WEBINAR

Towards energy efficient retail refrigeration in developing countries

Hosted by:

IIF IIR

UNIDO

Supported by:

KIGALI COOLING EFFICIENCY PROGRAM

Mary Najjuma
Moderator

https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/energy-efficient-and-green-cold-chain

AGENDA

UNIDO/IIR workshop Agenda: (Moderated by Mary Najjuma, UNIDO, Uganda)	
Introduction *Didier Coulomb, IIR General Director*	5 minutes
Barriers for the adoption of energy-efficient technology in the retail refrigeration industry - Survey results *Ina Colombo, IIR Deputy Director*	15 minutes
For an energy efficient and HFC free retail refrigeration *Jacques Guilpart, IIR Honorary member*	20 minutes
Successful case studies of energy efficiency in supermarkets: • UNIDO case studies introduction on the decision-making tree (5 min) How the decision tree can be applied/ used • UNIDO Brazil case study (15 min) Focus: Operation and maintenance of energy efficient refrigeration systems using natural refrigerants in supermarkets. *Rogerio Marson Rodrigues, Refrigeration Engineering Manager Eletrofrio Refrigeração Ltda* • Uganda supermarket manager's reflection on energy efficient cooling options (10 min) Decision making procedure towards adopting energy efficient and HCFC free refrigeration systems for supermarkets in Uganda. *Frank Kasozi, Branch Manager Capital Shoppers Uganda*	30 minutes
Q&A *Moderator*	15 minutes
Closing remarks *Fukuya Iino, PhD, Industrial Development Officer, UNIDO*	5 minutes

Barriers for the adoption of energy-efficient technology in the retail refrigeration industry - Survey results

	No of countries	No of responses
Article 5	36	84
Non Article 5	17	70
Total	53	154

Country	no of responses
France	18
Uganda	13
Italy	11
Tunisia and United States	7
Antigua and Barbuda	6
Canada	5
United Kingdom	5
Brazil, India and South Africa	4

56%: Consultants and academics

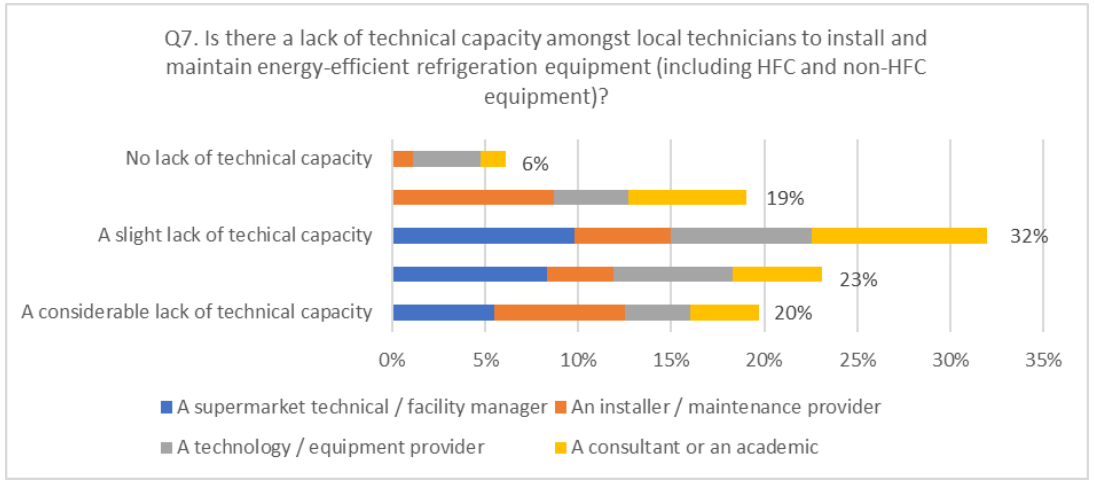
5%: Supermarket technical / facility managers

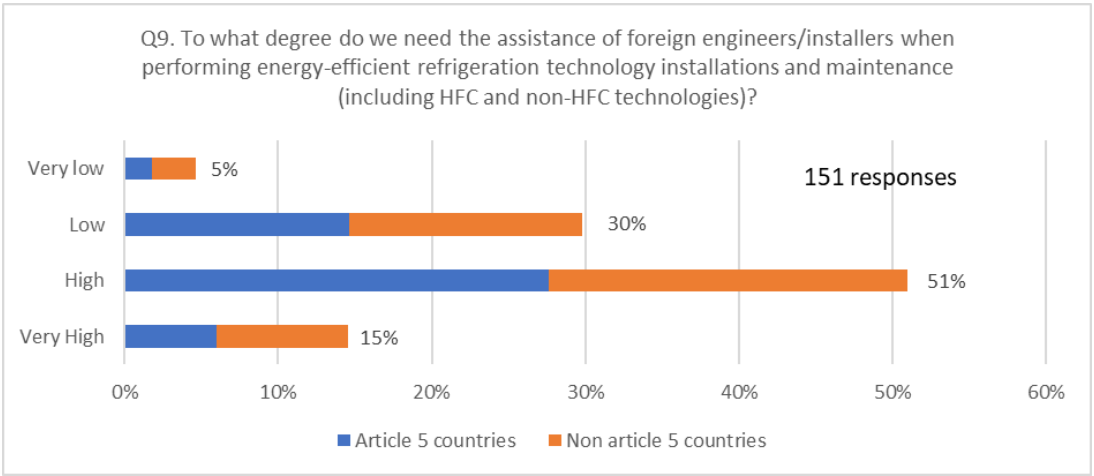
22%: Technology providers

18%: installers

38% have already been involved in energy efficiency actions in retail refrigeration, and 53% are interested in being involved in such actions

Survey Results: Technical Barriers

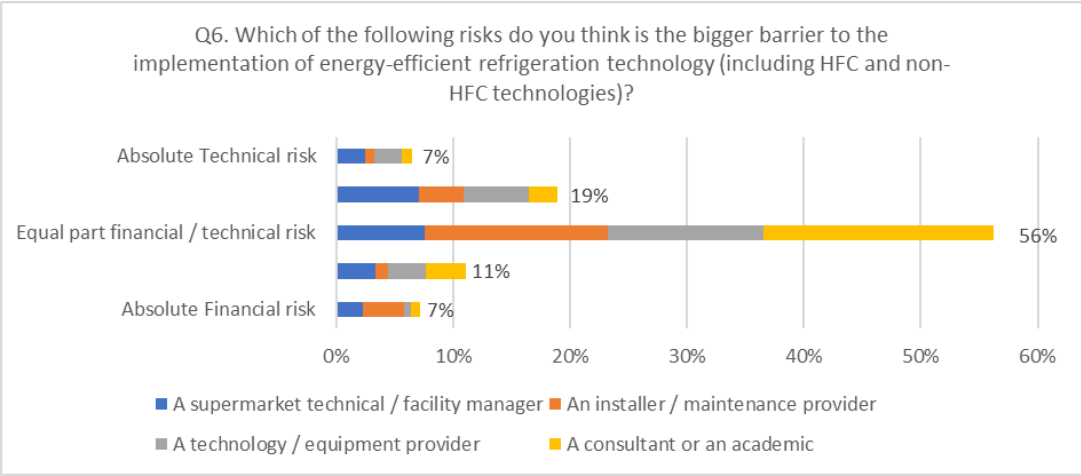




Related to the lack of local technicians to ensure the commissioning and maintenance of non-conventional refrigeration installations

Survey Results: Social Barriers

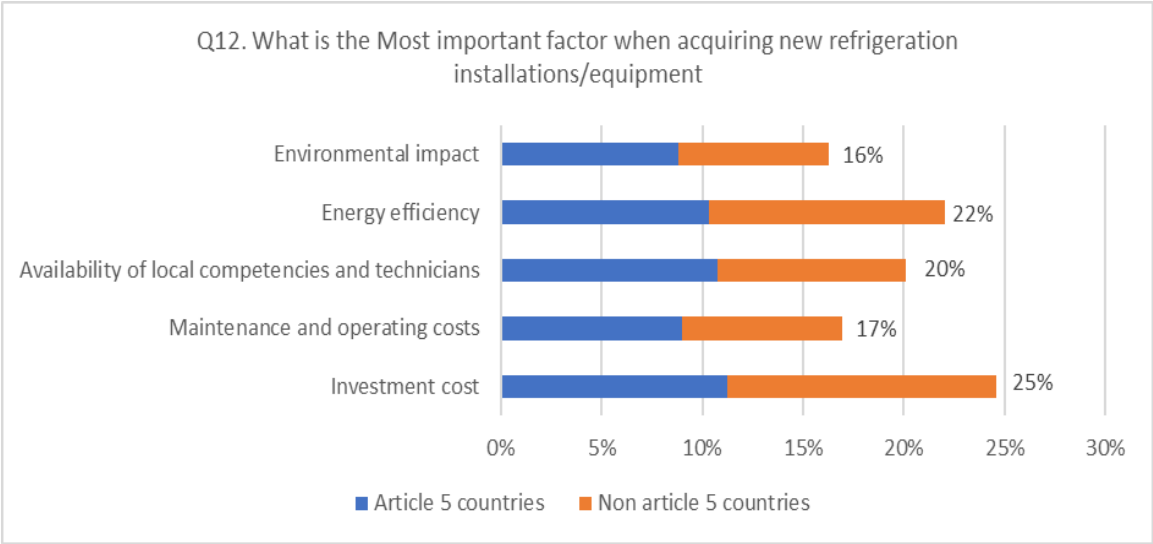
Related to the acceptance of the risk associated with investing in a "new" technology: *the adoption of energy-efficient technologies in retail refrigeration encompasses both technical and financial risks in equal parts*



The perception of disruptive technologies (such as solar cooling, tritherm systems and adiabatic cooling) were cautious with many responders replying; "I don't know" or "not suitable for my country". Responses were more positive in relation to conventional technologies based on low GWP, CO_2, ammonia or hydrocarbons.

Survey Results: Economic Barriers

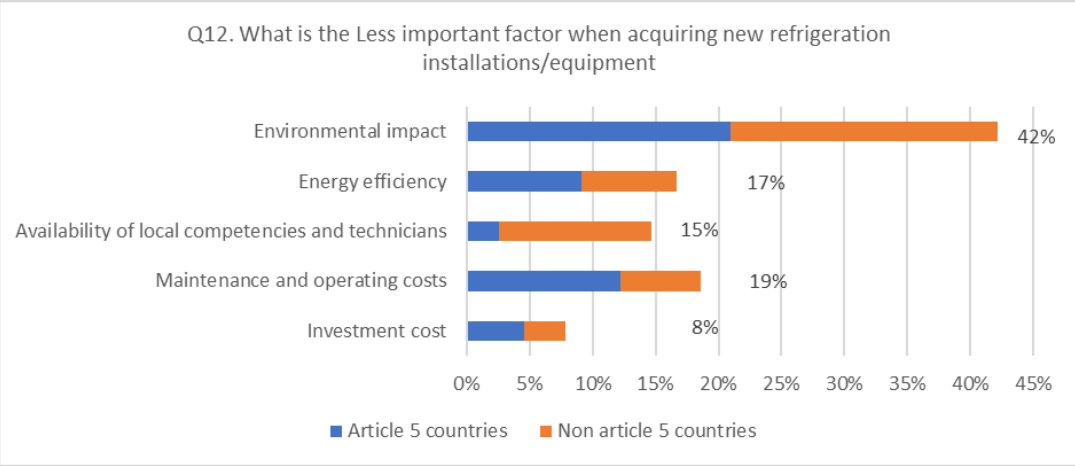
Mainly related to the cost of the investment, which was considered as the most important factor when acquiring new refrigeration installations/equipment by 25% of respondents.

