

# Save energy and protect the environment with our CO<sub>2</sub> solutions

Experience the Danfoss CO<sub>2</sub> expertise in Food Retail, Commercial and Industrial Refrigeration

up to 20%  
energy savings

when choosing a suitable system with CO<sub>2</sub>  
compared to traditional systems with HFCs.

Trusted

in over 2000 systems

including more than 1000  
transcritical systems.



# #1

in refrigeration with CO<sub>2</sub>

## CO<sub>2</sub> info

In recent years, CO<sub>2</sub> has become an increasingly important refrigerant in a number of applications. Most important to this development, is that from an environmental and safety perspective, CO<sub>2</sub> is one of the few sustainable refrigerants for supermarket systems. However, CO<sub>2</sub> is not a drop-in replacement for all existing refrigerants, and its suitability for each application should be evaluated against TEWI (Total Equivalent Warming Impact) and life-time cost.

Danfoss considers CO<sub>2</sub> to be among the most useful refrigerants in industrial refrigeration and food retail applications. This is also confirmed by developments seen in the refrigeration market-place. In particular, in areas where there is a greater focus on reducing greenhouse gas emissions, Danfoss offers a variety of products for all CO<sub>2</sub> applications, including subcritical, transcritical, pump-circulated and hybrid systems.

## Why CO<sub>2</sub>

### A sustainable choice

- Environmentally exceptional
- CO<sub>2</sub> does not effect the ozone layer and compared with traditional HFC refrigerants has up to 4000 times less impact on global warming
- A refrigerant that won't be phased out. Therefore no need to worry about pending legislation for HFC reduction and phase out, costly refrigerant management schemes, or increasing refrigerant cost and taxation
- It's the easiest way to shrink your carbon footprint
- Supermarkets report carbon footprint reductions of more than 30%

### An efficient choice

- Superior thermophysical properties
- High volumetric efficiency translates into smaller pipes, insulation and compressors
- High heat transfer efficiency translates into greater capacities with smaller footprints
- Proven savings – End users, both industrial and commercial are beginning to report results. CO<sub>2</sub> reduces running costs
- Cascade systems with CO<sub>2</sub> provide high efficiency in all climates
- Transcritical systems provide an efficient, simple and cost effective solution in milder climates
- In secondary systems CO<sub>2</sub> will save up to 90% on pumping power vs. traditional brines



## Customer benefits

### Danfoss offers complete CO<sub>2</sub> system solutions including:

ADAP-KOOL® control and monitoring systems, Regulating and injection valves, Sensors (temperature, pressure, gas detectors), Filter-driers and Line components.

Danfoss components provide the lowest total cost of ownership, while also reducing the total carbon footprint of supermarket refrigeration systems; both direct and indirect. With the experience from hundreds of subcritical CO<sub>2</sub> systems and more than 1000 transcritical systems commissioned, Danfoss is a reliable partner. All components released for CO<sub>2</sub> have been thoroughly tested to ensure that they can withstand the impact of CO<sub>2</sub>. Danfoss can offer support as well as monitoring services for CO<sub>2</sub> systems.

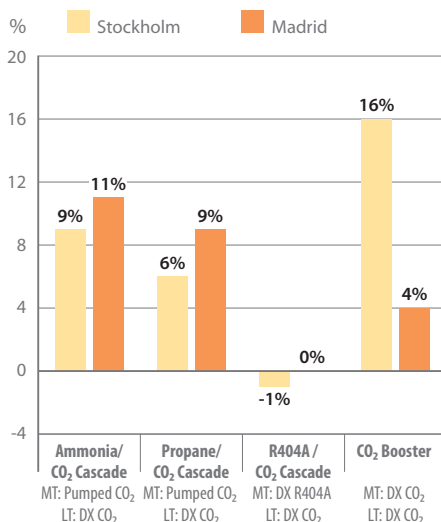
## Energy Savings

### Energy Savings/environmentally sustainable

As a refrigerant CO<sub>2</sub> has excellent thermodynamic properties, in terms of good heat-transfer inside an evaporator.

A 500 kW high temperature system with CO<sub>2</sub> as a fluid can save as much as 2.2 MWh over 15 years of operation, or about 15,000 tons of CO<sub>2</sub>.

