

ENGINEERING
TOMORROW

Danfoss

Solutions

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A young girl with brown hair, wearing a pink and blue plaid shirt, is smiling and holding a large, ripe red tomato with green leaves. She is surrounded by various fresh vegetables, including purple eggplants, green zucchini, and orange carrots, in a garden setting with green foliage and purple flowers in the background.

Engineering Tomorrow's
**Sustainable Food
Supply**

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FEATURE: Transforming Food Production and the Cold Chain to Meet Modern Demands



CASE STUDY: CO₂ Chillers Give Pro Refrigeration A 'Future-Proof Solution'



CASE STUDY: Cold Chains Can Save Lives: How Danfoss and Trane Technologies Accelerated the Delivery of Critical Components and Goods for the COVID-19 Vaccine



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PRODUCT HIGHLIGHT: Danfoss VLT® Refrigeration Drive FC 103 Increases Efficiency and Reduces System Lifecycle Costs

LETTER FROM THE EDITOR



Dear Readers,

Across the globe, concern about the quantity and quality of the food supply and the cold chain is increasing. With the world's population growing and with nearly a third of all food produced for human consumption lost or wasted, effective production and refrigeration technologies are essential. At the same time, reducing carbon emissions in all facets of life is critical to slow the rate of global warming and meet the goals of the Paris Climate Agreement. According to the [UN's 2021 Food Waste Index Report](#), food loss and waste is responsible for up to 10 percent of global greenhouse gas emissions.

As the push toward emissions reduction and decarbonization continues, all aspects of the cold chain will need to be energy-efficient and sustainable.

As the push toward emissions reduction and decarbonization continues, all aspects of the cold chain will need to be energy-efficient and sustainable. Harvesting and production technologies need to be efficient and accessible. Cold chain technologies, which also allow for the safe transport and storage of critical medical supplies, including vaccines, will need to be cost-effective and scalable in order to meet global need, particularly in the developing world, where food loss is most prevalent. Reducing post-harvest losses will require innovation and transformation.

As growers, processors, retailers and policymakers all consider how to reduce food loss and ensure quality and safety in our food supply, Danfoss has developed technologies that can help lead the industry toward a more sustainable and healthier future. Our solutions for commercial refrigeration and food retail provide effective and efficient performance and allow our customers to optimize their refrigeration systems to prevent loss and waste.

This issue of Solutions highlights how Danfoss technologies are inspiring and supporting innovation in food production and cooling. As part of our ESG (Environmental, Social, Governance) goals, we are committed to working with our customers to create energy-efficient, cost-effective solutions that address the most pressing global challenges.

As always, we welcome your suggestions and feedback on this issue.

Lisa Tryson, Editor
solutions@danfoss.com

With deep roots in **engineering**, Danfoss provides **innovative technologies** and **solutions** that **do more with less today** and stands ready with a **broad portfolio** and **expertise** to meet the world's growing set of challenges in **infrastructure**, a safe **food supply, energy efficiency**, and low-GWP, **climate-friendly solutions**.

That's how we're Engineering Tomorrow.

Transforming **Food Production** and the **Cold Chain** to **Meet Modern Demands**

According to the United Nations, about 30 percent of all food produced globally for human consumption is lost or wasted. The problem is particularly critical in sub-Saharan Africa and Southeast Asia, where roughly half of all food supply is lost due to handling, storage and distribution, versus around 20 percent in Europe and 13 percent in North America and Oceania. With worldwide demand for food expected to increase 60 percent by 2050 due to population growth, developing efficient harvesting methods and reliable and sustainable cold chain technologies is essential to our survival. ▶

In order to produce a food supply sufficient for the world's population, we will need efficient and accessible technologies for harvesting and production. We also need an effective cold chain to maintain food quality and safety from farm to fork. To ensure a stable food supply, we must come together to scale access to refrigerated transport and storage and modernize logistics and data collection operations. Reducing food loss will reduce malnutrition, increase food security, and, if done in a sustainable and energy-efficient way, contribute to emission reductions and safeguard our climate.