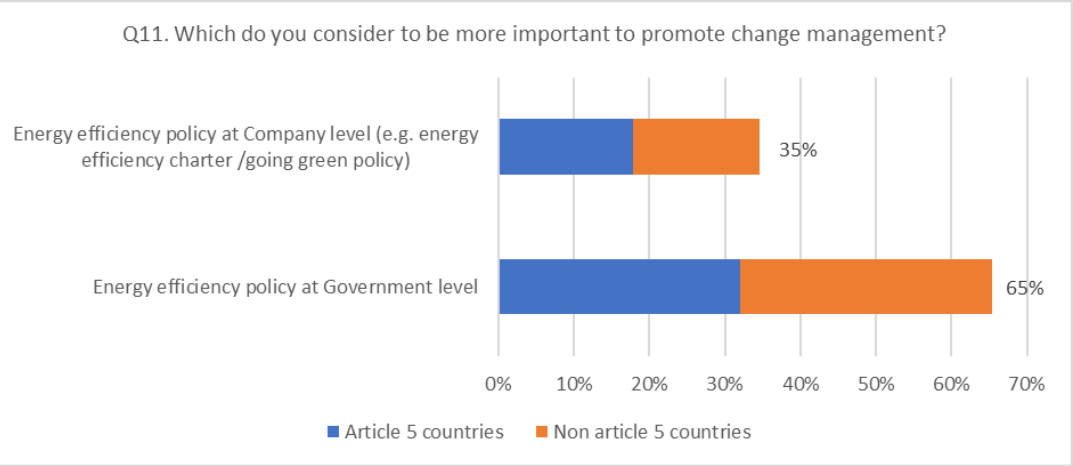


Barriers for the adoption of energy-efficient technology in the retail refrigeration industry - Survey results

Large majority (57%) of respondents agree that the environmental impact was not at all important when acquiring new refrigeration installations/equipment

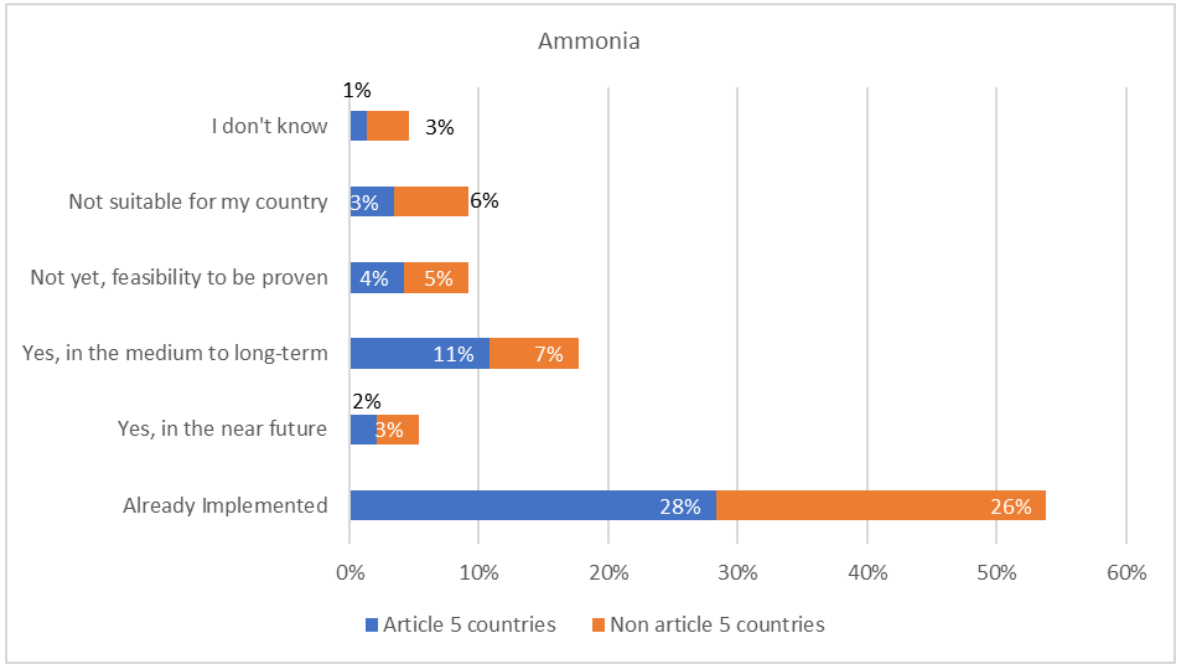
To promote change, 65% of respondents believed that implementing government energy efficiency policies is the best way to proceed, while 35% believed more in corporate policies



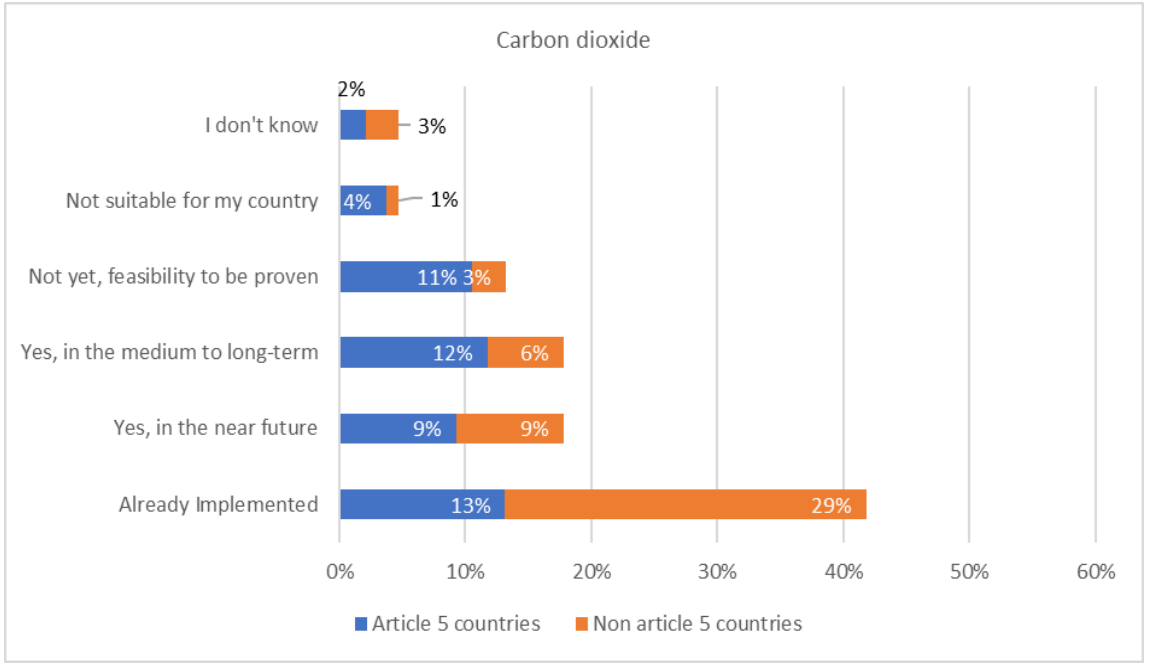


What retail refrigeration technology for the future?

Ammonia

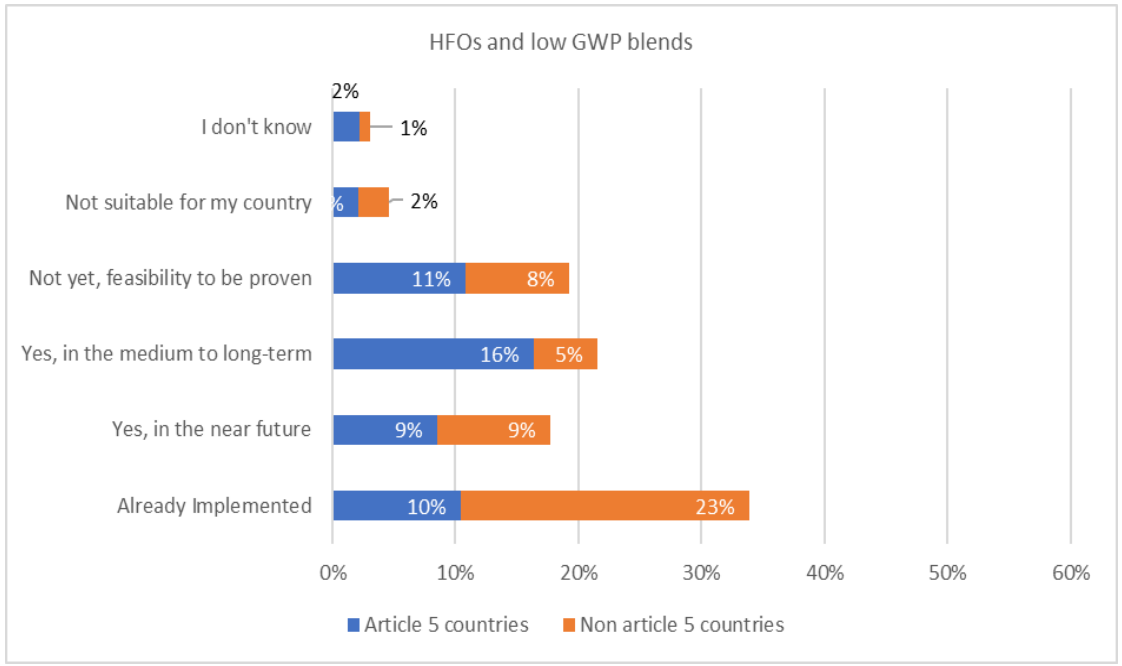


Carbon dioxide

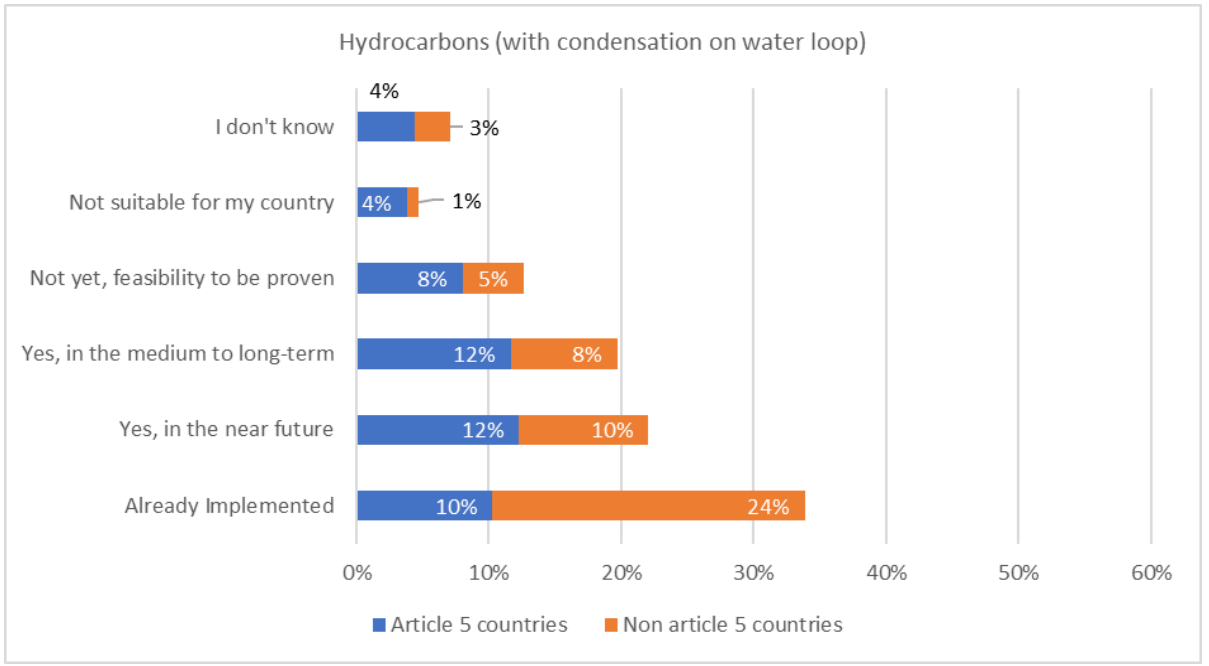


What retail refrigeration technology for the future?

HFOs and Low-GWP



Hydrocarbons



What retail refrigeration technology for the future?