### Energy saving with CO<sub>2</sub> as a refrigerant compared to a traditional solution with two single stage R404A systems



## Expert in CO<sub>2</sub> refrigeration

### Danfoss is an experienced and reliable partner

- with over 1000 CO<sub>2</sub> transcritical systems installed globally
- with more than 9 years of field tests
- with extensive experience within CO<sub>2</sub> system design since 2001 in all areas (control, valves and compressors)



# CO<sub>2</sub> Applications and environmental impact

## Commercial



Food retail

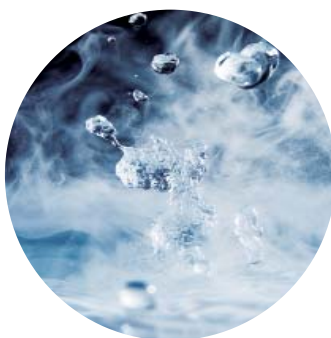
## Industrial



Industrial



Transport refrigeration



Heat Pumps



Server and electronic cabinet cooling

## Broad application range

Due to factors such as the efficiency, safety, toxicity and global climate impact of a refrigerant, it is clear that no single refrigerant is ideal for every application. Danfoss believes that CO<sub>2</sub> as a refrigerant is beneficial in a broad variety of applications for different reasons. The primary applications where the use of CO<sub>2</sub> can provide most advantage include the following; food retail, industrial, heat pumps, transport refrigeration, server cooling and electronic cabinet cooling. The main reasons for each are listed.

**Food retail:** The leakage of high GWP (Global Warming Potential) refrigerants from food retail installations make this a natural target for environmental legislation. Non-toxic and non-flammable, CO<sub>2</sub> lends itself well to this segment.

**Industrial:** CO<sub>2</sub> is extremely efficient as a secondary fluid for medium temperature applications. As a refrigerant it is most efficient at low temperatures. As it also has excellent heat transfer properties and high volumetric efficiency, many products can be frozen in small footprints.

**Transport:** This is an application where refrigerant leakage rates can cause significant environmental impact. Non-toxic and non-flammable, CO<sub>2</sub> can be applied here to reduce the overall carbon footprint within the sector.

**Heat pumps:** Where hot water is needed, CO<sub>2</sub> is the perfect solution. Transcritical CO<sub>2</sub> cycles reject a large proportion of the cycle heat at high temperatures. This also makes CO<sub>2</sub> an efficient choice in applications where both heating and cooling is required.

**Server and electronic cabinet cooling:** Non-flammability and high heat transfer efficiency within small footprints is key when dealing with electronic applications. CO<sub>2</sub> may also be used in free-cooling circuits where minimal power is needed to circulate the media.

Danfoss is joining customers in celebrating the successes of implementing CO<sub>2</sub> systems. The following pages highlight two key applications and just a few of these success stories.



# 30.000 km

is how far you can

drive a Volkswagen Golf 2.0 TDI to emit  
an amount of CO<sub>2</sub> equivalent to leaking  
1kg of R404a.

