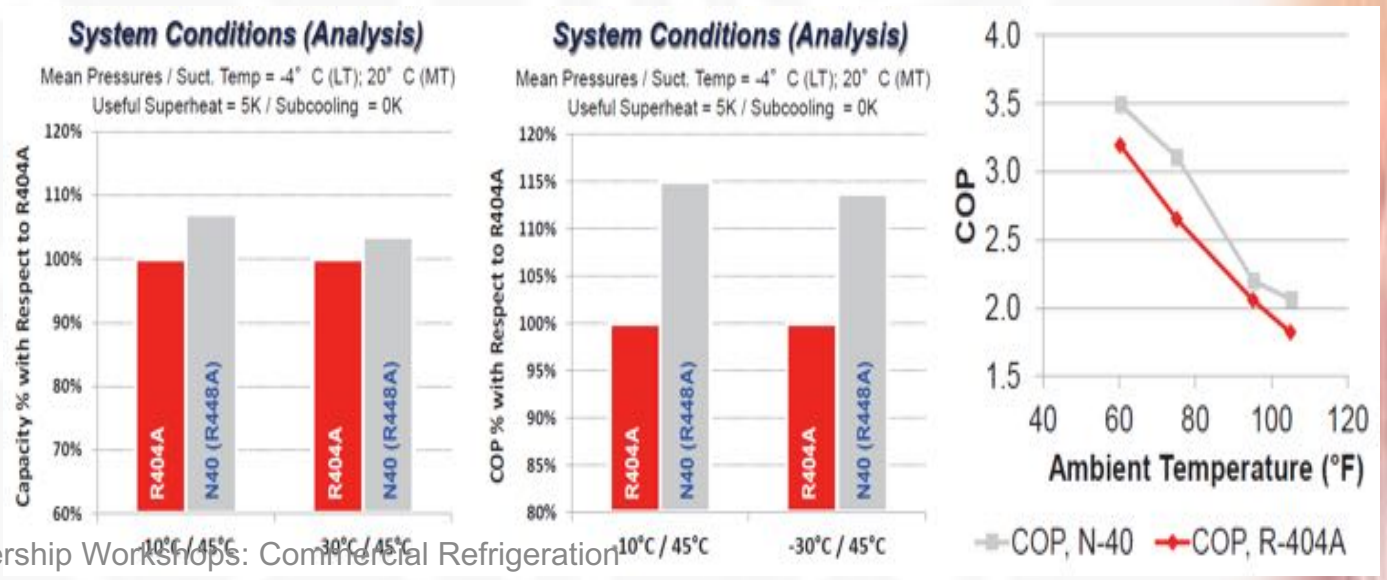
- Equipment compliant with ecocompatible technology, improving energy efficiency?
- Retrofit with HFO blend quick, easy, cost-effective
- Safe and non-flammable (ASHRAE A1)
- Extensively field tested with no equipment/lubricant changes (in case of R404 retrofit)
- Miscible with POE lubricants

Solstice® N40

Solstice® N40 (R-448A) is the Honeywell equivalent as XP40 (R-449A), a non-flammable, reduced GWP HFO refrigerant for new supermarkets and R-404A/R22 retrofits.

Composition is 1234yf / 1234ze / R32 / R125 / R134a (20% / 7% / 26% / 26% / 21%)

Product	Capacity	Efficiency	GWP AR5
R404A	100%	100%	3943
Solstice® N40 (R448A)	100-105%	110-115%	1273



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Today's workshop agenda

1. International regulatory developments and performance certification in commercial refrigeration and their potential for the Middle
2. Influence of cooler units in preventing moisture and aroma loss in open-shelf products in the cold storages
3. Natural refrigerant systems in warm climates: existing solutions, case studies and future developments for the Middle East
4. **Examining the benefits of Air Curtains in Cold Storage applications**
5. Open Discussion
6. Closing and buffet dinner

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Examining the benefits of Air Curtains in Cold Storage applications

Session 4

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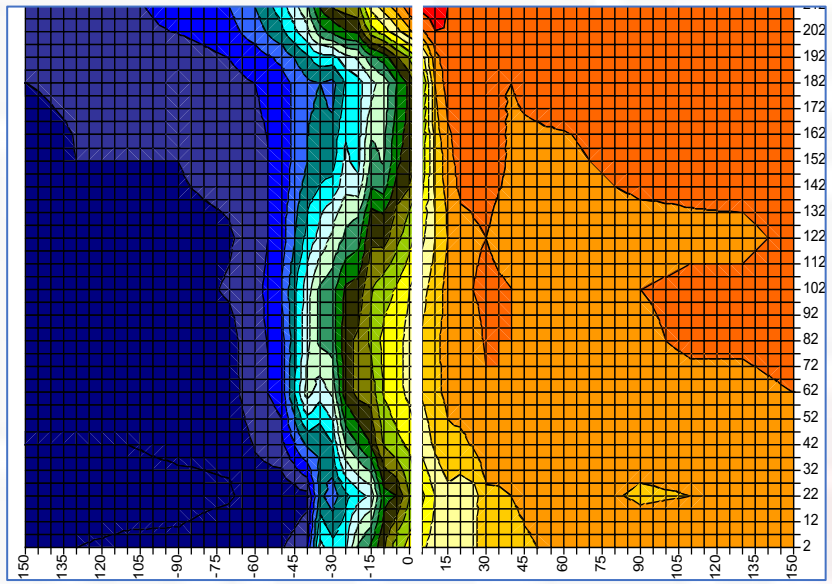
Pontus Grimberg

International Sales Director

Frico AB, Sweden


More hygienic
Safer environment
Less maintenance
Up to 75% energy savings with air curtains