The position of respondents regarding other possible technologies (tritherm systems , adiabatic cooling and solar systems) was more mitigated : The answers “feasibility to be proven”, “not suitable for my country” or “I don’t know” were in the majority. Please note that the adiabatic cooling of condensers is considered to be already implemented by 24% of respondents from Article 5 countries and 9% from non-Article 5 countries.

Conclusion

- The “conventional” technologies (in order: ammonia , carbon dioxide, HFO/low-GWP blends, and hydrocarbons) were already being implemented in Article 5 countries according to the majority of respondents, as well as for respondents from non-Article 5 countries. Industrial only???
- The development of these technologies to replace old HFC systems is expected in the future, none of them were definitely assessed as “not suitable for my country”.
- Demonstration actions proving the feasibility of these techniques was expected, mainly for HFO/low GWP blends and for CO_2.
- Confidence in the future of other “disruptive” technologies seems rather low, as these technologies required proof of feasibility or are assessed as “not suitable for my country”; most likely due to the lack of knowledge of these technologies.

Introduction

Refrigeration count for 50 % of supermarket's energy bill and up to 70% for convenience stores

It uses refrigerants presenting a high environmental impact

(when released in atmosphere, 1 kg of R404A refrigerant present a warming impact equivalent to 3 920 kg of CO2)

The question is: how to reduce the energy consumption and the environmental impact of retail refrigeration, and especially in Article 5 countries where specific constraints apply.

First response : 1- the best way to make energy savings is to reduce the demand

« the cheapest energy is the energy that is not consumed »

2- avoid leaks and properly maintain your installations

Second response : Use efficient refrigeration systems working with refrigerants presenting a low environmental impact

London South Bank University

i-STUTE

Technological Options for Retail Refrigeration

Authors: A. Foster, E. Hammond, T. Brown, G. Maidment, J. Evans

INTERNATIONAL INSTITUTE OF REFRIGERATION

www.iifiir.org

An excellent IIR reference to help you in selecting the most efficient and environmentally friendly refrigeration technologies

available on https://iifiir.org/

How to reduce the energy demand in retail refrigeration?

A refrigeration balance on display cabinets indicate that:

1- Air infiltration in the cabinet is responsible of the major heat and moisture load

⇒ Install doors, night blinds, …

(efficient doors reduces the demand up to 50% of the refrigeration demand)

Credit photo : Energie+

Doors on display cabinets : a key action for energy savings

2- Lighting is responsible of approx. 10% of the heat load

⇒ Change for efficient lightening (high efficiency fluorescent tubes, LED lights). Using led lights reduces the refrigeration demand up to 6 – 7 %

3- Fans on evaporator represent an important part of the heat balance

⇒ The use efficient fans reduces the refrigeration demand up to 4 – 5%

How to reduce the energy demand in retail refrigeration ?

Number of other energy savings suggestions are proposed in the literature

(defrost control, strip heaters control, radiant heat reflectors, … see IIR reference above)

Install (or invest in) these efficient devices in event of a retrofit of your display aera is the best way to reduce the refrigeration demand and consequently the energy demand of your retail refrigeration system.

It is also proved that

⇒ A smart preventive maintenance could lead to 10 – 15% additional savings

(condenser cleaning, pressure/temperature control, …)

=> The formation of collaborators and their sensibilization to energy could add 2 – 5% additional savings

(loading procedure, check door closing, switch lights off, pull night curtains, …)

What priorities in order to make energy savings ?

Most of these quick-wins options can be implemented during a retrofit of your sales aera ,

do not deprive yourself of it!

This ranking proposition integrates:

A technical score including

Ease of installation

Availability of components

Maintainability

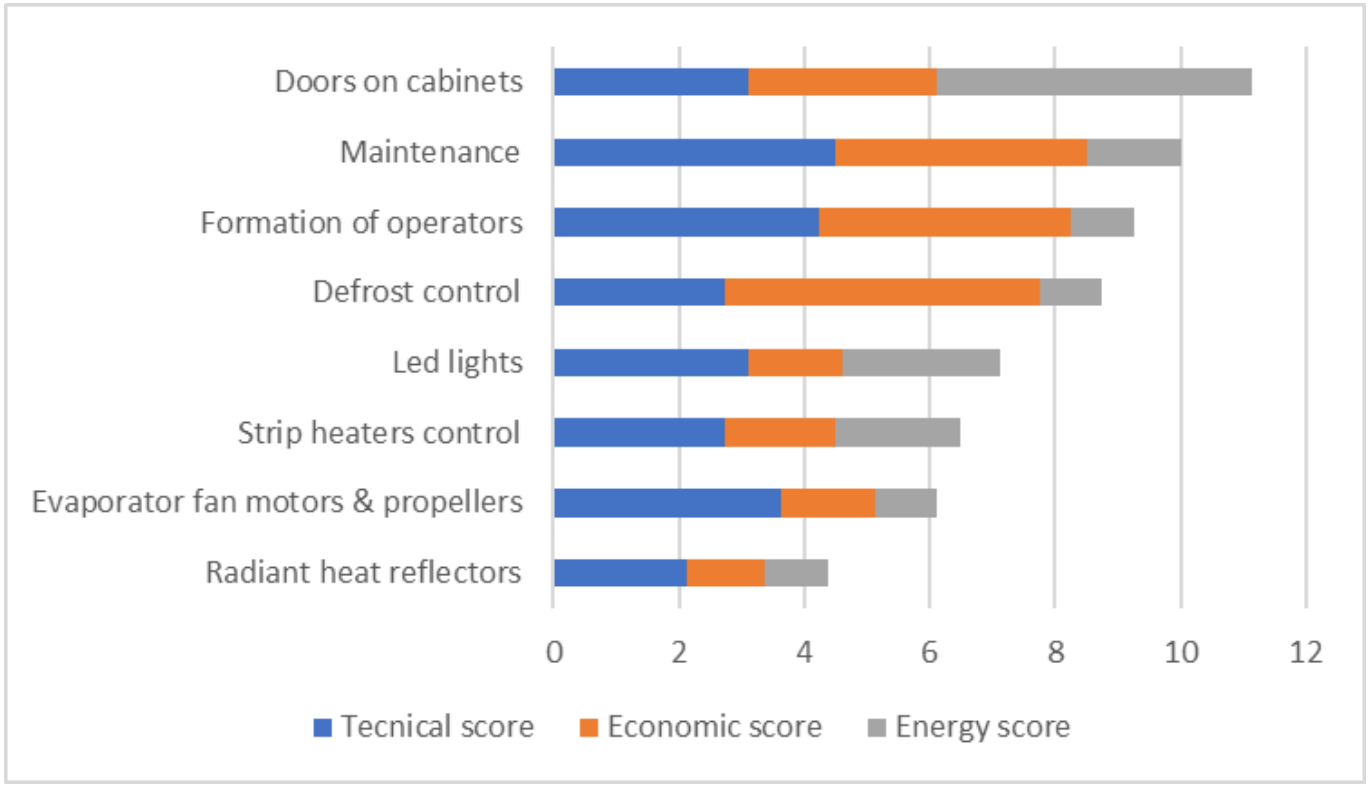
Required technicity

An economic score including

Investment cost

Payback time

And an energy score



How to reduce the environmental impact?

Of course, reduce the demand (see above)

Prevent the leakages

Annual leakage rates of 25 – 30% are common in retail refrigeration

- It has a direct cost (refilling)
- It has a huge impact on the climate change (global warming)

Improve your maintenance (periodic leakage detection, immediate corrective action)

Use efficient refrigeration systems working with low GWP refrigerants

….

Credit photo : Shecco – EIA - KCEP

Use efficient refrigeration systems working with low GWP refrigerants

There are not many solutions:

1. Use low GWP refrigerants (pure or blends)
   - Retrofit your installation and use new « chemical » refrigerants

     (if technically feasible; if not, change your installation)
   - Use « natural » refrigerants such as NH3, CO2 or hydrocarbons

In all cases, implement efficient technologies based on variable pressures, variable speed devices on fans, compressors and pumps, use of EC motors, internal heat exchangers, promote heat recovery, etc. …

2. Use alternative technologies

   Solar cooling

   Tritherm systems

   Magnetic cooling / thermoelectric cooling

Not mature yet
Large scale feasibility to be proven for retail refrigeration
Prohibitive CAPEX

1st possibility : Use low GWP refrigerants (pure or blends)

Retrofit (if technically feasible) or change to a new installation

- ☞ The cheapest solution.
- ☞ Requires relatively low technicity (accessible by most maintenance providers)
- ☞ The possible options for the replacement of R22 or of the R404A are at present numerous. Some of them are HFC blends. Some other HFO/HFC or HFO/HC blends.
- ☞ Depending on the refrigerant, and compared to old refrigerants, this solution could lead to a slight increase or decrease of the energy consumption (plus or minus 10 – 15%)
- ☞ If the GWP of the present option is much lower than the GWP of old refrigerants, it is still much higher than those of “natural” refrigerants.

Credit photo : Dehon

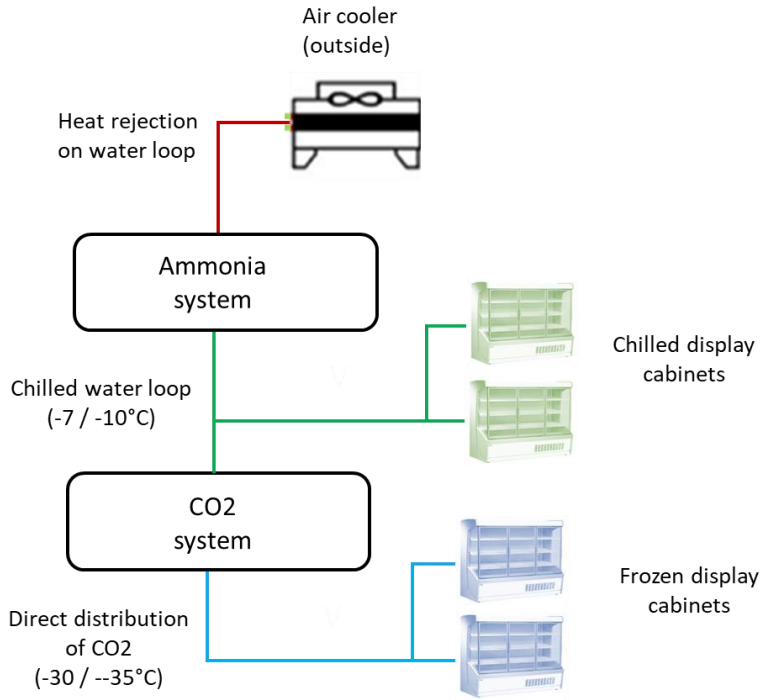
Typical rack of compressors working with low GWP blend

=> A possible choice for stakeholders who do not (want to) have a long-term vision of the supermarkets they manage.