## Carbon footprint or impact

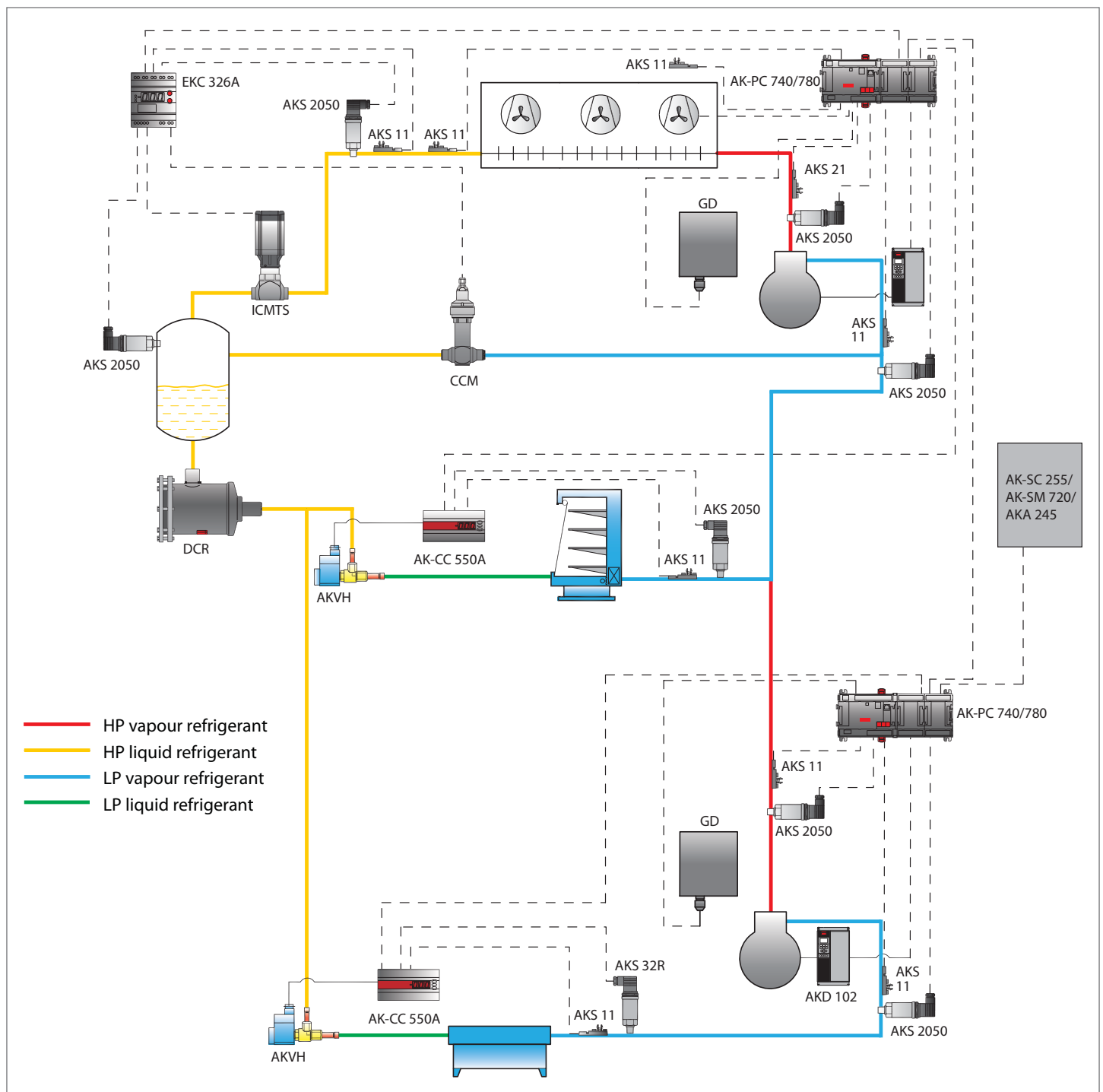
Globally, commercial refrigeration is the refrigeration subsector with the largest refrigerant emissions, calculated as CO<sub>2</sub> equivalents, representing more than 30% of the total refrigerant emissions. Cooling with CO<sub>2</sub> reduces the carbon footprint of commercial refrigeration systems to almost zero.

# Food retail transcritical booster system

The transcritical booster system is one of the most promising systems in cold climate areas. The reason for this is that the energy consumption is on the same level as R404a systems or better and the design is relatively simple.

A typical CO<sub>2</sub> transcritical booster system is divided in to three pressure sections; high pressure section, intermediate pressure section and low pressure section.

Controls for a transcritical system can be divided into four groups; gas cooler controls, receiver controls, injection controls and compressor capacity controls.