Air Curtains in Cold Storage Applications



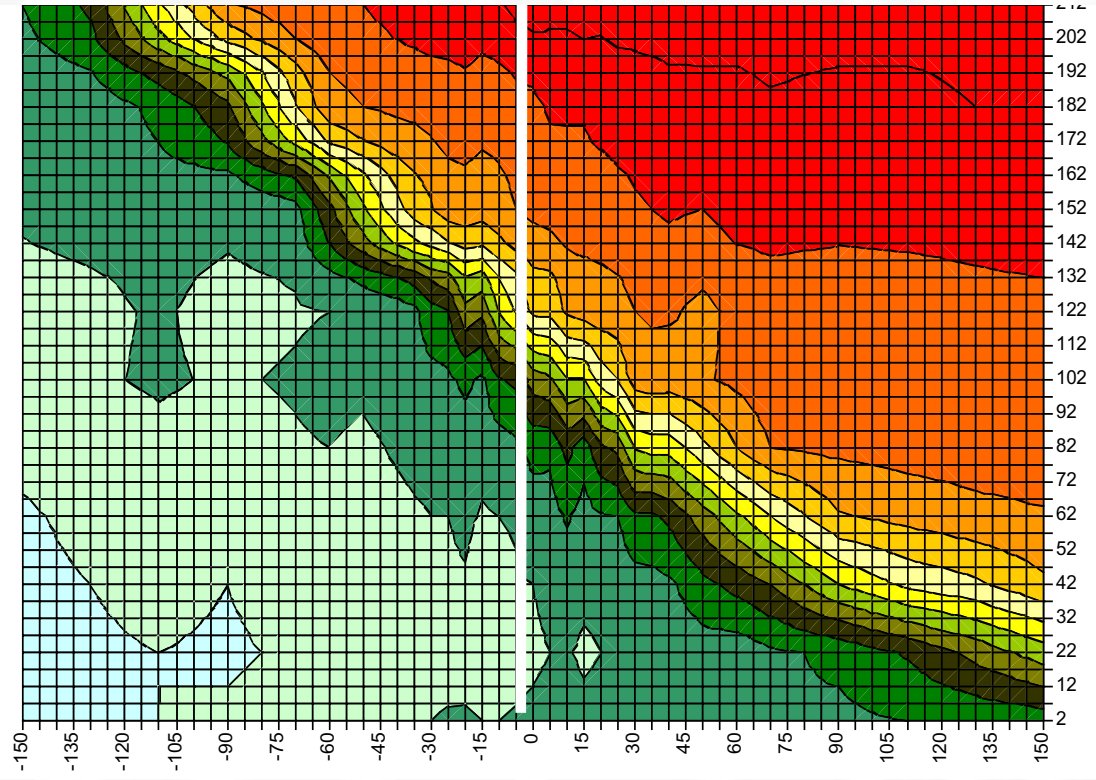
Side view

Dubai Green Building Regulations 501.04

”For all new air conditioned buildings, other than villas, all regularly used air conditioned entrance lobbies must be protected by a door design which acts as a barrier to the loss of conditioned air”

Open door – huge energy losses

Indoor



Outdoor

Door height

Side view

Source: Malmö Högskola

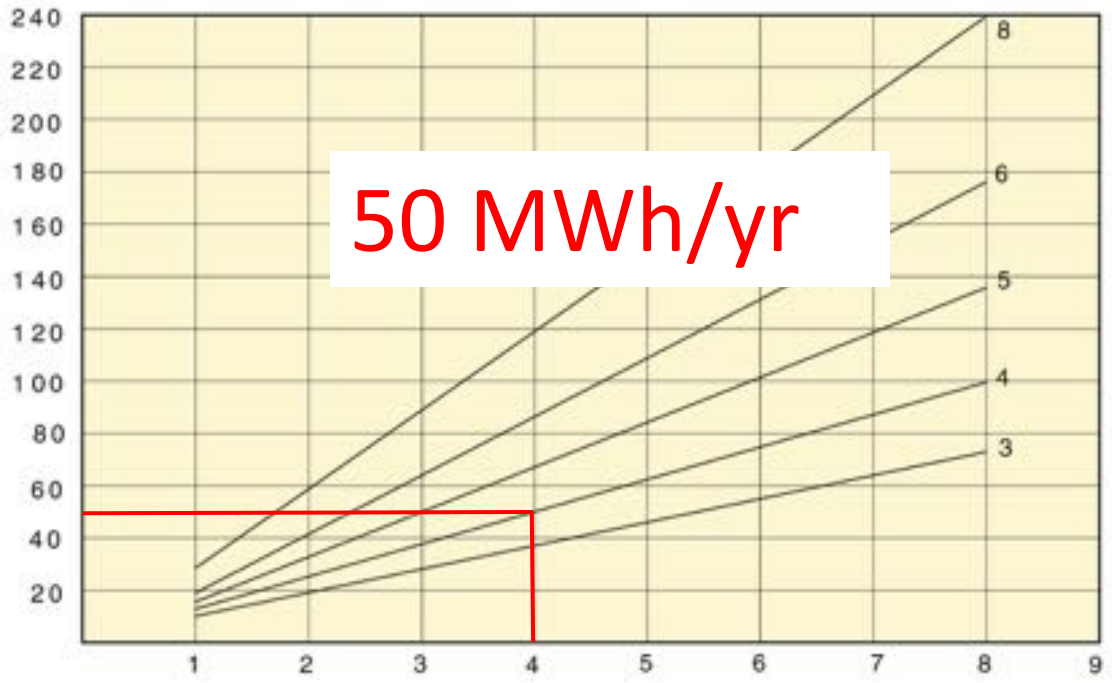
The Solution

- An air curtain with optimized air stream effectively protecting the entrance from the outdoor climate

The result

- Saving energy
- Providing comfort
- Improving the indoor air quality
- Less problems with insects, fumes etc.

Energy losses through open doors



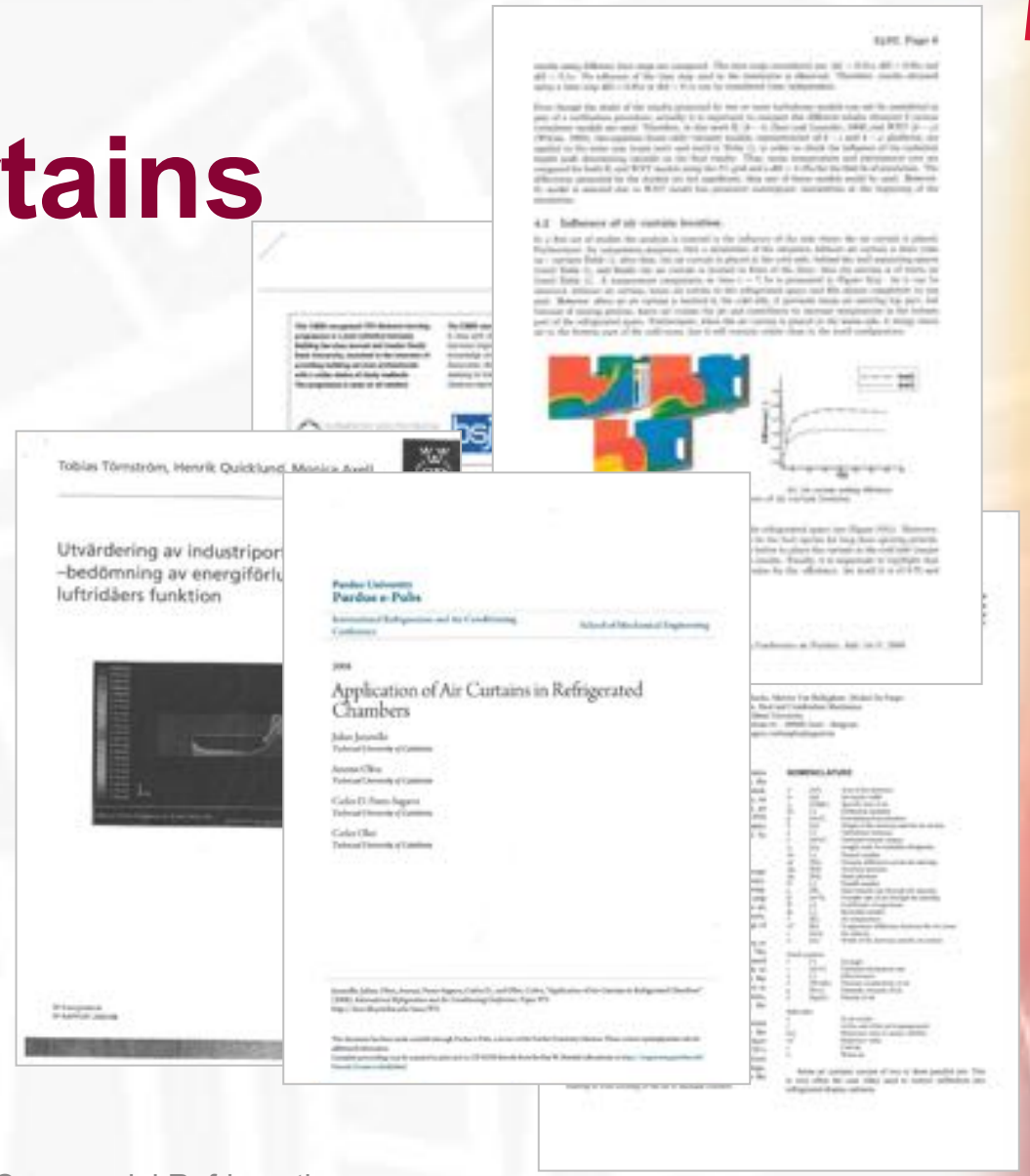
Industrial building/warehouse

- Temperature difference: 15 °C
- Year mean wind speed: 4 m/s
- Door open: 1h/day