Reducing post-harvest losses requires a transformation in our food system. Our population is growing, and the impacts of climate change, including increased water scarcity, will place added pressure on agriculture. We will need to expand production and reduce loss. If eliminated, food waste could feed up to 950 million people who currently lack access to nutritious foods. Additionally, food loss comes with severe environmental costs. According to the UNEP's 2021 Food Waste Index Report, up to 10 percent of all greenhouse gas emissions can be traced back to food loss and waste.

Transforming the Food System

Technologies such as autonomous machines that make farming and harvesting more efficient can increase our supply, but we also need technologies to prevent losses as the food moves to market. Proper cooling is the key ingredient to prevent food loss. A cold chain is an uninterrupted series of refrigerated transport and storage activities, that gets fresh produce safely from its production site to the tables where it will be enjoyed. Unfortunately, cold chains are often underdeveloped and overlooked. Lack of proper refrigeration and cold chain bottlenecks in the early stages of the supply chain can result in significant food loss before food even leaves the farm. Even small temperature changes can be extremely damaging to the shelf life of food, as well as its nutrition level. Whenever food is produced in surplus to what the local cold chain can handle, the food is lost.

Creating Change with Technology

To reduce post-harvest losses, we must scale and accelerate the roll-out of cold chain development around the world. Cold storage is an energy-intensive process. There can be massive differences between the energy consumption of different cooling systems used for the same application due to design, sizing, control, maintenance and performance monitoring.

Expanding the cold change goes hand in hand with utilizing the most energy-efficient technologies available, along with low-GWP (global warming potential) refrigerants to keep the climate impact as low as possible. Industry will be key for delivering these solutions. Additionally, there is a role for digital monitoring technologies to support temperature controls and alarms, ensuring the exact optimal amount of cooling is being applied to prevent loss and provide early detection of errors.

Danfoss digital solutions, such as the AK-SM 800A series of system managers and Alsense cloud-based monitoring solutions, are helping to optimize performance and energy use of commercial refrigeration systems for distributors and retail. Managers can set temperature parameters for individual refrigeration cases and receive alerts from our monitoring center when problems are detected, so they can quickly address the problem and prevent loss of inventory. This is especially critical during natural disasters. When Hurricane Ian caused power outages in a number of stores in Florida, the Danfoss support team worked directly with managers, providing more frequent reports and helping them prioritize the most urgent needs, based on feedback from the store's digital controllers.

Building Solutions Together

To implement solutions, we need support from policymakers to build frameworks and legislation to reduce barriers and raise awareness of the benefits of the cold chain, increase investment in researching better cold chain technologies around the world, provide financial incentive to ensure that the best available, energy-efficient technologies are used, and create training programs for contractors to boost skills in using low-GWP refrigerants. Investment in technologies that aid farmers, both large and small, in harvesting and production, will also be needed in the years ahead.

Collaboration, investment and innovation are essential for transformation. To ensure that our food supply can sustain our population growth while also sustaining our climate and planet, it is urgent that we act now. ■

The Greenest Energy is the Energy We Don't Use.

We are making climate commitments based on science and validated through science-based targets (SBTi).



CO₂ Chillers Give Pro Refrigeration **A 'Future-Proof Solution'**

With the approaching HFC phasedown, the demand for environmentally friendly cooling systems is driving chiller manufacturers to innovate. Washington-based Pro Refrigeration, Inc., a leading manufacturer and supplier of chillers for the industrial and beverage processing market, including the dairy, beer and wine industries, recognized an opportunity with CO₂ chillers. Since, as a natural substance, CO₂ has nearly zero impact on global warming, the company knew that demand would increase in the coming years as their customers look to reduce their environmental impact and comply with local, state and federal regulations. ▶

Most of Pro Refrigeration's traditional chillers use R-404A, which has a GWP rating of 3922. In comparison, CO₂, the baseline for GWP, has a rating of 1. CO₂ also allows refrigeration systems to recover 100 percent - three times that of chillers using synthetic refrigerants - of the heat rejected from their systems, generating hot water at up to 200 degrees. For Pro Refrigeration, heat recovery capability is an essential product feature. Dairy farms in particular use a high amount of natural gas or propane to heat water for sanitizing and wash-down. Heat recovery technology lowers both their costs and climate impact.