2nd possibility : Use “Natural” refrigerants

Ammonia on waterloop

- ☞ Is an old and efficient solution.
- ☞ Due to its toxicity and its low flammability,
  - its use in retail refrigeration is limited (sometimes by national regulation)
  - it requires a somewhat high-level technicity
  - consequently, investment costs are somewhat higher than classical refrigerants (+20 / +30%)
  - Its use in retail requires the use of secondary coolant loops (mandatory on cold side, recommended on hot side)



Basic principle of an ammonia system in supermarket

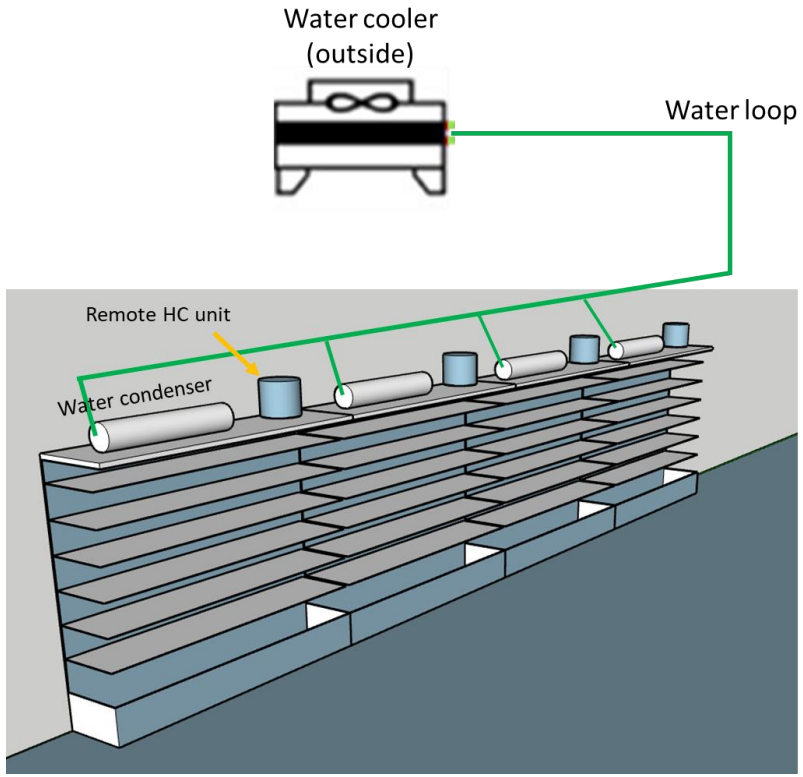
- ☞ Consequently, the performance of ammonia systems in retail leads to energy consumption similar or slightly lower than those with old techniques.
- ☞ For low temperature display cabinets where low temperature secondary coolants are not applicable, a condensation of CO2 or HC on chilled water loop may be advantageously used.

=> Proven reliability and guaranteed sustainability

2nd possibility : Use “natural” refrigerants

Hydrocarbon on heat rejection loop

- ☞ Is an efficient solution, easy to implement.
- ☞ Due to its high flammability,
  - its use in retail refrigeration is limited (sometimes by national regulation)
  - it requires the use of remote units, with heat rejection on water loop
  - consequently, investment costs are slightly higher than classical refrigerants (+10 / +20%)
- ☞ A smart design of the heat rejection loops allows an interesting flexibility of the organization of the sales areas
- ☞ Thanks to the direct expansion in evaporators, it delivers interesting energy performances (5 – 10% lower than those obtained with old refrigerants).



Basic principle of a heat rejection loop

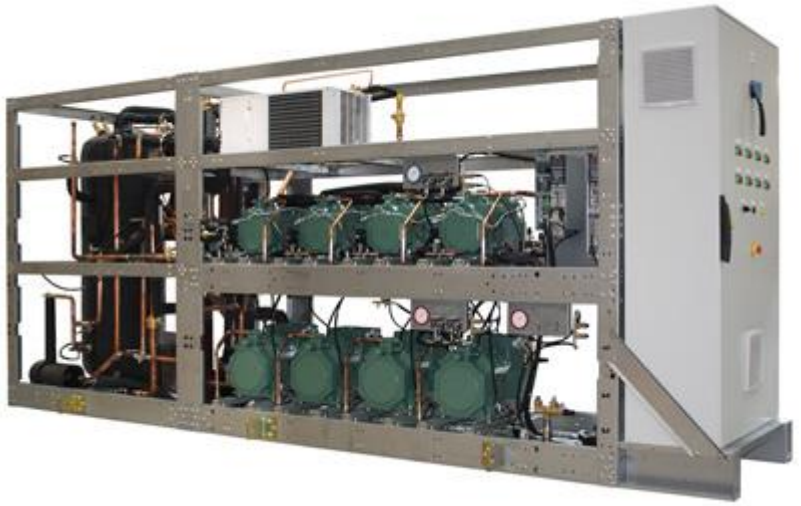
=> Proven reliability and guaranteed sustainability,

Specialized technicians are indispensable to achieve a reasonable safety level.

2nd possibility : use “natural” refrigerants

Carbon dioxide

- Is an interesting alternative.
- Due to its thermodynamic particularities (especially its critical point)
  - all other things being equal, its energy efficiency remains lower than those obtained with other refrigerants
  - to mitigate this disadvantage, the use of refrigeration cycles more complex than those used with classical refrigerants is mandatory (parallel or series compression, double expansion, use of ejectors, …)
- It results in
  - the necessity of a high technicity which is being appropriated by an increasing number of refrigeration technicians,
  - Investment costs are slightly higher than classical refrigerants (+20% / +30%)



Credit photo : Profoid

Typical two stage transcritical CO2 unit

For an energy efficient and HFC-free retail refrigeration

What solution for supermarket stakeholders ?

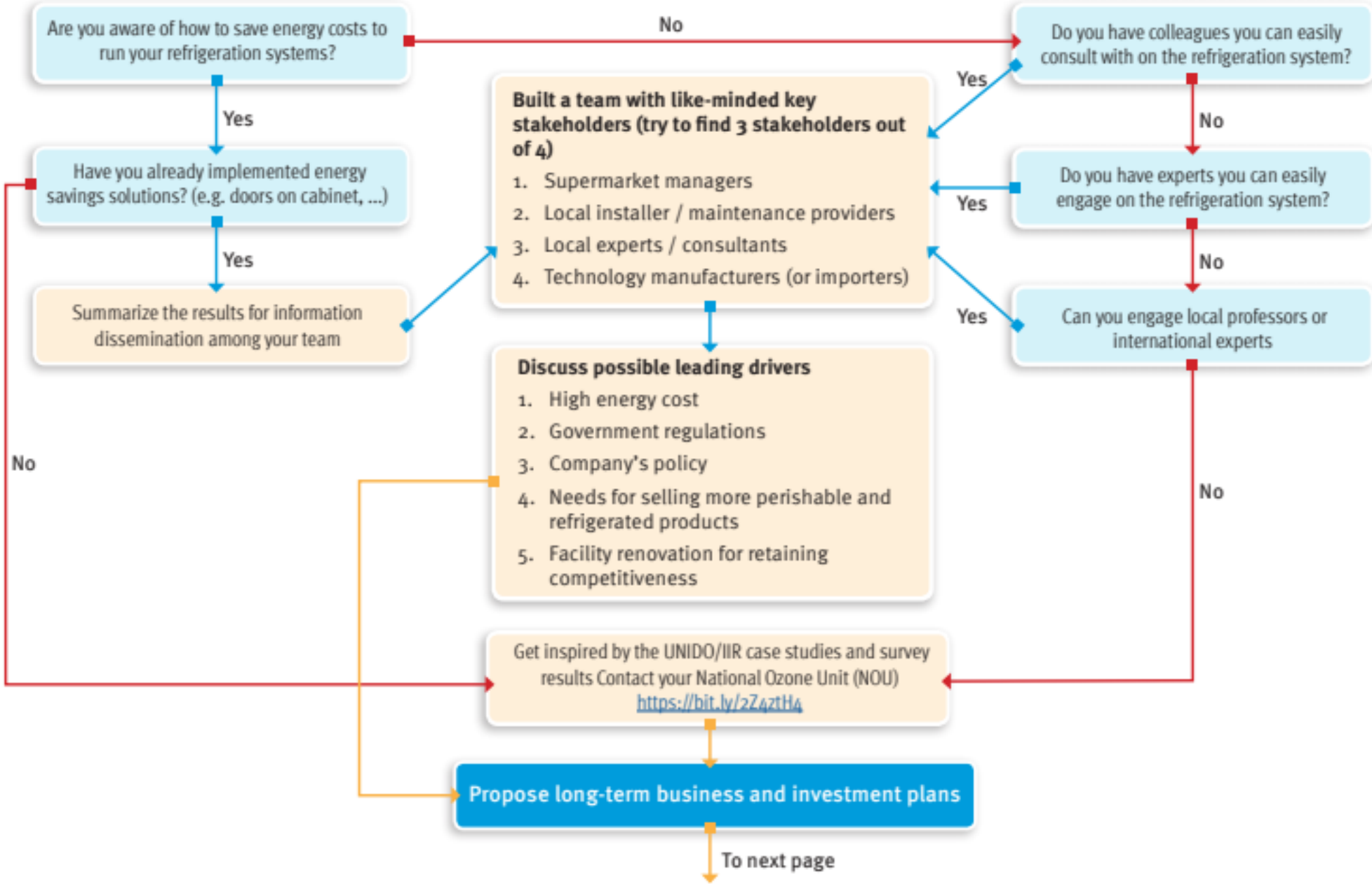
☞ The best choice depends on your priority and on your constraints.

You need to ask yourself some questions in order to identify the possible options :

- Does your refrigeration need a deep change? Why?
- Did you already implement energy savings options in display cabinets (doors on cabinets, …)?
- Is the investment cost a major constraints for you?
- Are you concerned about the environmental impact of your supermarket?
- Do you have technicians, maintainers and technical competencies around you?
- Is the supply of spare parts and components a problem for you?
- Are you reluctant to call on strangers' installers and maintenance providers to do the job?
- What is the state of regulations on refrigerants in your country?

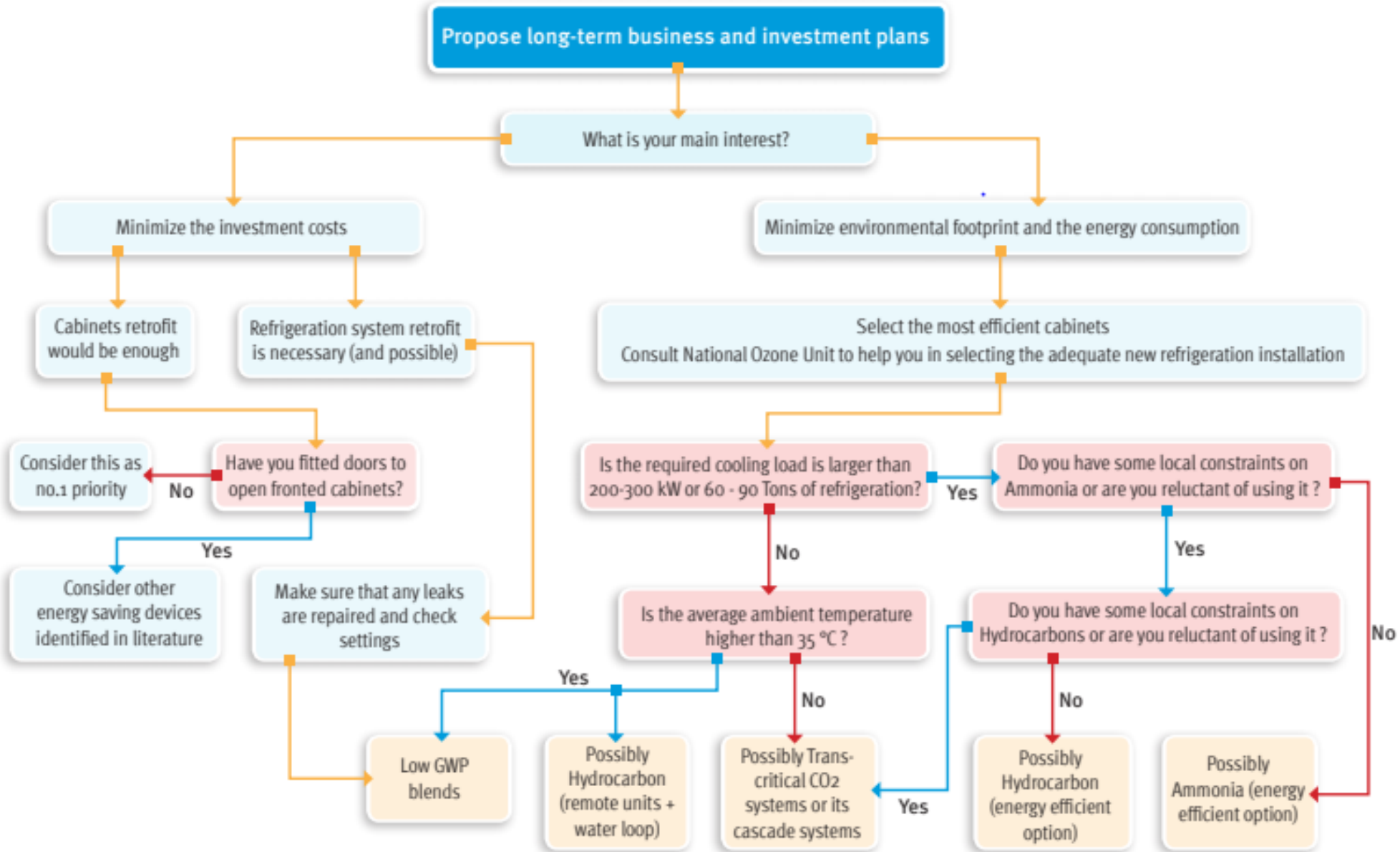
Decision **Tree**

1- Get to know your environment to get closer to competent people



2- Make the adequate technical choice, depending on your technical environment

(availability of local competencies, maintenance, components, ...)