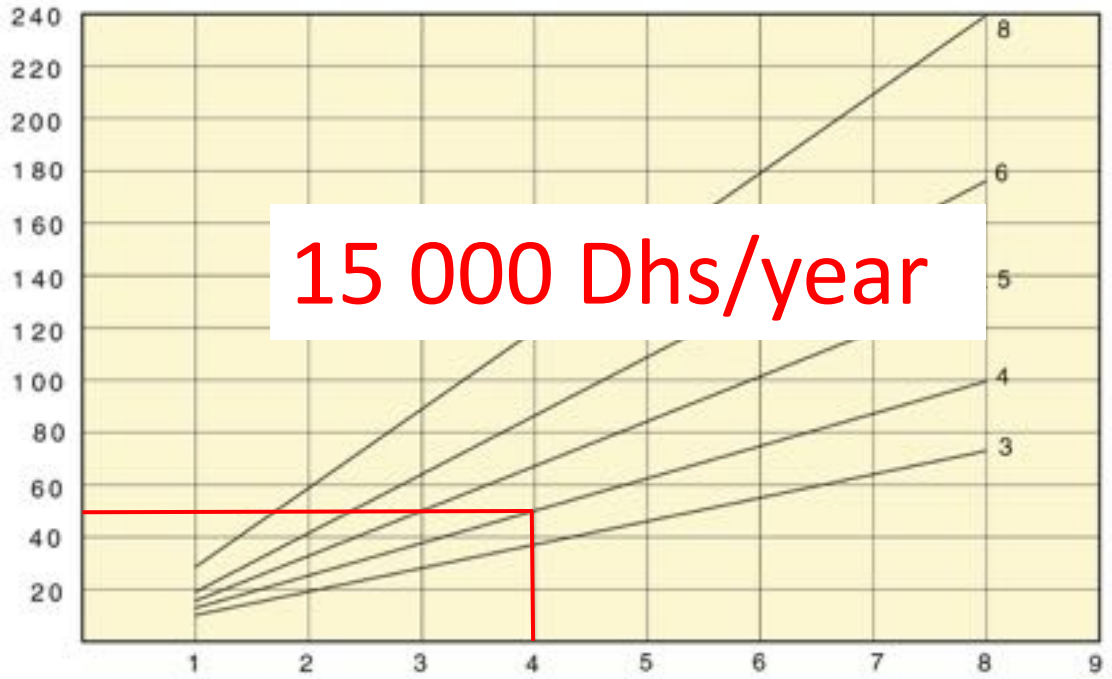
Efficiency of air curtains

Tests are showing that a correct installed air curtain significantly can reduce the energy losses in an open door

- **Ghent University** 80%
- **Purdue University** 75%
- **SP Swedish National Testing and Research Institute** 85%
- **London South Bank University** 70%



Energy losses through open doors



Industrial building/warehouse

- Temperature difference: 15 °C
- Year mean wind speed: 4 m/s
- Door open: 1h/day

Cold storage – case study

- Cold storage temp: -23°C
- Heated area temp: +26 °C
- Door dimensions: 2,4 x 2,1m
- Door opened 100 times a day

Cold storage – case study

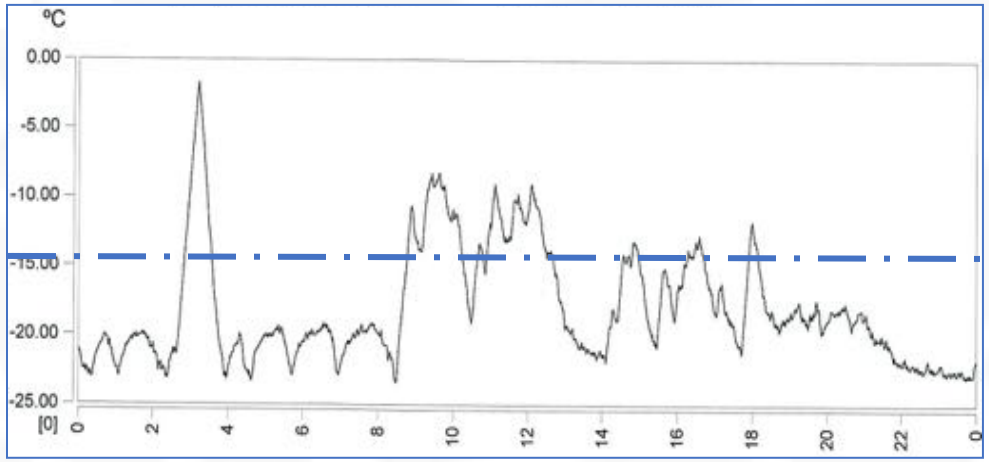
- Huge energy losses
- Temperature rise in the cold sections
- Ice on the refrigeration units
- Ice on the floor

Cold storage – case study

- **Lower cold losses**
- **Reduced build up of ice**
- **Extended defrosting intervals**
- **Easier to pass through the door without the plastic strips**