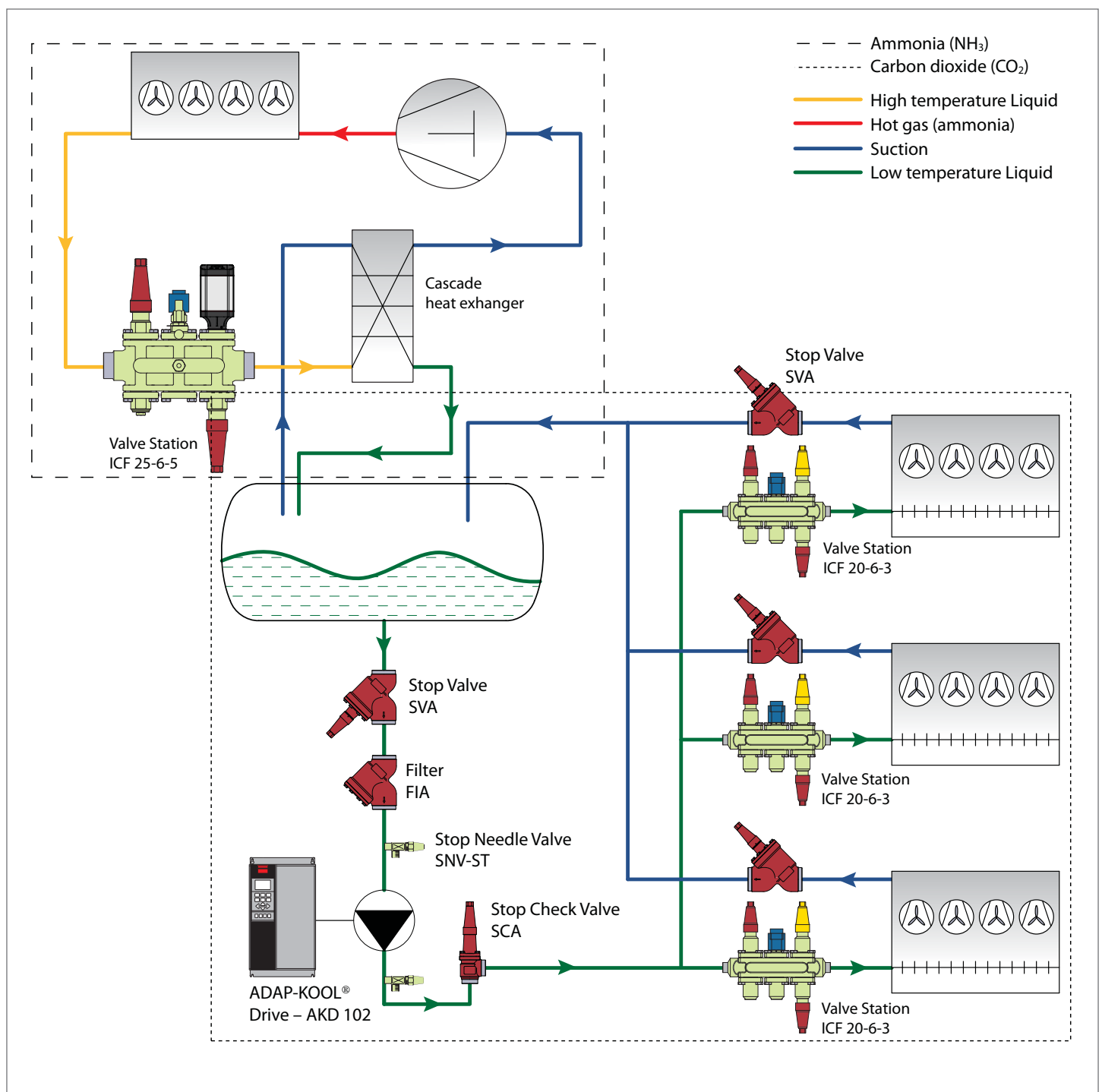


# Industrial refrigeration CO<sub>2</sub> secondary cooling system

Research has shown that installation of a refrigeration system using CO<sub>2</sub> as a fluid is no more expensive than a system installed using a water-based brine/glycol while providing energy savings of up to 20%.

For an experienced installation company it can be cheaper to install a 500 kW refrigeration installation for cold storage using CO<sub>2</sub> than a water-based secondary cooling system. Examples have shown that savings on the installation can be up to 12%, using a CO<sub>2</sub> based refrigeration system.

Systems using CO<sub>2</sub> as a fluid are relatively simple. The main difference when compared to a water-based brine/glycol system is that the piping and component size on a CO<sub>2</sub> system is considerably smaller for the same capacity. Visit [www.danfoss.com/COToo](http://www.danfoss.com/COToo) and calculate your own savings.