Successful case studies of energy efficiency in supermarkets

Brazil case study:
Condor supermarket

Rogerio Marson Rodrigues, Refrigeration Engineering Manager Eletrofrio Refrigeração Ltda, Brazil

PROPANE CHILLER PROJECT
R290

ELETROFRIO
REFRIGERAÇÃO

PARTNERS:

UNIDO ORGANIZAÇÃO DAS NAÇÕES UNIDAS PARA O DESENVOLVIMENTO INDUSTRIAL

MINISTÉRIO DO MEIO AMBIENTE

PÁTRIA AMADA BRASIL GOVERNO FEDERAL

ROGÉRIO MARSON RODRIGUES – MECHANICAL ENGINEER
ENGINEERING MANAGER AT ELETROFRIO - BRAZIL

Graduated in Industrial Mechanical Engineering in 1990 from the School of Industrial Engineering of São José dos Campos, Brazil. He worked for 8 years with Clean Room projects and facilities for the pharmaceutical and electronic industries. For 23 years he has worked at Eletrofrio Refrigeração Ltda as a Refrigeration Engineering Manager, focused on the design and manufacture of refrigeration machines and systems for supermarkets and storage. In recent years he has been dedicated to the development of refrigeration system solutions with natural fluids for application in commercial refrigeration.

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REFRIGERAÇÃO

- ✓ **MONTREAL PROTOCOL**
- ✓ **KIGALI AMENDMENT**

ELETROFRIO
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HCFC

SYNTHETIC GAS

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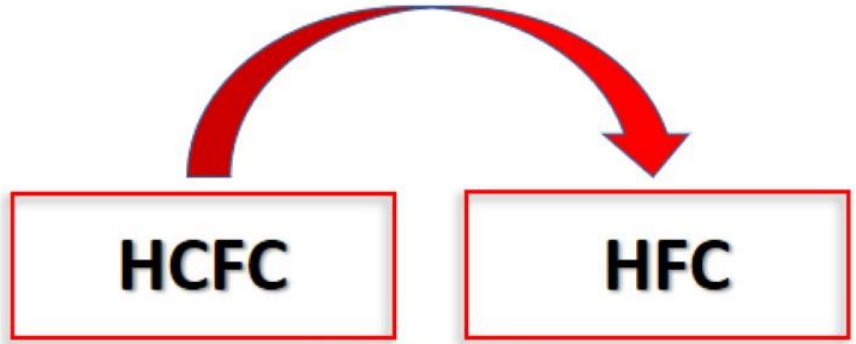
REFRIGERAÇÃO



SYNTHETIC GAS

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REFRIGERAÇÃO

HCFC

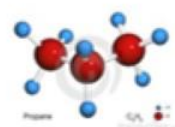
HFC

SYNTHETIC REFRIGERANTS

NATURAL REFRIGERANTS

CO_2

PROPANE



AMMONIA

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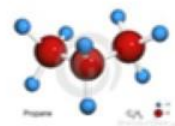
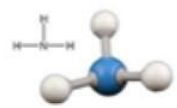
HCFC **HFC**

SYNTHETIC REFRIGERANTS

NATURAL REFRIGERANTS

CO_2	PROPANE	AMMONIA
		
HIGH PRESSURE	FLAMMABLE	TOXIC

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STANDARD HCFC/HFC RACK

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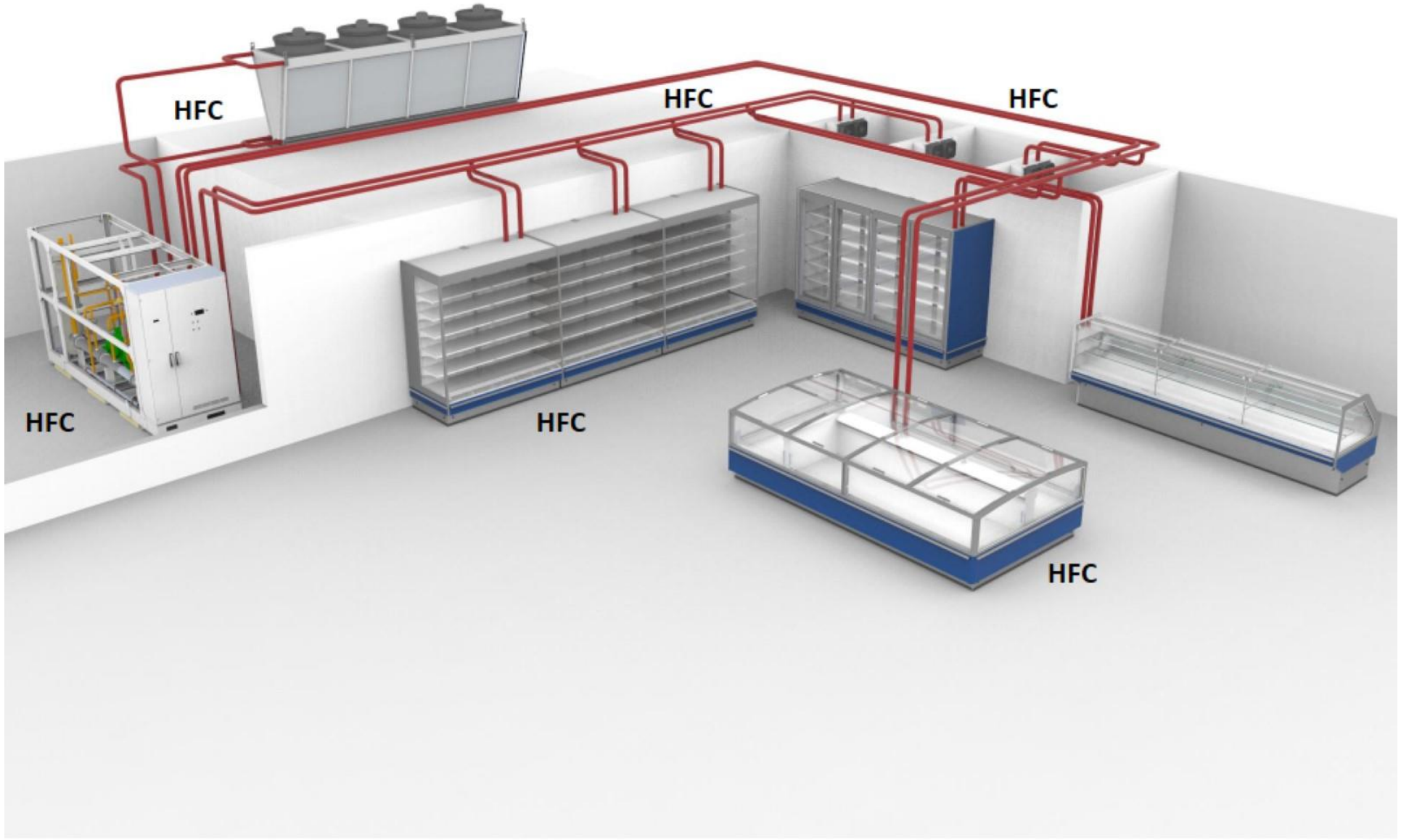
TRADITIONAL SUPERMARKET WITH HFC



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PROPANE CHILLER RACK

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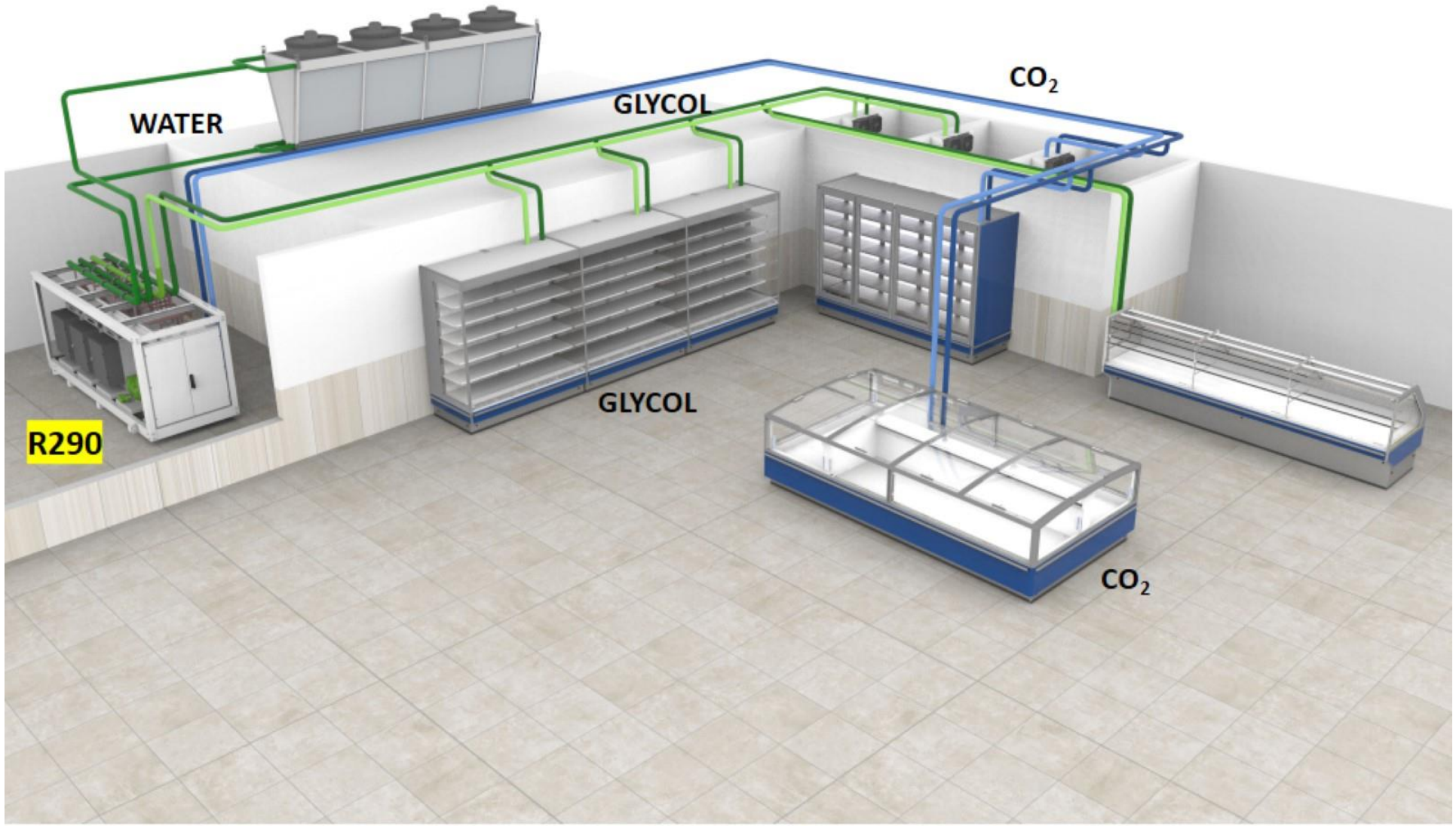
SUPERMARKET WITH PROPANE AND NATURAL REFRIGERANTS



ELETROFRIO
REFRIGERAÇÃO

EUROPE


TERIE
CHARCUTERIE
CHARCUTERIE
CHARCUTERIE
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CHARCUTERIE
CHARCUTERIE
CHARCUTERIE
CHARCUTERIE
CHARCUTERIE