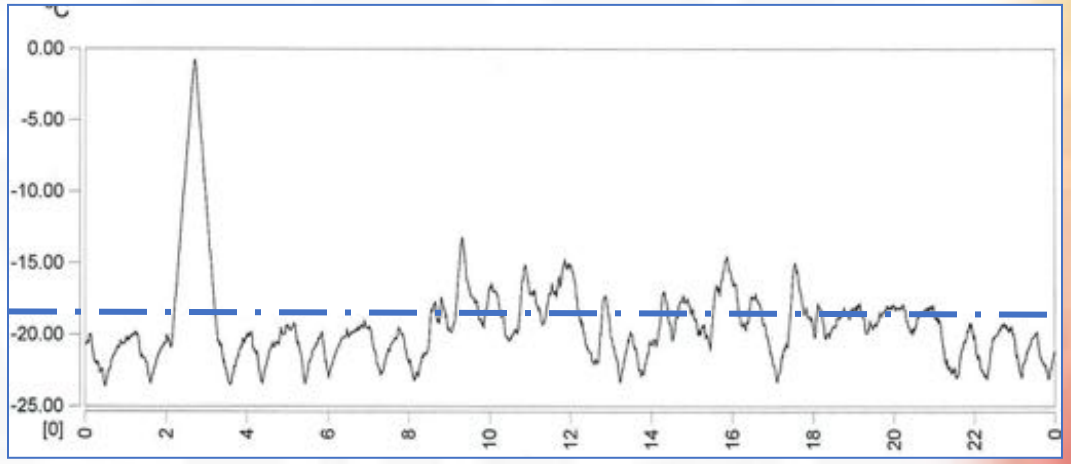
Cold storage – case study

With Plastic Strips



Av. cold room temperature: -14°C

With Air Curtains



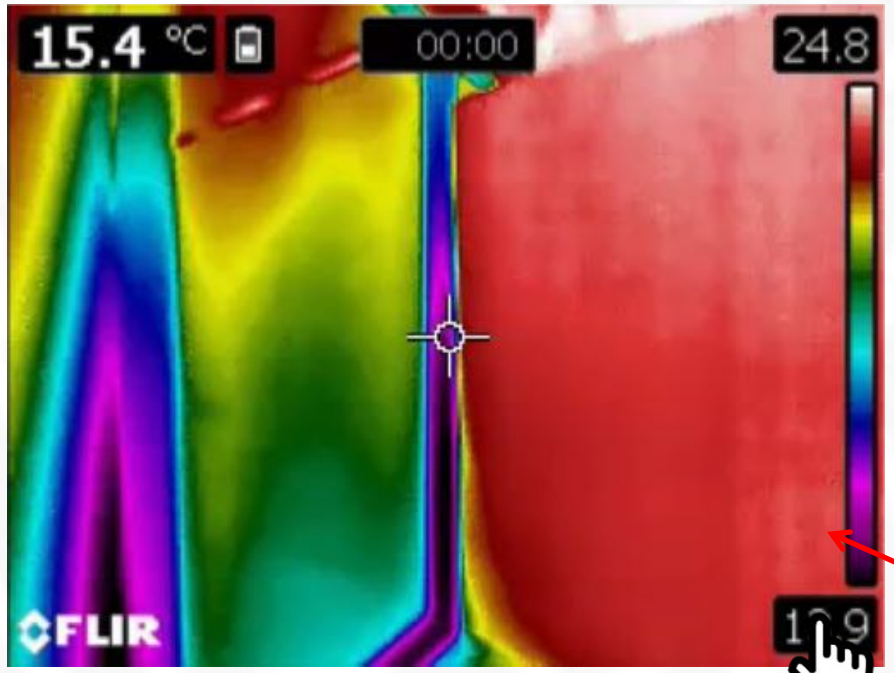
Av. cold room temperature: -19°C

Cold storage – case study

Combination of storage doors and air curtains provides the highest energy savings

