Natural Technologies for Sustainability

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The Life-C4R project, led by Epta, is an international marketing project sponsored by the EU created to accelerate the implementation and the dissemination of very high-efficiency CO_2 based commercial refrigeration systems. The project ultimately aims to combat climate change by replacing hydrochlorofluorocarbon (HCFC) and hydrofluorocarbon (HFC) refrigerants with CO_2 while providing substantial energy savings in any country with any external temperature.

Objectives

The technical objective is to improve efficiency, guaranteeing a minimum of 10–14 per cent energy savings in any country, independent of the external temperature, with installation and maintenance cost savings up to 30 per cent compared to the current solution.

The environmental objectives are:

- to dramatically reduce the global warming impact (GWP) of the refrigerant, from the baseline R404A 3920 down to 1
- to reduce the carbon footprint over the entire value chain based on a life cycle climate performance (LCCP) approach
- to reduce the EU global greenhouse gas (GHG) emissions by at least 1.5 per cent.

From a policy perspective, C4R stimulates the use of energy-efficient natural refrigeration systems and ultimately make the C4R technologies the new industrial standard for the future.

Thanks to the Life-C4R project, it will be possible in the future to upscale these specific CO_2 technologies achieving a total energy saving in Europe of 94.8 TWh/yr, or 39 million CO_2eqT (the CO_2 emissions of the entirety of Belgium), while phasing out HCFC and HFC GHGs.

Context

The HFC refrigerants in commercial refrigerators, air conditioners and heat pumps have a significant impact on our climate: in the past, they were responsible for depleting the ozone layer (today the ozone-depleting substances are banned), and today they are responsible for contributing to the current climate crisis.

The Paris Agreement aims at keeping the global average temperature rise well below 2°C compared to the pre-industrial levels, with intense efforts to limit it to 1.5°C. The subsequent Kigali Amendment, effective from 2019, requires that HFCs be abandoned in favour of natural refrigerants.

Globally, the phase-out of HFCs can contribute to avoiding 0.5°C warming by 2100.

The European Union, in particular, has the goal of reducing GHG emissions from HFCs by 80 per cent by 2030 and tracks the progress towards this long-term goal through a solid system of transparency and accountability.

The GWP expresses the greenhouse effect (in 100 years) of a refrigerant compared to R744/CO_2, a natural, non-toxic and non-flammable refrigerant, whose GWP is minimal and therefore used as an index 1.

Following the F-Gas Regulation, the use of refrigerants with very high GWP like R-404A and R-507A (market standard since 2009, approx. GWP 4,000) has been banned in new equipment. Thus, the commercial refrigeration industry has fully adapted its technologies and product portfolio favouring carbon dioxide (R744, CO_2) for direct expansion appliances in medium-large stores and propane (R290) for hermetically sealed or plug-in units.

Full Transcritical Efficiency

The heart of the project is the Full Transcritical Efficiency (FTE) system technology in its 2.0 version, which allows old refrigerants to be entirely replaced with CO_2 in a simple, efficient and reliable manner in any climate situation anywhere in the world.