GRUNDFOS
GRUNDFOS
GRUNDFOS
GRUNDFOS


GÜNTNERprofile

ELETROFRIO
REFRIGERAÇÃO

USA


WHOLE FOODS MARKET

ELETROFRIO
REFRIGERAÇÃO

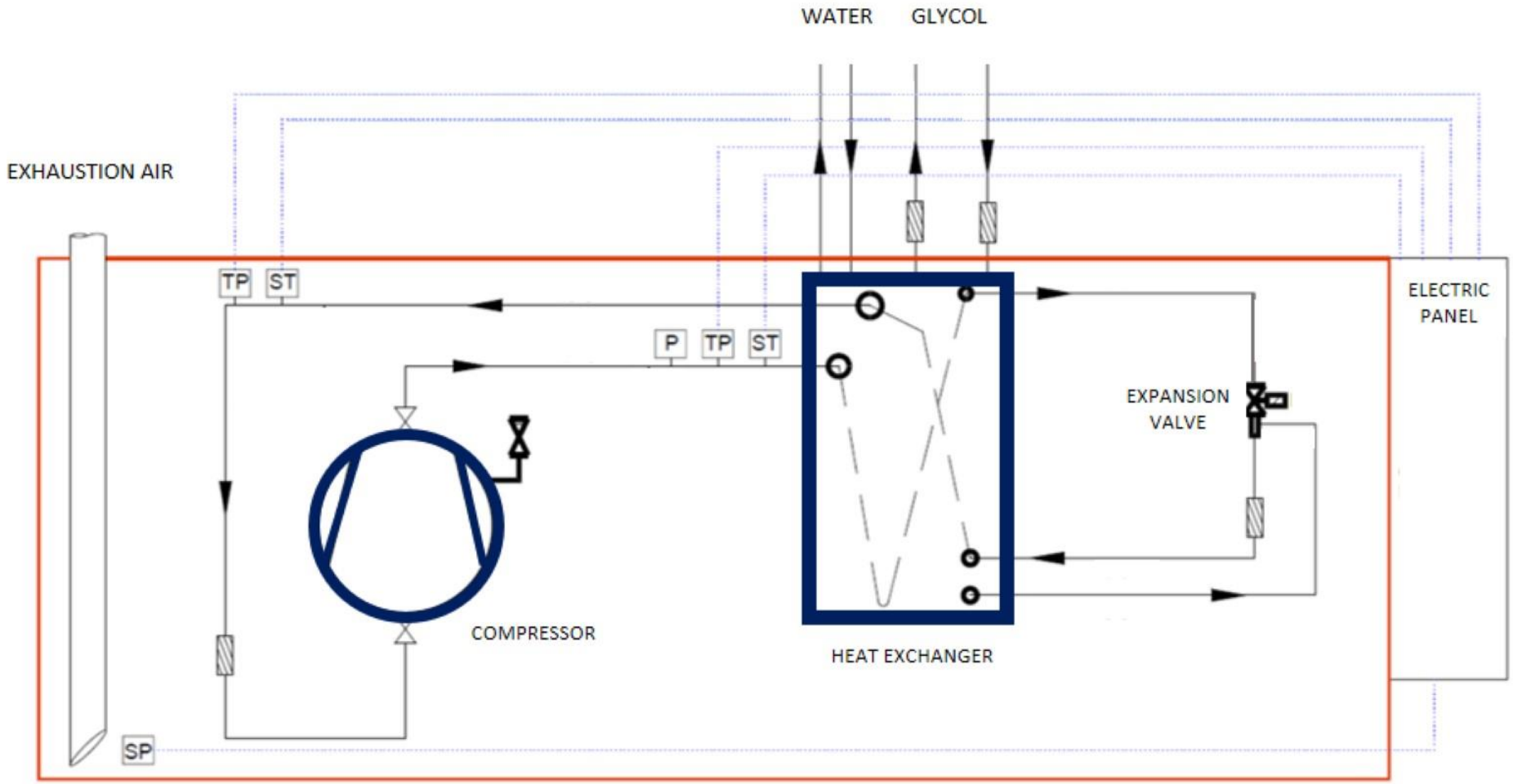
CO_2 rack inside building

ELETROFRIO
REFRIGERAÇÃO

PROPANE CHILLER

ELETROFRIO
REFRIGERAÇÃO

REFRIGERATION SYSTEM SCHEMATIC



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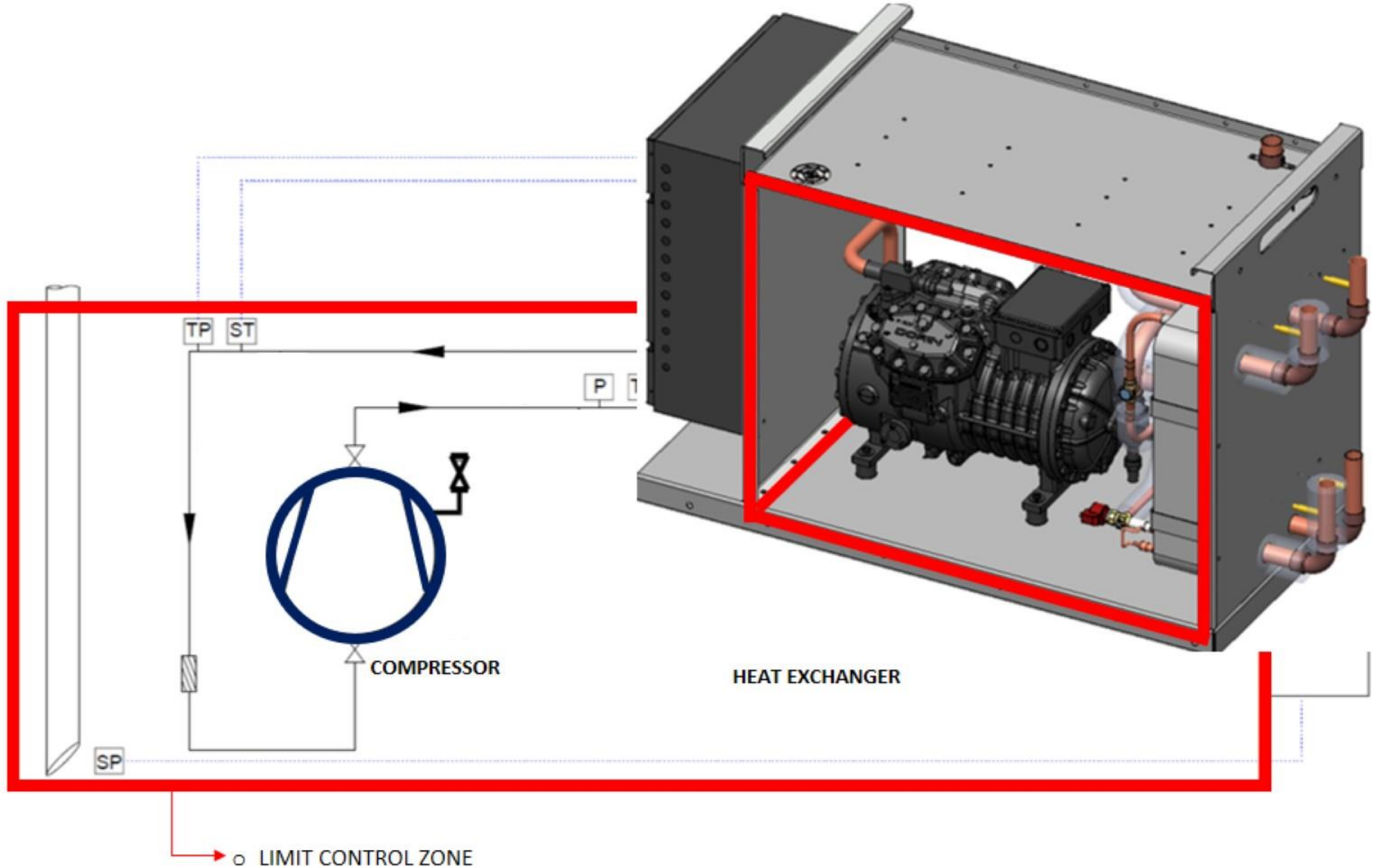
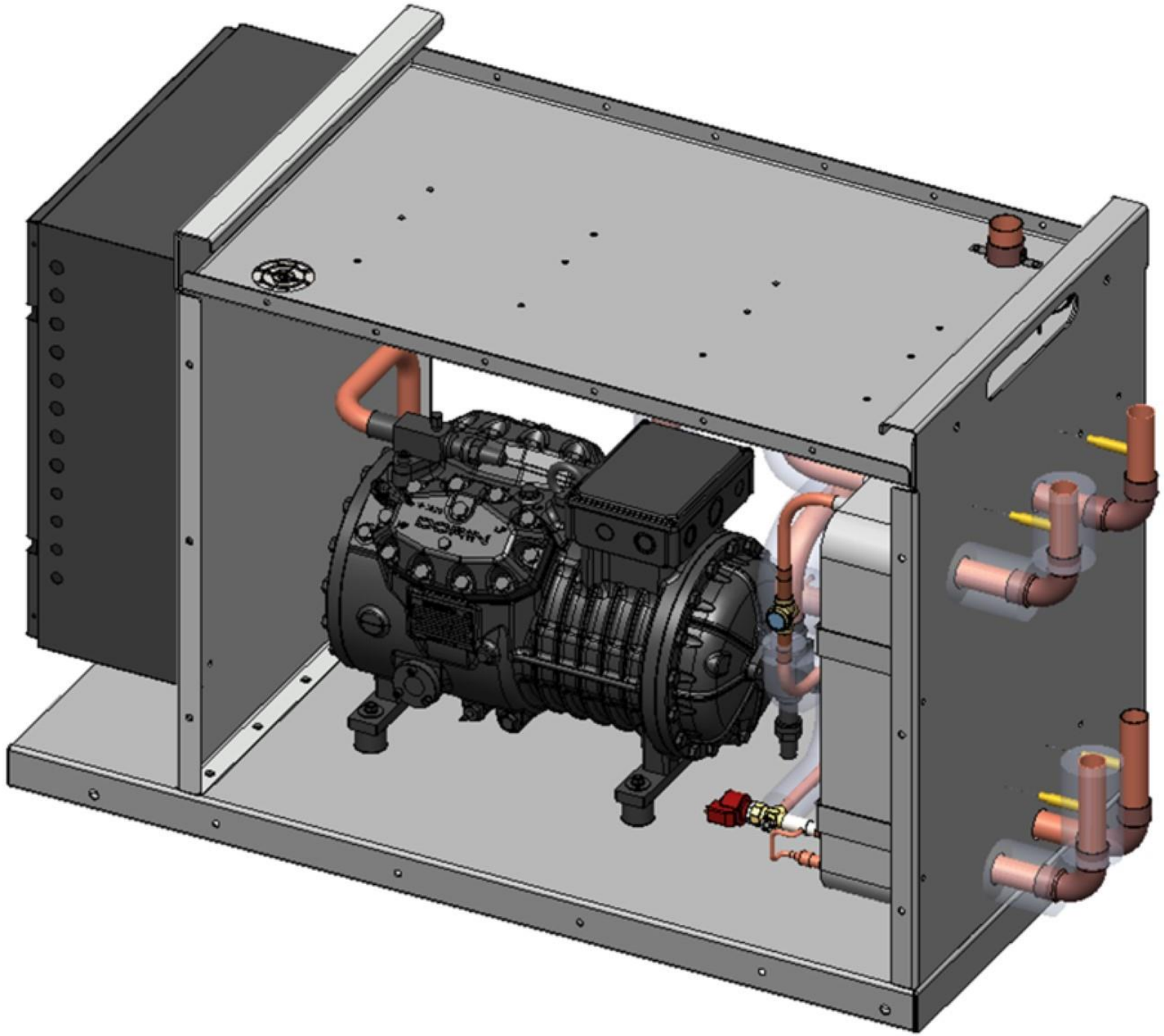
REFRIGERAÇÃO