Importance of correct velocity

Importance of correct velocity

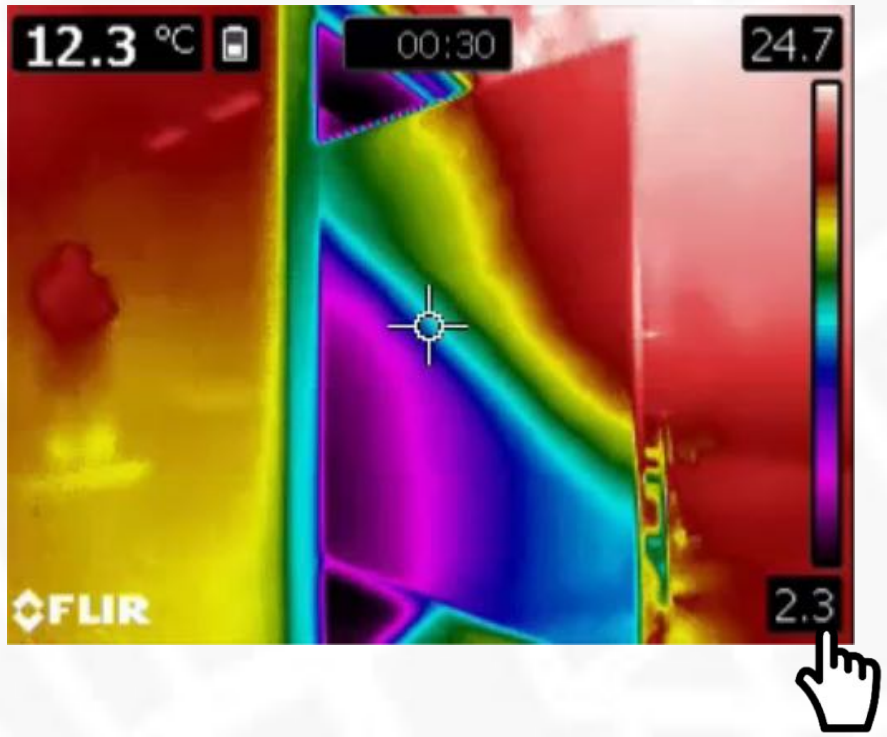


Press to play

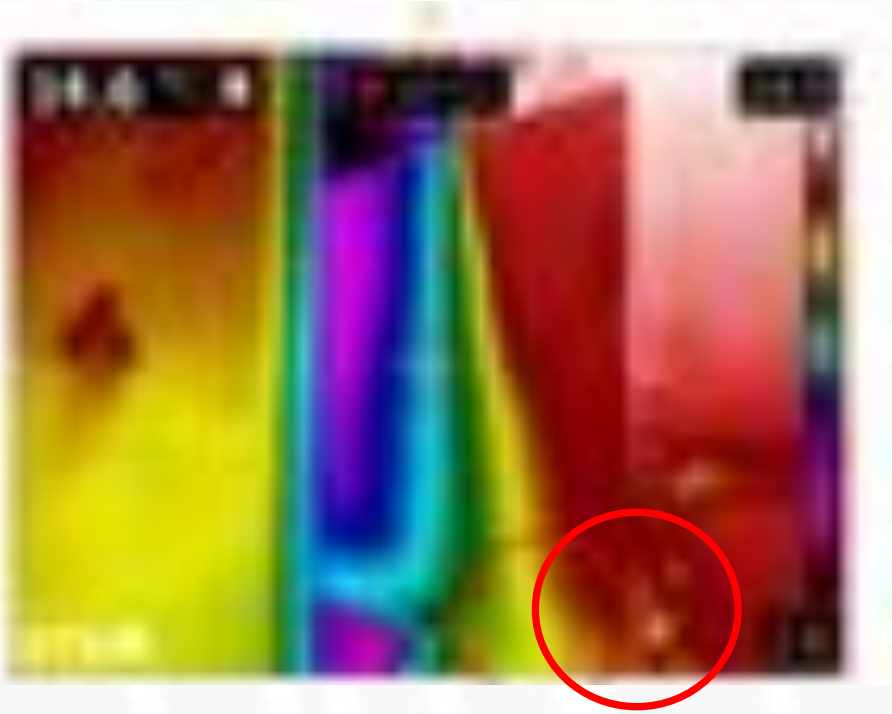
Entrance without air curtain

Shield placed in middle of doorway once door opens up

Importance of correct velocity



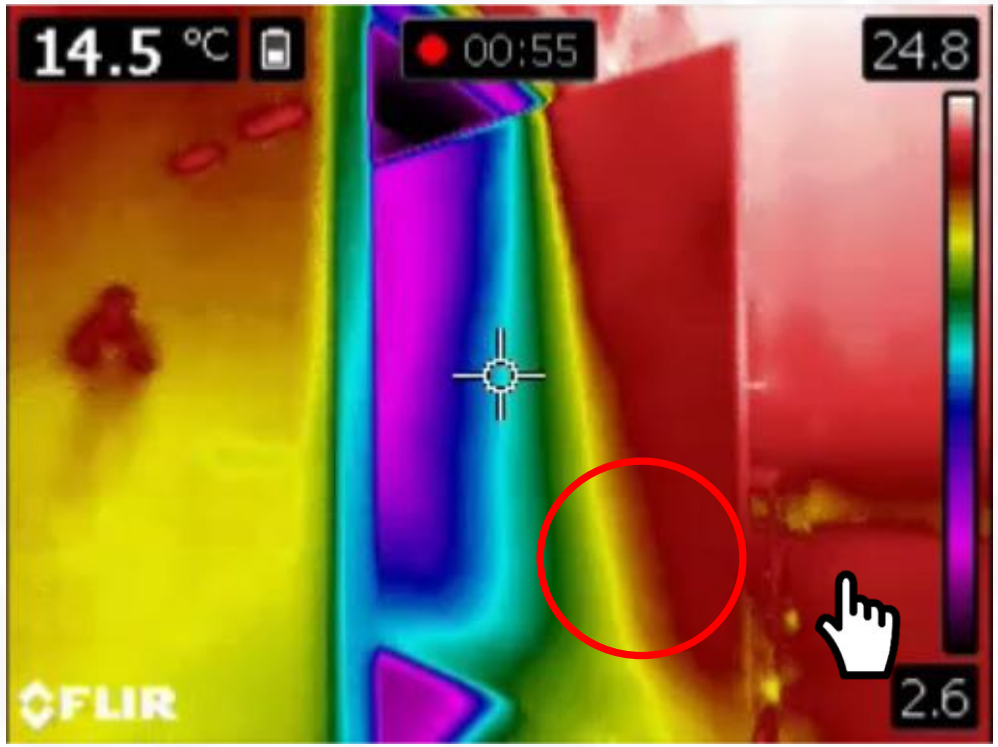
Air curtain with correct air speed



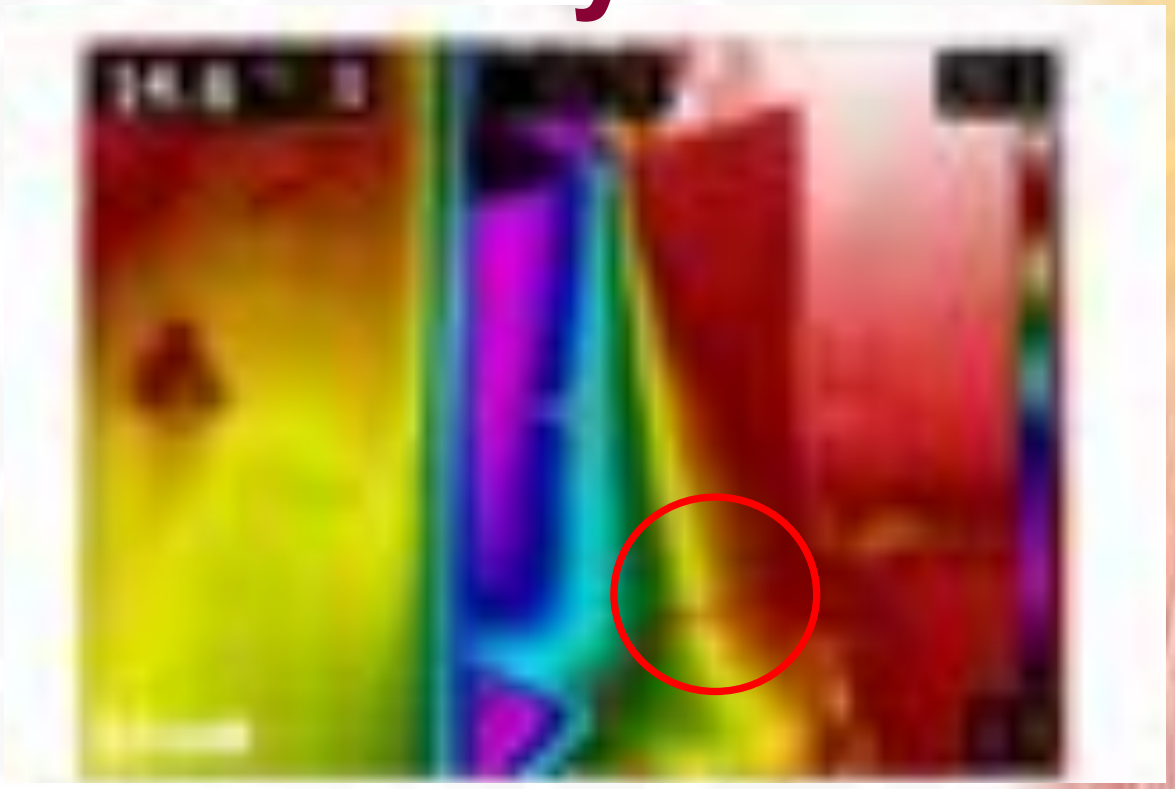
Air curtain with correct air speed

- Distinct air-barrier at the floor

Importance of correct velocity



Air curtain with too high speed

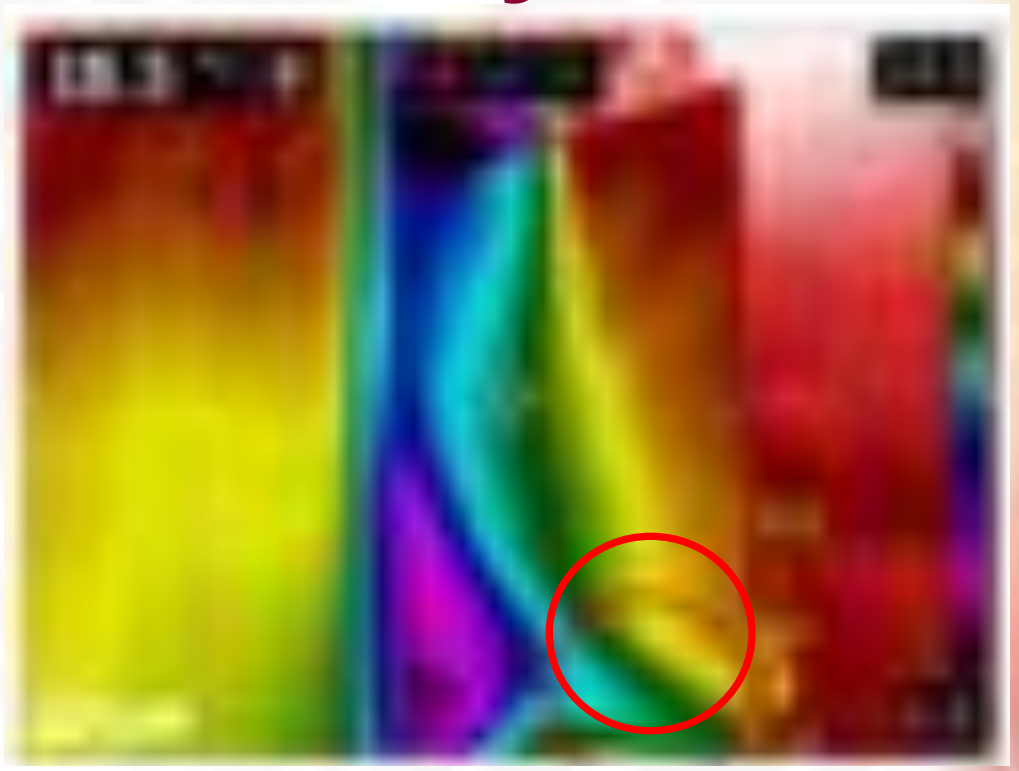


Air curtain with too high speed

- Turbulence at floor level, causing losses

Importance of correct velocity

Air curtain with too low speed



Air curtain with too low speed
The barrier cannot resist stress load

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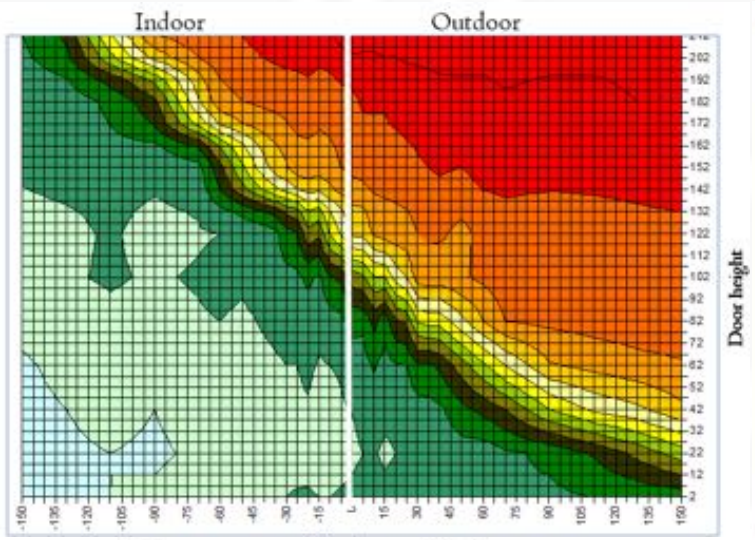