# Customer case studies









# 100%

**natural**

Danfoss technology helps to provide outstanding results in temperature control and energy efficiency in a dual temperature ammonia/CO<sub>2</sub> fluid refrigeration system.

## Industrial refrigeration – Dual temperature ammonia/CO<sub>2</sub> fluid system

Flanagan Foodservice is a leading distribution service company located in Kitchener, Ontario – Canada. To keep up with growing demand, a new 6,000m<sup>2</sup> addition doubles the size of the current facility, featuring state-of-the-art CO<sub>2</sub> refrigeration technology, and creating the first facility in Canada to implement this technology.

A dual temperature ammonia/CO<sub>2</sub> fluid refrigeration package system refrigerates the 360 kW at –15°C of 4,200 m<sup>2</sup> of freezer space and 120 kW at –28°C of 450 m<sup>2</sup> of Ice Cream freezer supplied by Mayekawa Canada.

A cross-divisional effort within Danfoss supplied the well known ICF valve stations feeding CO<sub>2</sub> to the evaporators, flooded shell and tube NH<sub>3</sub>/CO<sub>2</sub> exchangers as well as variable frequency drives and pressure transmitters which run the NH<sub>3</sub> screw compressors and CO<sub>2</sub> pumps. The use of ICM motorized valves in the ICF assembly played a key role in maintaining a stable liquid supply.

The Danfoss frequency converters allow for full balance in the load control of the NH<sub>3</sub>/CO<sub>2</sub> system, meeting the challenges of the flow and the thermal dynamics of CO<sub>2</sub>.

Flanagan describes the project as “exciting”, as innovative technology will help to drive the performance of the plant. The system utilises only natural refrigerants; ammonia and carbon dioxide that have minimal (0 and 1, respectively) global warming potential. Besides that, it is more energy efficient than corresponding systems using traditional fluids like propylene glycol.







## Food Retail – CO<sub>2</sub> as refrigerant in supermarkets experiences huge growth

It may sound absurd, but if supermarkets worldwide began to use CO<sub>2</sub> as a refrigerant to keep the steaks and fish cold, they would benefit the climate. Because, even though CO<sub>2</sub> is one of the gases that warms up the earth, the greenhouse effect of the so-called F-gases used by supermarkets is 3,000-6,000 times higher.

And this is why the new 21,500m<sup>2</sup> fresh meat product warehouse owned by the retail chain, Netto, is being run using the refrigerant, CO<sub>2</sub>, exclusively. Danfoss has contributed by supplying electronic valves, pressure transmitters and an ADAP-KOOL® control and monitoring system which ensures optimum operation of the cold store and the minimum use of electricity.

"Danfoss has been on their toes, developing the technology for us to supply the products for use in CO<sub>2</sub> systems. If this had not happened, the number of customers queuing would go down quickly, because CO<sub>2</sub> systems are the future within supermarket cooling," says Sales Manager at Danfoss Food Chain, Denmark, Kristian Breitenbauch.

Over the course of a year, even state-of-the-art refrigeration systems leak up to 20 per cent of their refrigerant. This means that, typically, supermarkets can halve their greenhouse effect by substituting harmful refrigerants for CO<sub>2</sub>.

"For supermarkets, which are required to comply with stricter environmental rules, shifting to CO<sub>2</sub> will be the fastest and best way to reach the target – it's like picking the lowest hanging fruit," says Kristian Breitenbauch.

Danfoss worked on the project with Vojens Køleteknik, who supplied the complete refrigeration system. The Danfoss components are perfectly designed for CO<sub>2</sub> refrigeration systems that work at pressures which exceed those of traditional systems.

The Danish supermarket chain Netto's new CO<sub>2</sub> cold store does not consume any more power than systems that use refrigerants which have a much more harmful effect on the climate.

Three years ago, there were less than ten supermarket refrigeration systems in Europe using CO<sub>2</sub> as the refrigerant. Today, there are 500. The figure remains low in other parts of the world, but Danfoss expects this to increase dramatically over the next few years.



15-20%

energy savings

by piping CO<sub>2</sub> directly from the gas cooler to airhandling units.