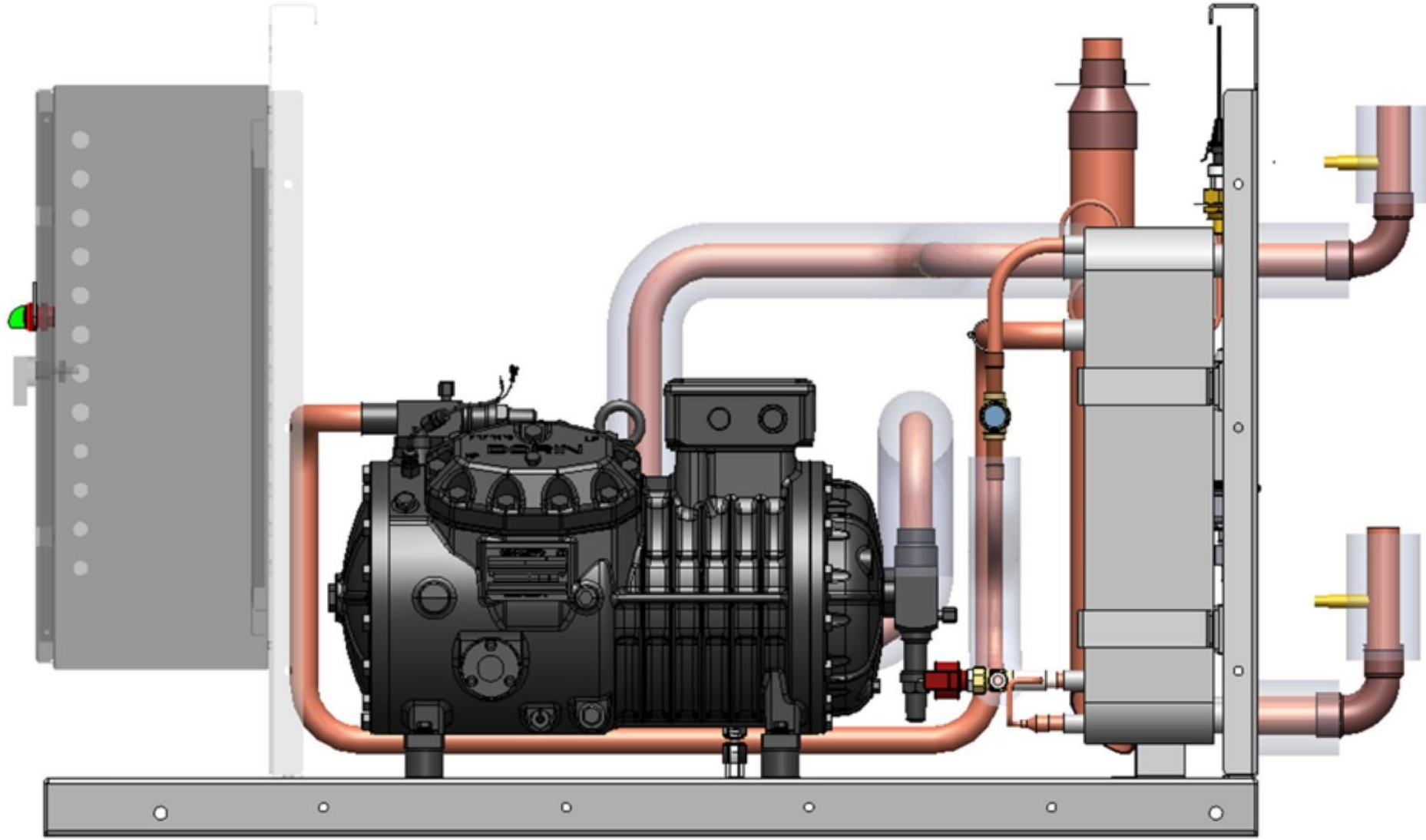
CONTROL ZONE



CONTROL ZONE: DEFINED VOLUME WHERE THERE IS THE POSSIBILITY OF THE PRESENCE OF THE PROPANE


Congelados
ELETROFRIO
FLUIDO REFRIGERANTE NATURAL





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REFRIGERAÇÃO

Condor

CONDOR SUPERMARKET
750, Presidente Wenceslau Braz Avenue
Curitiba - PR
Brazil


MANTEIGAS · SOBREMESAS
QUEIJOS · BEBIDAS LÁCTEAS
SEM LACTOSE
SEM LACTOSE
Frutas · legumes · ver
ELETROFRIO


LETROFRIO
ORGANIZAÇÃO DAS NAÇÕES UNIDAS
PARA O DESENVOLVIMENTO INDUSTRIAL


MODULO - 1
ELETROFRIO
OK
ELETROFRIO
LIGA COMPRESSOR
COMPRESSOR LIGADO
FALHA FALTA DE FASE

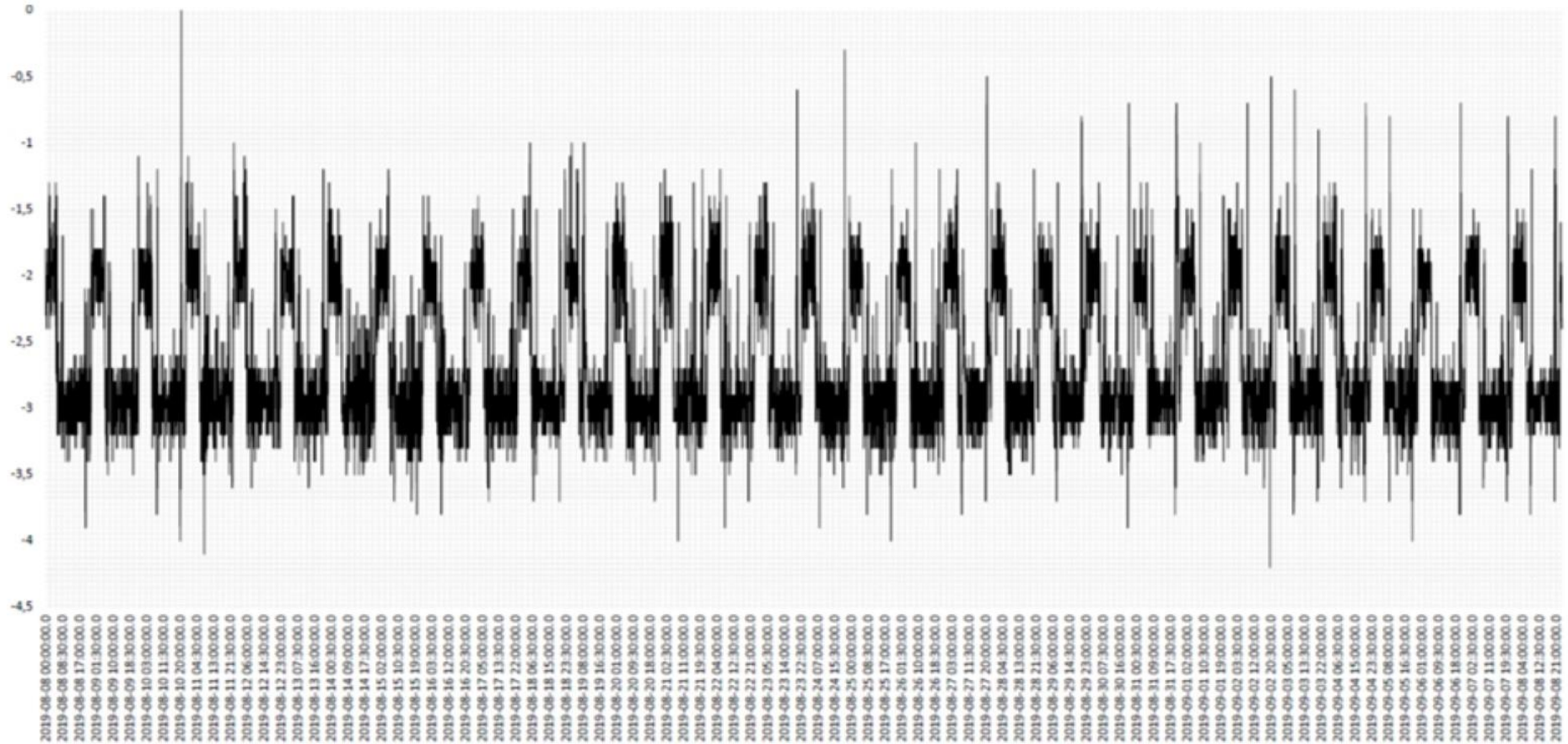
ELETROFRIO
REFRIGERAÇÃO

GLYCOL TEMPERATURE MONITORING

GLYCOL TEMPERATURE SETPOINT

- **DAY : -3°C**
- **NIGHT : -2°C**

30 DAYS



ELETROFRIO
REFRIGERAÇÃO

ENERGY CONSUMPTION COMPARATION

CONDOR WENCESLAU BRAZ x CONDOR FRANCISCO DEROSSO

Condor Wenceslau Braz : **R290** x Glycol x Subcritical CO_2

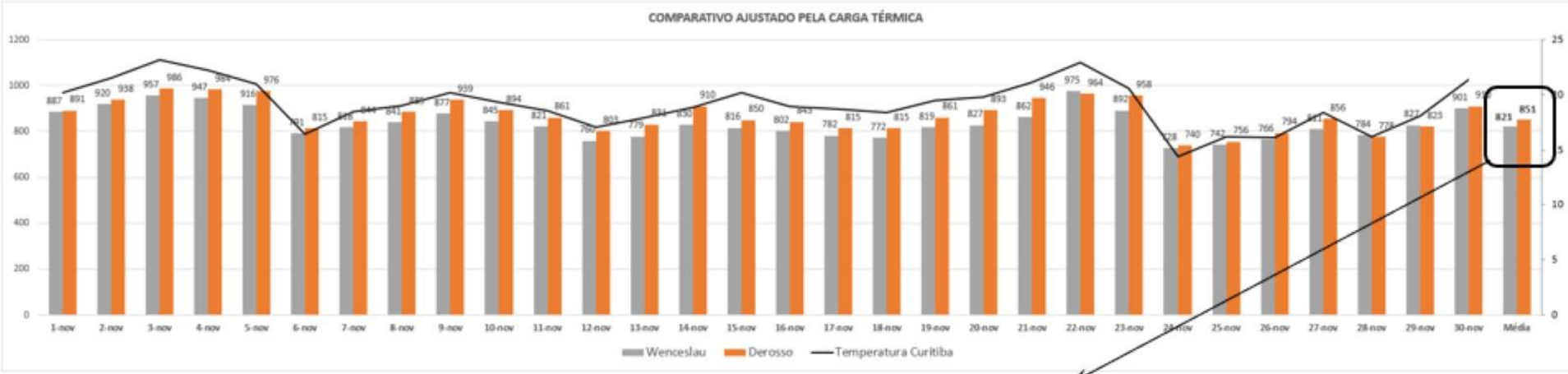
Condor Francisco Derosso : **R134a** x Glycol x Subcritical CO_2

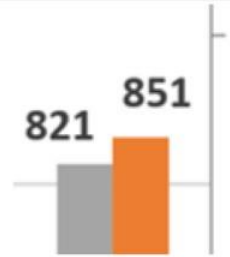
WENCESLAU BRAZ

Group	1-nov	2-nov	3-nov	4-nov	5-nov	6-nov	7-nov	8-nov	9-nov	10-nov	11-nov	12-nov	13-nov	14-nov	15-nov	16-nov	17-nov	18-nov	19-nov	20-nov	21-nov	22-nov	23-nov	24-nov	25-nov	26-nov	27-nov	28-nov	29-nov	30-nov	Tot	Média
RACK MT UNIDADES 1-2-3	317	336	345	346	342	297	306	312	333	312	297	288	299	334	354	347	341	340	354	355	395	530	414	307	392	418	449	394	428	492	2.811	408
RACK MT UNIDADES 4-5-6	421	437	466	453	425	343	362	379	398	386	374	322	330	346	315	304	291	281	315	321	317	295	327	269	197	196	208	235	246	258	1.922	261
RACK DRYCOOLER + BOMBA	149	147	146	148	149	151	150	150	146	147	150	150	150	150	147	151	150	151	150	151	150	150	151	152	153	152	154	155	153	151	1.059	152
	887	920	957	947	916	791	818	841	877	845	821	760	779	830	816	802	782	772	819	827	862	975	892	728	742	766	811	784	827	901	5.792	821