Building the Product

When the company made the decision to move forward with manufacturing, they investigated controls and valves from several major manufacturers. Danfoss control valves had the combination of higher capacities and safety ratings that were required to meet the needs of the project. Danfoss had been supplying components for the company's industrial chillers for nearly 30 years, so Pro Refrigeration was confident in Danfoss' ability to meet their production needs. While the global supply chain disruption extended the production timetable, the companies worked together to produce and procure the necessary components.

The Danfoss components utilized in the CO₂ chiller include the AK-SM 850A system manager, AK-CC 750A case controller, AK-PC 781A pack controller, as well as the CCM 20 and CCMT 30 electric regulating valves, BC 5100 pressure switches, pressure and temperature sensors, and other accessories such as AK-PS 250 power supply and GDC gas detector. All of the parts work together to monitor the cooling system, gather data from the sensors, control when the compressors cycle on and off and ensure the fans and expansion valves are working correctly.

"The Danfoss components provide the brains of the system," explained Jim VanderGiessen, Pro Refrigeration's co-founder and CEO. "They keep the system running in an optimal manner." As part of its constant monitoring and adjustment to external conditions, the system manager generates alerts and alarms, so that the facilities staff can immediately identify and address potential mechanical problems. The refrigeration

control system also allows Pro Refrigeration engineers to access the data remotely for improved customer support and troubleshooting capabilities.

Putting Innovation into Practice

While using CO₂ as a refrigerant pays dividends for the environment, VanderGiessen noted that it does come at a premium. The chiller costs nearly 30 percent more to produce than a traditional chiller. While VanderGiessen projected that the cost will come down as the technology becomes mainstream and is deployed across more industries, the current cost can present a barrier to adoption. Fortunately, one of the company's customers, a California dairy farm, was excited about blazing a new trail and was confident the new chiller would meet its needs.

Installation of the CO₂ chiller was a smooth process, VanderGiessen reported. Pro Refrigeration installers placed the chiller alongside the current system, on the opposite side of the barn, and when the new chiller was ready to begin operating, the crew was able to easily connect the chiller to the rest of the refrigeration system. Pro Refrigeration crews remained on-site to monitor the new chiller around the clock for the first week, until everyone was confident it was performing as expected.

The chiller, operating at 100 HP, is now fully operational, chilling milk after it passes through a heat exchanger and arrives at a tank for cooling and storage. The chiller has the capacity to service dairy farms of any size, enabling farms to utilize heat recovery on top of the benefits of energy efficiency and low-GWP refrigerants. VanderGiessen noted that the farm has reported the CO₂ chiller "consistently produces colder and higher-quality milk" than its previous 120 HP R-404A chiller.

In order for dairy farmers to earn a quality bonus of up to 10 percent above market rate from milk processors, the milk must be cooled to a temperature below 40 F and run a high temperature CIP (Clean in Place) system every 24 hours to ensure proper system sanitation. Since the CO₂ chiller was installed, the milk temperature has averaged 37.1 F, whereas their previous chiller was unable to cool below 40 F. As a result, the dairy farm was able to see revenue increases in the range of \$1,400 to \$2,800 per day.

The chiller also recovers the waste heat from the chiller system to heat the wash water, heating 3,000 gallons of well water per day from 70 F to 170 F and eliminating the need to use fossil fuels (propane) as a heating source. Early results tracking indicates that the heat recovery operation is saving the farm 40 gallons of propane each day, totaling about \$2,100 in savings per month and preventing 517 pounds of carbon emissions from entering the atmosphere.