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

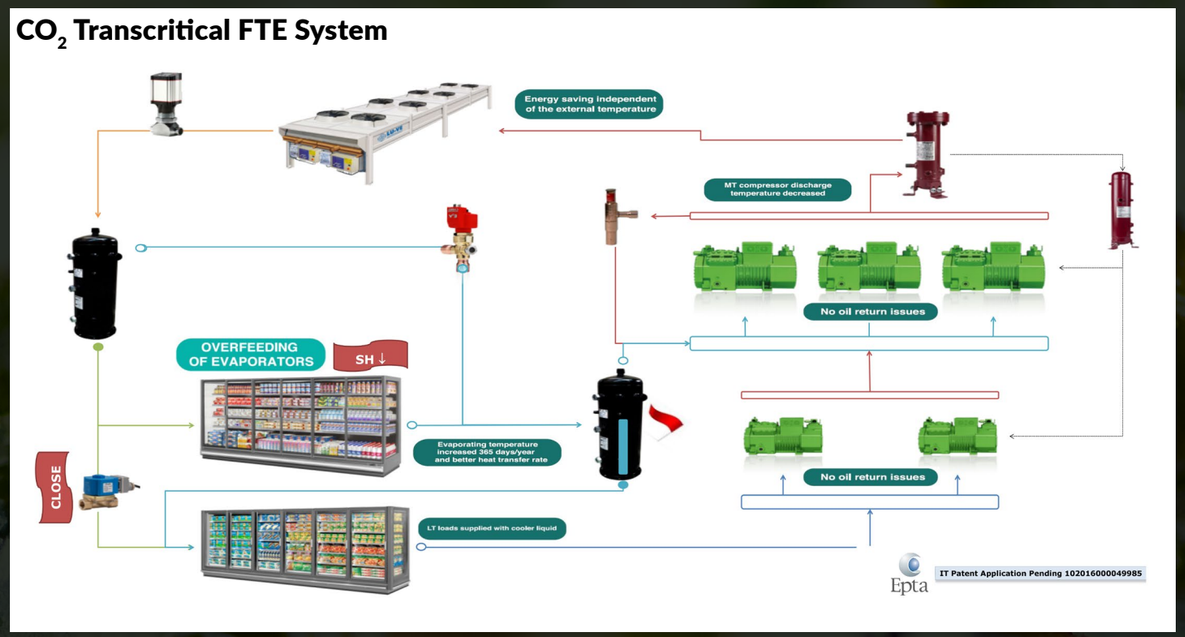


Figure 1: Refrigeration diagram of a CO_2 system with Full Transcritical Efficiency.

The FTE technology works with overfeeding of the medium temperature (MT) evaporators. Therefore the superheat is completely eliminated. This results in a significant increase in the evaporation temperature (up to 6K) and excellent heat transfer given by the liquid refrigerant, with consequent substantial energy savings (approx. 2.5-3 per cent each K). In fact, the heat transfer to the refrigerant occurs along the entire length of the evaporator, unlike conventional systems with overheating where a part of the exchange battery is not used because it is dedicated to overheating.

The increase in the evaporation temperature is pivotal in the design of efficient refrigeration systems, and with the flooding of the MT evaporators, the maximum possible level is reached.

To recover the liquid present at the outlet of the MT evaporators, a low-pressure liquid separator (FTE module) is located between the medium temperature loads and the suction of the MT compressors. This liquid receiver collects the liquid that comes out of the MT loads and supplies

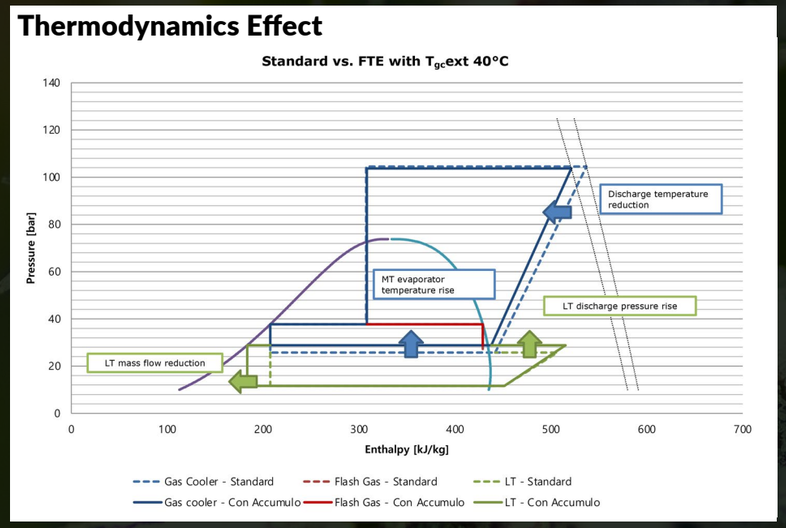


Figure 2: Thermodynamical diagram of a CO_2 system with Full Transcritical Efficiency.

the accumulated liquid directly to the low temperature loads.

FTE additionally addresses and solves some typical limits of CO_2 systems in hot climates: it introduces a substantial (10K) reduction of the discharge temperature of the MT compressors, ensures the perfect lubrication of the compressors thanks to an uninterrupted oil circulation and reduces the effect of the flash gas, which generally causes the refrigeration system to lose useful cooling capacity in summer mode.