## Commercial Refrigeration – Keeping a national stadium cool

This application to keep Parken, the national stadium in Copenhagen, Denmark, energy efficient, was one of the first installations to receive Danfoss components engineered for higher standstill pressures, allowing for intrinsic standstill security, all year round.

To the meet all local regulations on refrigerants, engineers turned to natural refrigerants to cool the national stadium. The system had to be cost effective,

compact and quiet. By choosing CO<sub>2</sub>, all of these parameters could be met in addition to providing a system with minimal environmental impact.

Non-toxic, and non-flammable, CO<sub>2</sub> was piped directly from the gas cooler to the air handling units. Calculations showed that by choosing a DX CO<sub>2</sub> system annual energy savings of between 15% and 20% could be achieved.

# Danfoss CO<sub>2</sub> product range

Product Grouping	Product	Product Description
<b>Transcritical Expansion Valves</b>	ICMTS	Motorized transcritical control valves
<b>Pressure Regulating &amp; Gas-Bypass Valves</b>	ICS with CVP-HP/XP	Mechanical backpressure regulators
	CCM	Standstill capable electronic backpressure regulators
<b>Electronic Expansion Valves</b>	AKVH	Standstill capable pulse width modulating expansion valves
	AKV	Pulse width modulating expansion valves
	AKVA	Industrial pulse width modulating expansion valves
	ICM	Industrial motorized expansion valves
	CCM	Standstill capable motorized expansion valves
<b>Valve Stations</b>	ICF	Industrial valve stations
<b>Solenoid Valves</b>	EVR 2-8	Small solenoids
	EVRH 10-40	Large solenoids
	EVRs	Industrial solenoids
	EVRST	Industrial solenoids capable of opening at 0 differential
	ICS + EVM	Industrial solenoid valves for large capacities
<b>Line Components</b>	SVA	Stop valves
	SCA	Industrial check valves
	GBC for CO <sub>2</sub>	Ball valves
	NRV	Check valves
	SG	Sight glasses - inline and socket versions
	DCRH	Exchangeable core filter driers
	DML	Filter driers
	DMT	Transcritical oil and refrigerant driers
	FIA	Filters
<b>Regulating Valves</b>	REG/ REG (SS)	Regulating valves for pump recirculated systems
<b>Liquid Level Controls</b>	AKS 4100	Liquid level transducers
	EKC 347	PI controllers
<b>Safety valves</b>	SFA 15	Safety relief valves
	DSV	Industrial double safety relief valve manifolds
<b>Pressure Switches</b>	RT	Differential pressure switches
	MBS 5000	Transcritical pressure switches
	KP 6	Pressure switches
<b>Pressure Sensors</b>	AKS 2050	Radiometric transcritical pressure transmitters
	AKS 32	Pressure transmitters (0-5V signal)
	AKS 32R	Radiometric pressure transmitters
	AKS 33	Pressure transmitters (4-20mA signal)
<b>Temperature Sensors</b>	AKS 11	Suction side sensor
	AKS 21A	Discharge side sensor
<b>Gas Detection</b>	GD	Gas detectors
<b>Electronic HP Controls</b>	EKC326A	Controllers for transcritical operation and gas bypass
<b>Electronic Case Controllers</b>	AK CC 450	CO <sub>2</sub> "brine" case controllers
	AK CC 550	Single case controllers
	AK CC 750	Multi-case controllers
<b>Cascade HX controller</b>	EKC 313	CO <sub>2</sub> /CO <sub>2</sub> cascade heat exchanger controllers
	EKC 316A	X-refrigerant/CO <sub>2</sub> expansion valve controllers
<b>Pack Controllers</b>	AK PC 740	Case controllers (up to 4 compressors)
	AK PC 780	Case controllers (up to 8 compressors)
	XM 205A	8 analog input/ 8 output relay extension module
<b>System Manager</b>	AK SC 255	CO <sub>2</sub> supermarket system manager
<b>Service Tool</b>	MIMIC	Graphical system monitoring software
	AKM	Service technician software
<b>Variable Frequency Drives</b>	AKD 102	Compressor, pump and fan motor drives







**Danfoss.**  
**Your expert**  
**in CO<sub>2</sub>**

**For more information**  
**please visit us at**  
**[danfoss.com/co2](http://danfoss.com/co2)**