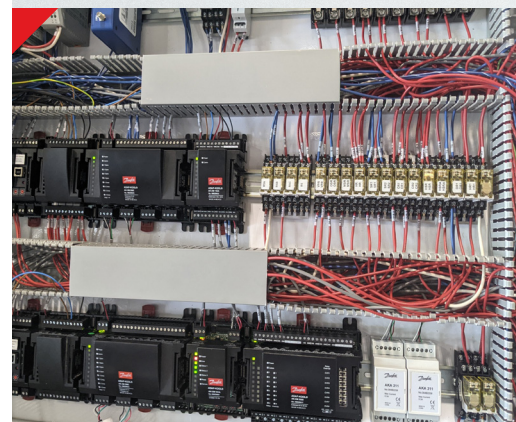
The Future of CO₂

VanderGiessen is optimistic about the future adoption of CO₂ as a refrigerant, noting that the technology is

applicable to any industry with a constant cooling load. Pro Refrigeration has received more inquiries about its latest technology and plans to increase production on CO₂ chillers in the years ahead.

Referencing the pending changes in the industry, VanderGiessen noted that the CO₂ chiller is "a future-proof solution." Our design will evolve and improve over time but we won't need to build new equipment." He also noted that while "the price differential needs to ease," he is confident that "the technology will be considered in all industries. We see a huge opportunity to offer CO₂ chillers across many vertical markets." ■

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"The Danfoss components provide the brains of the system, they keep the system running in an optimal manner."

— Jim VanderGiessen, Pro Refrigeration's co-founder and CEO



Cold Chains Can Save Lives: How Danfoss and Trane Technologies Accelerated the Delivery of Critical Components and Goods for the COVID-19 Vaccine

The launch of the COVID-19 vaccination campaign in December 2020 led to great relief around the world and was greeted with hope after the virus had affected almost all aspects of life for most of the year. While public discourse focused on the lack of production capacity, another major challenge came into play: the safe transport and storage of vaccines at very low temperatures. This issue is still highly topical in 2023. ▶

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The SuperFreezer – From Seafood to Vaccines

Thermo King has long been a global leader in refrigerated transport and storage of food, medicines and other sensitive, perishable goods. This often involves the use of the powerful, adaptable SuperFreezer solution, which has been co-designed and built with Danfoss since 1996 to achieve ultra-low temperatures and optimal preservation.

The SuperFreezer is typically used for sea transport of sushi-grade tuna, but also for biopharmaceutical products such as blood plasma and other pharmaceutical agents, as well as biological samples. It ensures consistent temperature control, prevention of microbial decay and efficient storage and transport - even under challenging conditions such as high ambient temperatures, frequent door openings or long operating times.

The SuperFreezer is a cascade system with two refrigeration circuits, each with its own compressor, refrigerant and inline components, both managed by a common advanced controller. Each

SuperFreezer unit relies on Danfoss inline components such as expansion valves, solenoid valves, regulators, sight glasses, and pressure switches to ensure smooth and reliable operation of the refrigerant and to maintain the correct cryogenic temperature.

The Delivery of Essential Goods is a Responsibility

The COVID-19 mRNA vaccines, with their unique ultra-cold temperature specifications - down to -94 F - are ideal for the SuperFreezer. However, the equipment had to be slightly modified to reach and maintain the extremely cold temperatures. Danfoss components played a crucial role in this process.

Many rural hospitals, doctors' surgeries or clinics do not have access to suitable temperature-controlled storage facilities. Rural regions often do not have a suitable infrastructure to ensure the required cold chain. The situation is also particularly critical in third world countries, where vaccination rates are still far too low, even two years after the first vaccines were approved.