Finally, the system efficiency is always

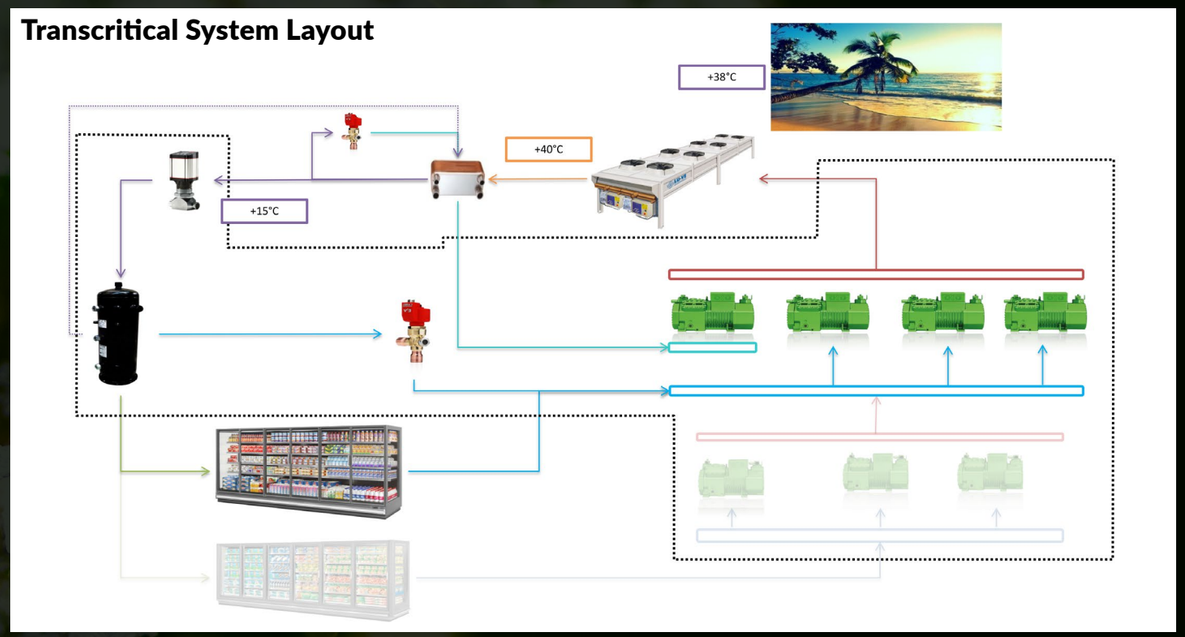


Figure 3: Refrigeration diagram of a CO_2 system with Extreme Temperature Efficiency.

assured throughout summer and winter, day and night, 365 days a year, and in any geographical area because it does not depend on the external ambient temperature.

In the 2.0 version, the FTE is fully integrated into the power rack, thus requiring no extra space in the technical room and further reduced installation and startup times.

Needless to say, one of the key advantages of FTE is its simplicity because it does not need ejectors or any sophisticated component, so it does not add considerable costs or complication, and it is as simple as a standard basic CO_2 booster system.

Extreme Temperature Efficiency

Extreme Temperature Efficiency (ETE) is designed to complement the FTE in extreme temperature conditions. It supersedes the limits of CO_2 systems at temperatures well above 40°C, where a decline in performance and an enormous increase in consumption is generally experienced.

The ETE is a mechanical subcooling system, i.e. a system capable of helping the gas cooler cool the refrigerant before expanding in the high-pressure valve, working with refrigerant CO_2, fully integrated into the refrigeration power rack. It is automatically activated at the external ambient temperature where the system goes in transcritical mode with the appearance of the flash gas, and allows its complete elimination allowing the system to function as if the external temperature were 10–12°C lower.

Since ETE works on the high-pressure circuit and does not require any low temperature (LT) user connected to the power rack, it is suitable also for stores where the LT cabinets and cold rooms are not connected to the central system, such as plug-in cabinets and independent condensing units for cold rooms.

Additionally, ETE is suitable for industrial refrigeration, logistics centres for the storage and the distribution of perishable goods, processing and packaging centres, etc. In other words, another horizon opens up for CO_2!

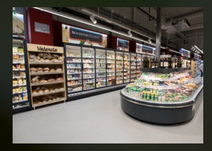
The future of natural refrigeration depends on systems that combine costs, energy savings and reliability in a simple design. With FTE and ETE, we have reached the optimal synthesis of all these aspects.

Scope and implementation activities

After the industrial development of C4R, starting from tests and results performed by Epta in the laboratory, the FTE and ETE technologies have been tested with fully instrumented installations in Italy, Romania and Spain.

These different locations provided a reliable verification of the performances with different store sizes and climate conditions.