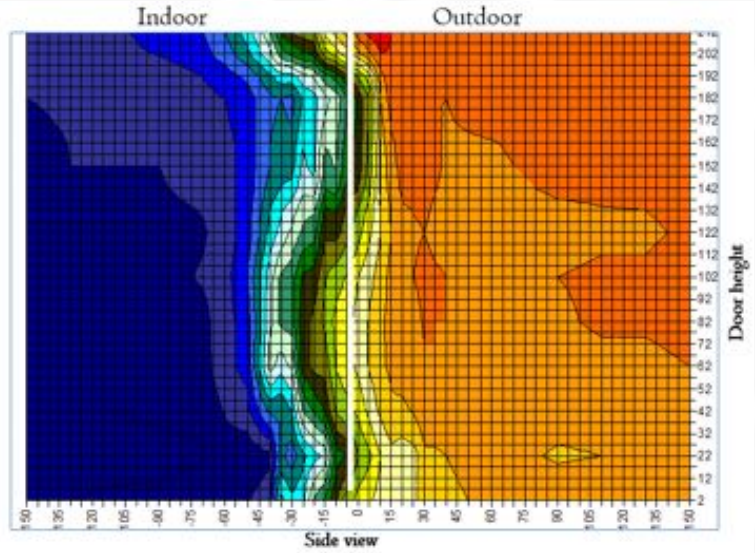
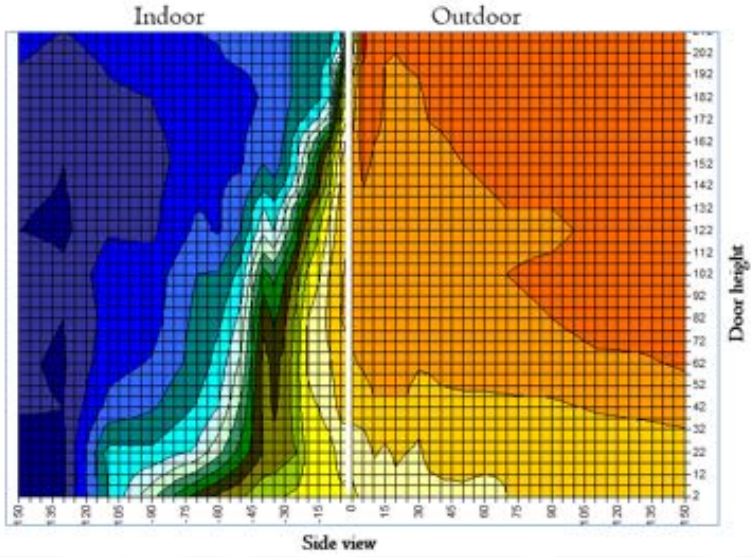
Without air curtain



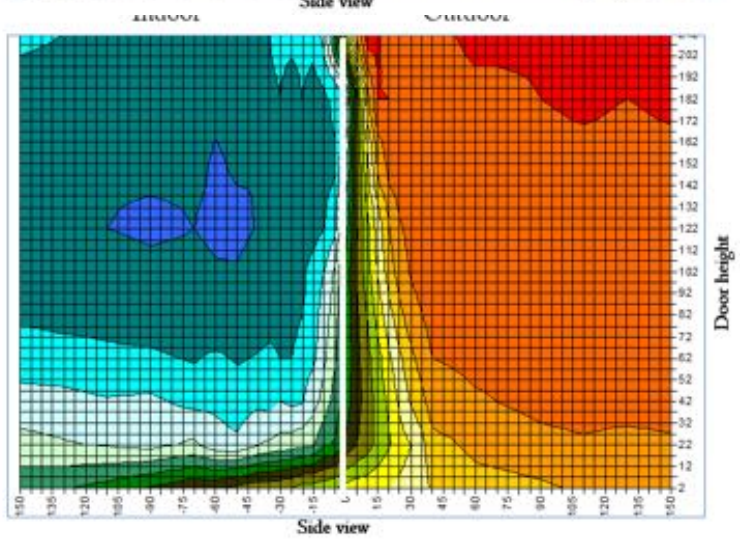
Optimal installation



Wrong angle on outlet



Too high speed



Air Velocity - Air Curtain Standards

INTERNATIONAL STANDARD

ISO 27327-1

First edition
2009-06-15

Fans — Air curtain units —

Part 1:
Laboratory methods of testing for aerodynamic performance rating

Ventilateurs — Rideaux d'air —

Partie 1: Méthodes d'essai en laboratoire des caractéristiques de performance aérodynamique

ISO 27327 establishes uniform methods for laboratory testing of air curtain units to determine aerodynamic performance in terms of:

- airflow rate
- outlet air velocity
- Uniformity
- power consumption
- air velocity projection

for rating or guarantee purposes.