FRANCISCO DEROSSO

Group	1-nov	2-nov	3-nov	4-nov	5-nov	6-nov	7-nov	8-nov	9-nov	10-nov	11-nov	12-nov	13-nov	14-nov	15-nov	16-nov	17-nov	18-nov	19-nov	20-nov	21-nov	22-nov	23-nov	24-nov	25-nov	26-nov	27-nov	28-nov	29-nov	30-nov	Tot	Média
RACK MT	713	750	789	787	781	652	675	708	751	715	689	642	665	728	680	674	652	652	689	714	757	771	766	592	605	635	685	622	658	728	4.840	681
	713	750	789	787	781	652	675	708	751	715	689	642	665	728	680	674	652	652	689	714	757	771	766	592	605	635	685	622	658	728	4.840	681





ENERGY CONSUMPTION REDUCTION

30 kW.h/month

3,5%

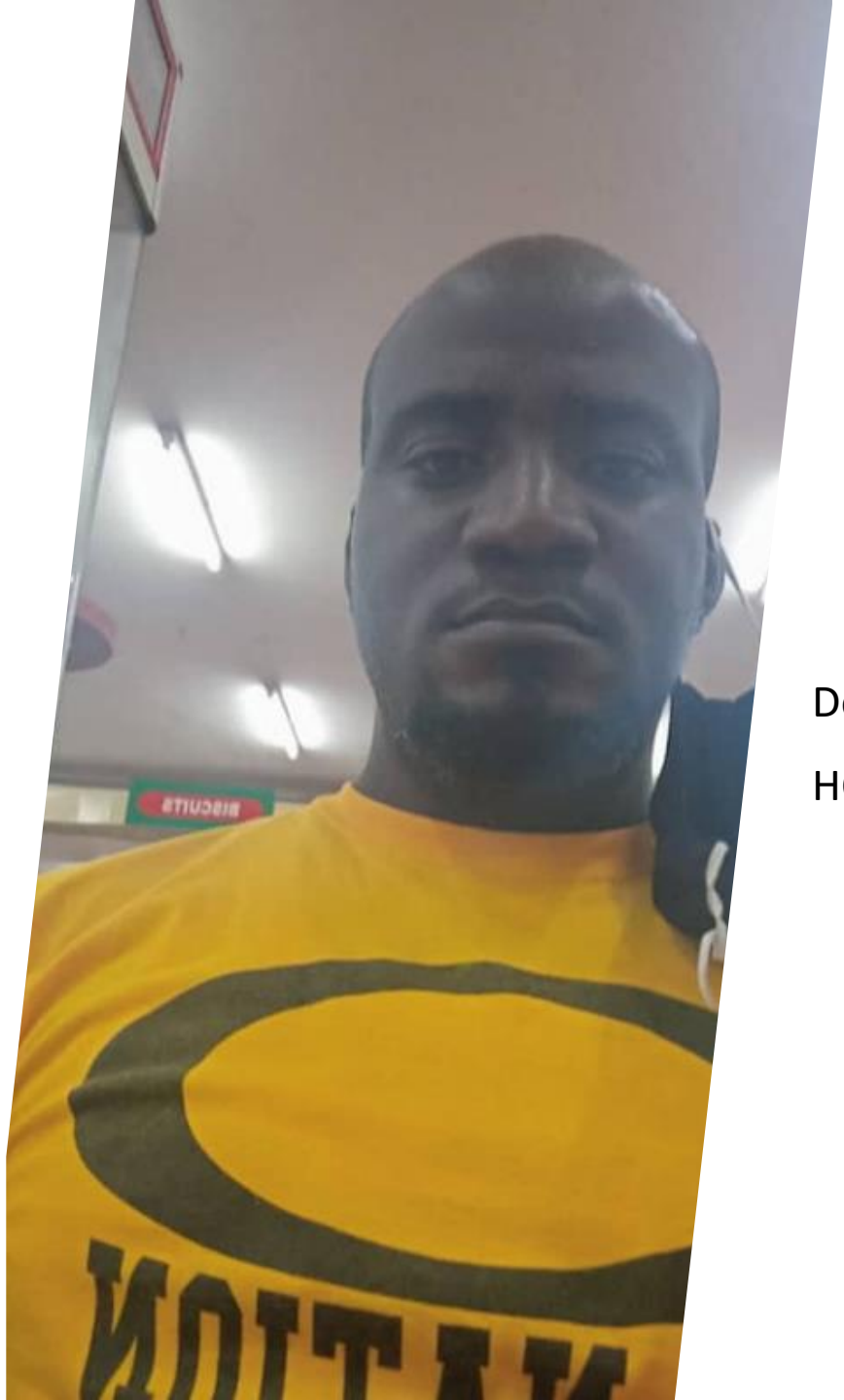
ELETROFRIO
REFRIGERAÇÃO

R290

DO NOT

BE AFRAID

PROPANE
YOU NEED TO HAVE
KNOWLEDGE, PROCEEDURE AND RESPECT



Uganda case study: Capital Shoppers supermarket

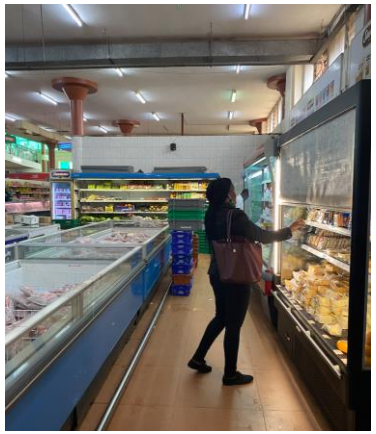
Frank Kasozi

Supermarket Manager

Decision making procedure towards adopting energy efficient and HCFC free refrigeration systems for supermarkets in Uganda

About The Supermarket Cooling Section:

An outside company (LM Engineering Services Ltd) does the servicing and maintenance the refrigeration systems. LM is a local service provider.

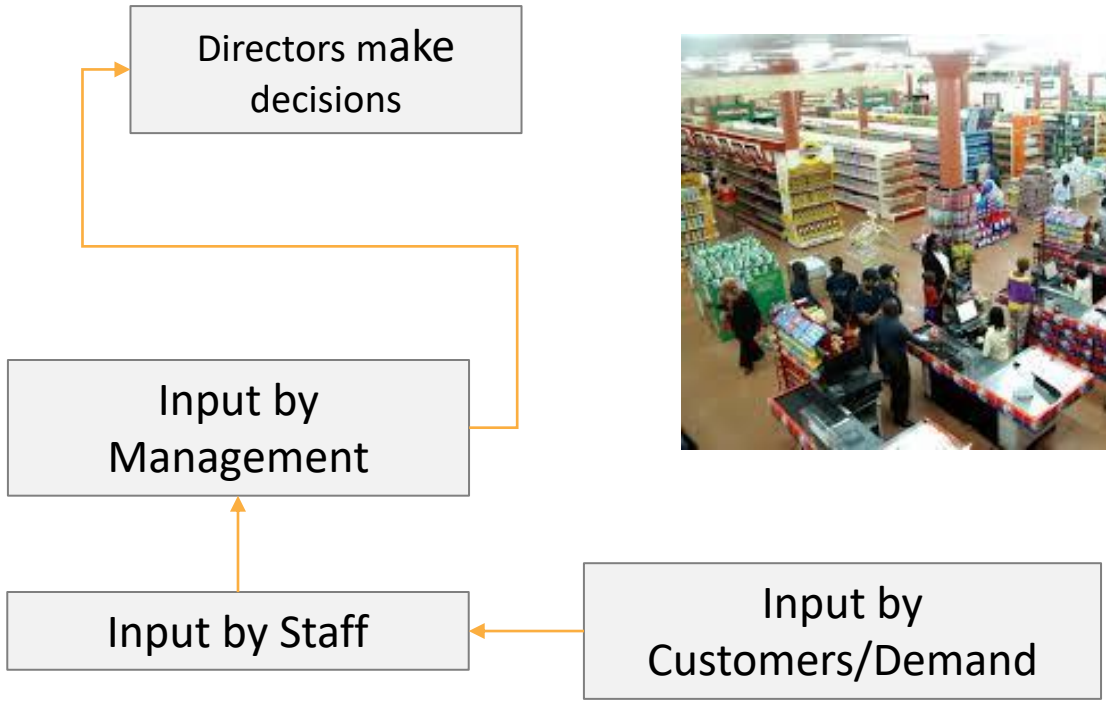


Refrigeration systems are bought from distributors abroad (UK, UAE). We buy them new in specified models (no custom fridges).

No central distribution center and no storage on site with fridges for food. All foods that need refrigeration have to be added to this section and will be ordered accordingly.

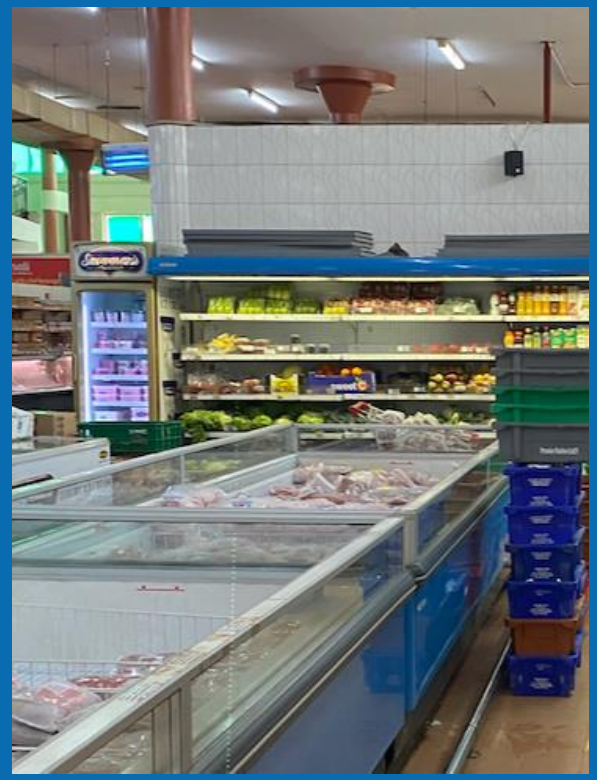
We cover the open fridges, and the cabinet fridges have blinders as provided by the manufacturer. We do regular servicing every 6 months. The open freezers are covered at night with a refrigeration cover.

Current Decision Making Procedure:



Takeaways from the Involvement:

- Learned about the phasing out of R22 which has a negative effect on the environment.
- Learned about the availability of local refrigeration manufacturers, GETS
- Learned about alternative energy efficient technologies that we can use to save energy costs in our supermarket.



Q&A

Please feel free to use the chat box to ask your questions. Due to the large number of attendees, please provide only written questions.

Closing Remarks

Take away messages

1. 4 stakeholders
2. More capacities of local suppliers and maintenance service technicians
3. Change agent with passion
4. More examples of new technologies in developing countries

A. The decision-making tool

B. The case studies

C. Today's presentation

D. UNIDO/IIR report

Will be posted on the UNIDO website shown on the right →

Special thanks to KCEP, IIR, and Prof. Judith Evans (LSBU, UK)

Dr. Fukuya Iino Ph.D.

United Nations Industrial Organization

Email: f.iino@unido.org

The results of the UNIDO KCEP project

Energy efficient retail refrigeration

https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/energy-efficient-and-green-cold-chain

Domestic and commercial refrigeration cost guidelines:

https://www.unido.org/cera

Thank you for attending!

The webinar has been recorded and the recording will be sent to your email

The report, brochure and presentation can be found and downloaded from the UNIDO website

https://www.unido.org/our-focus-safeguarding-environment-implementation-multilateral-environmental-agreements-montreal-protocol/energy-efficient-and-green-cold-chain