- Carpenedolo (IT)
- 1.650mq
- FTE 2.0
- 56MT+10LT kW



- Sibiu (RO)
- 1.000mq
- FTE 2.0
- 111MT+19LT kW

- Bologna (IT)
- 6.010mq
- ETE
- 125MT kW

- Colmenar (ES)
- 1.500mq
- FTE 2.0 + ETE
- 84MT+10LT kW

- Timisoara (RO)
- 1.995mq
- FTE 2.0 + ETE
- 113MT+22LT kW

- Valencia (ES)
- 1.380mq
- FTE 2.0 + ETE
- 50MT+20LT kW

Figure 4: LIFE C4R pilot stores equipped with FTE and ETE.

The data from these pilot stores confirm the efficiency also in harsh conditions and allow a model to be built to forecast the behaviour of the technology under different conditions. A supporting tool has been created to give precise estimations to be used in the business activity.

Epta is performing a full life cycle analysis according to the standards of LCCP to monitor and evaluate the project's global carbon footprint, and a socio-economic analysis is ongoing to assess the potential impacts in terms of jobs creation, social wealth, European industry competitiveness, etc.

The Life-C4R project achievements are disseminated to several stakeholders, academia, policymakers and the general public. Stakeholders from all over Europe are engaged to foster a wide spreading of knowledge and fast adoption of the technology after the project end.

PROJECT NAME

LIFE C4R
(CARBON 4 RETAIL REFRIGERATION)

PROJECT SUMMARY

The Life-C4R project is an international marketing project that, thanks to Eptas Full Transcritical Efficiency (FTE) and Extreme Temperature Efficiency (ETE) systems, will substantially contribute to replacing HCFC and HFC greenhouse refrigerants with CO_2 in commercial refrigeration in a very simple, efficient and reliable way in any country, with any external temperature, allowing 10 per cent energy and 30 per cent installation and maintenance savings.

PROJECT LEAD

Epta combines a solid industrial culture, great competitive and innovative strength and a significant presence worldwide. The group offers the widest and most comprehensive range of solutions for commercial refrigeration, ensuring the supply, installation and maintenance of systems. Epta also has a strong presence within the food and beverage market and Ho.Re.Ca sector, working in partnership with major players in the sector.

PROJECT PARTNERS

Epta is a multinational group specialising in commercial refrigeration that operates worldwide, helping its customers reach excellent performances in the retail, Ho.Re.Ca (hotel, restaurant, café) and, food and beverage sectors.

Epta Iberia is specialised in the commercialisation of Epta products and the engineering, installation and commissioning of retailers refrigerated sites.

DAAS is an engineering, maintenance and project management company that provides turnkey projects for commercial retail, industrial and Ho.Re.Ca. sectors.

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Insights from the most comprehensive study ever on the world's glacier retreat

A new study published in 'Nature' has shown that almost all of the world's glaciers have become thinner and have lost substantial mass over the past two decades—and that this trend is only accelerating. In the most comprehensive and accurate analysis yet, an international research team, which also included the EU-funded ICEMASS project, has raised the alarm about the potential dire consequences if the trend continues.

The study highlighted that the fastest melting glaciers are in Alaska, Iceland and the Alps, but glaciers in the Pamir Mountains, the Hindu Kush and the Himalayas are also profoundly affected. This is particularly concerning for countries in South Asia, such as India and Pakistan, where glacial meltwater in the dry season is a crucial source of water. However, the study also surprisingly found some glaciers experienced slower rates of retreat from 2010–2019, such as those on Greenland's east coast and in Scandinavia—but the researchers attribute this to a weather anomaly in the North Atlantic that caused higher precipitation and lower temperatures.

The European Research Council-supported ICEMASS (Global Glacier Mass Continuity) project contributed to the wider global study by developing an innovative 'sensor model' that enabled the exploration of 20 years of satellite stereo imagery (imagery taken of the same point on the Earth's surface but from different space camera angles). This allowed the researchers to unlock valuable repeat Earth surface measurements hidden deep within the data. ICEMASS also conducted several pilot studies that tested and demonstrated for smaller regions, which was then done globally for the entire study.

For more information on the study, which was led by the Swiss Federal Institute of Technology in Zurich (ETH Zürich), please go to: https://titan.uio.no/english/2021/worlds-glaciers-are-melting-faster-20-years-ago

For the study itself, please go to:
https://www.nature.com/articles/s41586-021-03436-z

"ICEMASS contributed a number of methods that were crucial to the study, and I'm very pleased with how our findings and developments were taken up in such a collaborative and interactive way as was done with the 'Nature' study."

Andreas Kääb, ICEMASS principal investigator

Source: **The European Commission:** https://cordis.europa.eu/article/id/430336-insights-from-most-comprehensive-study-ever-on-worlds-glacier-retreat

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