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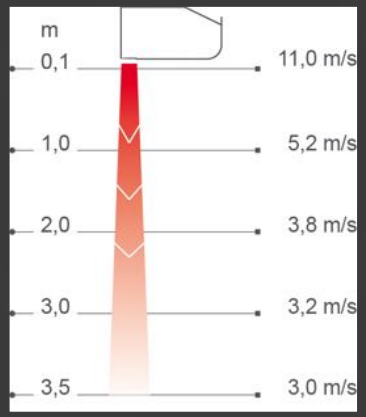
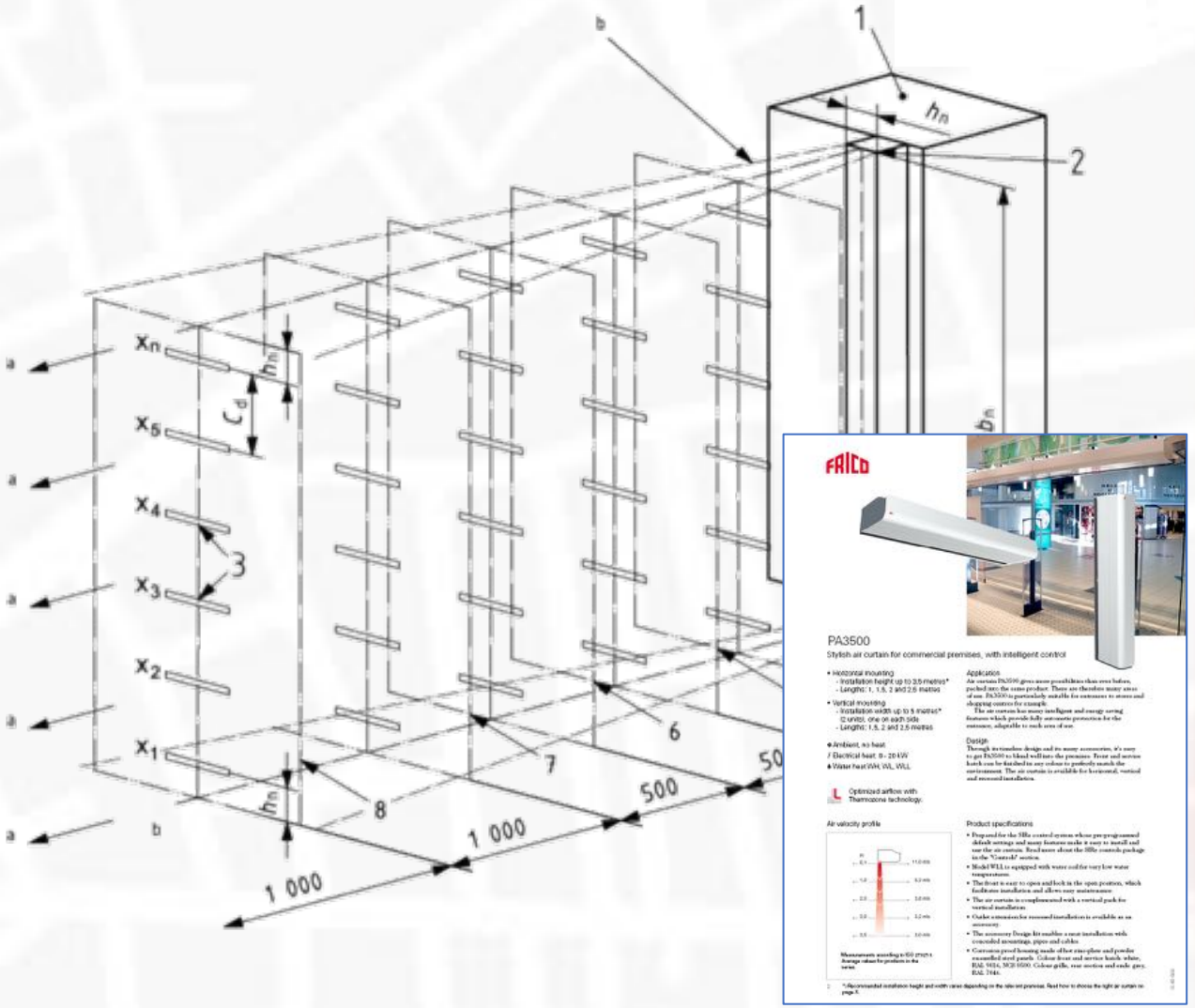
Optimized air curtains for cold storages.

Velocity according to the ISO 27327-1 standard.





Air curtain for cold storage - criteria

- Easy and accurate control of the speed – stepless
- The lowest possible power consumption
- Homogenous air beam

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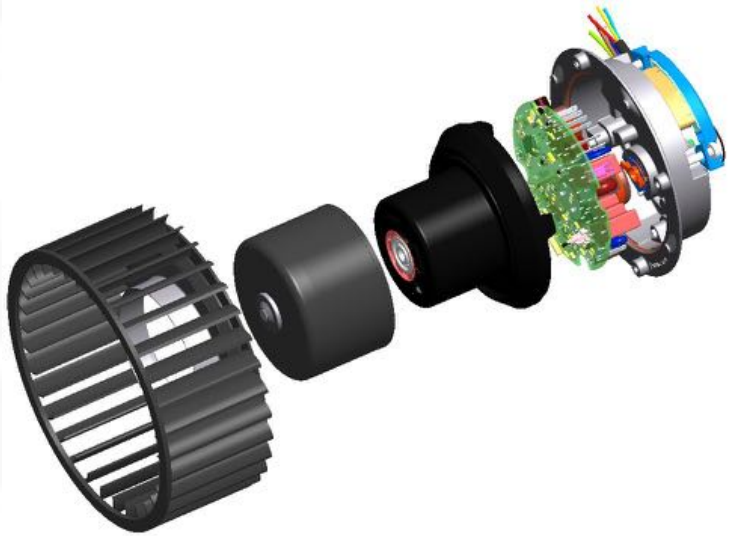
Combining EC-motors with tangential impellers



EC-Motor

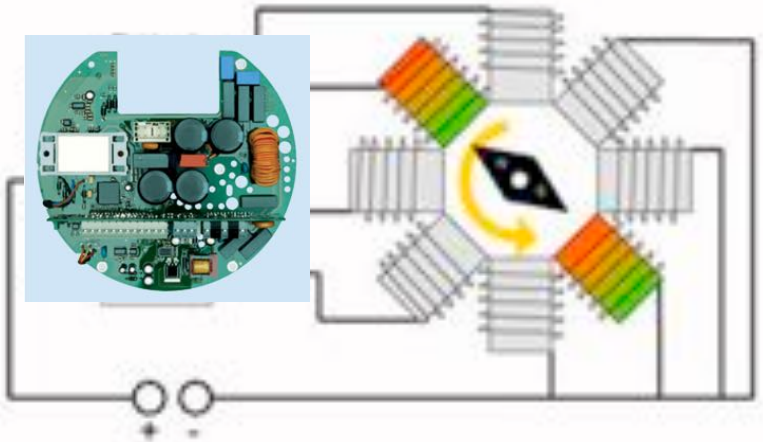
Driven by EC

EC-motor	= electronically commutated motor

Definition: **Commutation** **in power electronics describes the process through which a current passes and flows from one branch to another.**

EC-Motor

- **EC-motors with integrated electronics can be controlled steplessly at the required air volume and have a high efficiency.**



- **The power saving is not only at maximum power, but also especially in lower power operation dependant on demand.**

Example: Duct fan

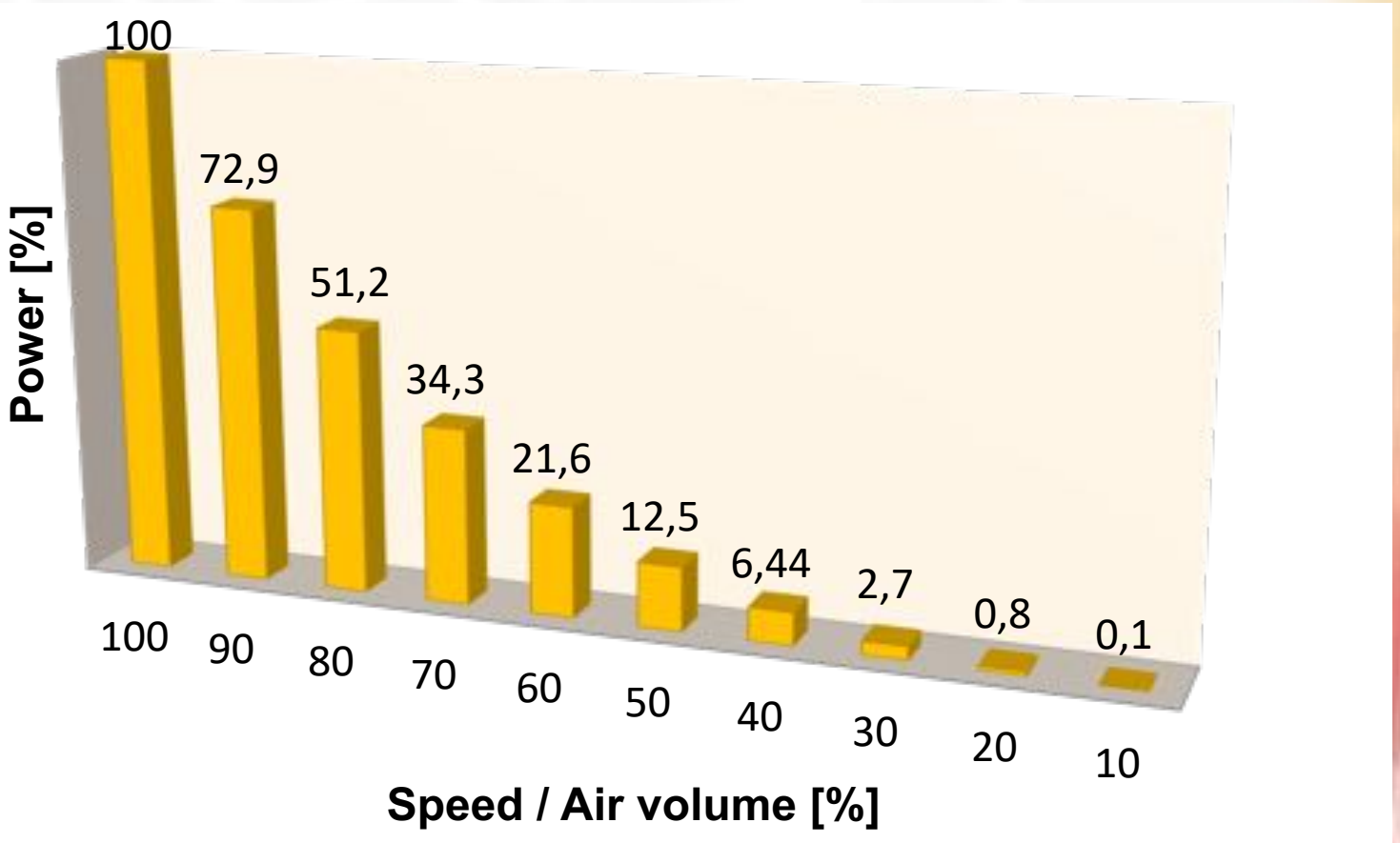
Speed [1/min]	Airvol. [m³/h]	Pressure [Pa]	Power [W]	Savings
2289	**1000**	**250**	**220,00**	**(100%)**
2060	900	203	160,38	-27%
1831	800	160	112,64	-49%
1602	700	123	75,46	-66%
1373	600	90	47,52	-78%
1145	**500**	**63**	**27,50**	**-88%**
916	400	40	14,08	-94%

Fan laws

$V1/V2 = n1/n2$
$p1/p2 = (n1/n2)^2$
$Pw1/Pw2 = (n1/n2)^3$

Power – Speed / Air volume

•MIHU OCT 2016

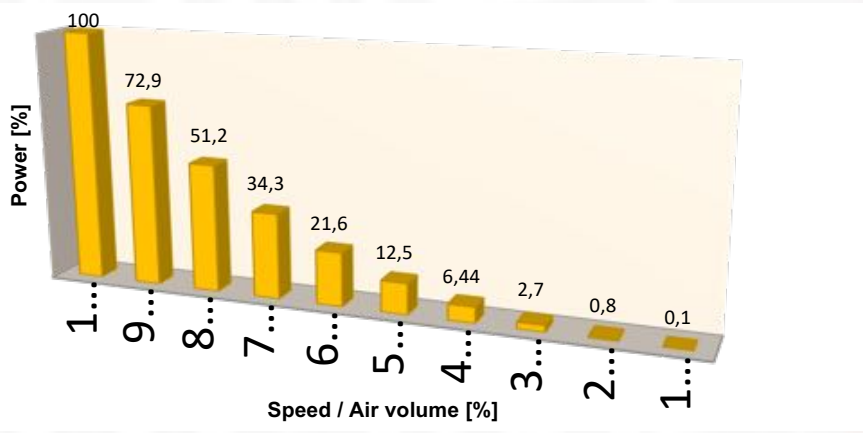


V1/V2 = n1/n2

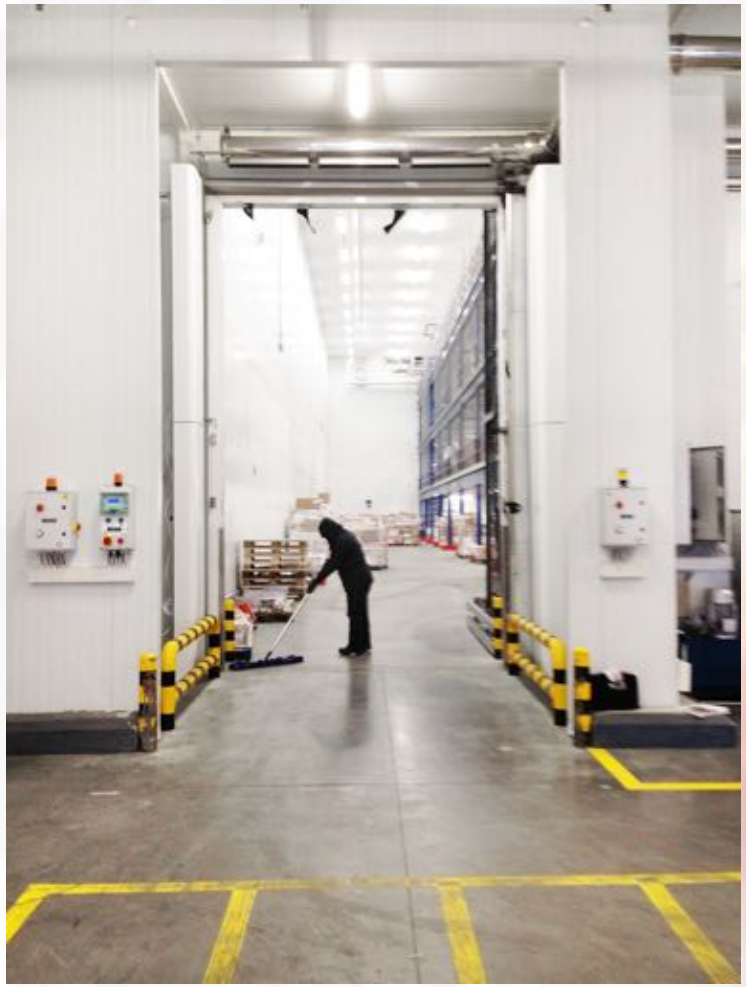
Pw1/Pw2 = (n1/n2)³

Air curtain for cold storage - criteria

- Easy and accurate control of the speed – stepless
- The lowest possible power consumption
- Homogenous air beam



Installation examples



Cold Storage Solutions
Key Take Aways

- **Saving energy**
- **Reducing maintenance**
- **Safer and more hygienic environment**
- **Reducing food waste**
- **Less need for defrost**

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4. Examining the benefits of Air Curtains in Cold Storage applications
5. **Open Discussion**
6. Closing and buffet dinner

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Open Discussion

The rise of new refrigerants: Assets and drawbacks
Commercial refrigeration in hot climate zones: Best practices
Consultants in commercial refrigeration: Core issues and challenges

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Closing remarks

Mr Brian Suggitt, Eurovent ME Chairman
Managing Director Middle East, Systemair AB