EACH SUPERFREEZER UNIT RELIES ON DANFOSS INLINE COMPONENTS SUCH AS EXPANSION VALVES, SOLENOID VALVES, REGULATORS, SIGHT GLASSES, AND PRESSURE SWITCHES TO ENSURE SMOOTH AND RELIABLE OPERATION OF THE REFRIGERANT AND TO MAINTAIN THE CORRECT CRYOGENIC TEMPERATURE.

To reduce the spoilage of life-saving vaccines, active refrigeration like the Thermo King SuperFreezer is the ideal solution.

"To meet the demands of shipping and storing vaccines worldwide, we had to customize the units and produce them quickly," says Dwayne Cowan, president of Thermo King EMEA and Global Marine, Rail and Air at Trane Technologies. "This meant we had to source additional components supplied by Danfoss in an extremely short time."

Danfoss received its first component order from Thermo King in late 2020, and production was immediately up and running. As the components are manufactured in several factories around the world - in Denmark, Poland, China, Mexico and India - each factory had to follow the same strict production schedule to meet the demand for the SuperFreezer.

"The entire supply chain had to be accelerated," said Carlos Zamudio, senior director of global accounts at Danfoss. "Instead of a normal eight-week process, production became a three- to four-week process," Zamudio said. "The entire supply chain worked together to produce the parts needed for the SuperFreezer. All

Danfoss factories worked together to supply Thermo King and subcontractors with parts."

Initially, the factories had to source sufficient raw materials, which was a challenge due to shortages in the market. "We were able to leverage our relationships with our suppliers," says Jason Pederson, Global Key Account Manager at Danfoss. "We made sure we had enough manpower to complete production. When total customer demand exceeded our production capacity by 25 percent, we prioritized the products we made for the SuperFreezers."

"We were able to respond quickly," says Zamudio. "Everyone understood the importance of what we were doing. Thermo King relied on us to deliver the components on time. Throughout the supply chain, many companies worked together to ensure the vaccines could be delivered and stored."

"It was critical that there were no delays in production or shipping," Cowan stressed. "The support of Danfoss was instrumental in ensuring that we were able to transport this critical cargo through all the countries in Europe and to many remote locations around the world. The fact that we were able to respond quickly and efficiently to

a crisis of this magnitude is a testament to the strength of partnerships like this."

After all components were airlifted to Thermo King, the SuperFreezers were quickly assembled and ready for their life-saving cargo - becoming a vital part of the first mass immunization and pop-up clinics. Due to the urgency, Thermo King transported the parts by air freight from Danfoss' manufacturing and distribution sites in Europe, North America and Asia Pacific to Thermo King in China.

The last two years have been challenging, but also educational. Thermo King has decades of experience and played a role in safeguarding past vaccines such the one used during the Ebola outbreak in West Africa, and over the past two years has accumulated a wealth of experience that is vital as infections and variant formations continue to rise. The COVID-19 pandemic is unfortunately more topical than ever and society must prepare for further follow-up vaccinations. A fast and safe vaccine distribution must be guaranteed to help overcome this pandemic once and for all. ■





CALIFORNIA'S COOLEST CART

Slowly, silently, efficiently. The self-driving – or autonomous – grape cart does not necessarily attract much attention as it drives through the rows at Parminder Brar’s 900-acre family farm in Kern County, California. But it has a big effect.

Parminder has volunteered to test the cart at his table grape farm this harvesting season. And his verdict is clear: the cart not only makes the workday for his seasonal employees a lot easier. It also drives up productivity.

With the cart between the rows, more human hands can focus on picking. They simply fill up the autonomous cart with boxes full of ripe table grapes as it passes.

Goodbye, Bumpy Ride

This marks a big difference compared to the traditional method, where a member of each picking crew collects the grapes in a wheelbarrow which he or she manually pushes through the rows. “The rows are 100 meters long. Pushing the wheelbarrow is a dusty, sweaty job

eating up a lot of time which this cart enables us to spend picking grapes instead. We have six picking crews working in teams. If we had three or four carts for each crew, we would get a huge productivity boost,” says Parminder Brar adding that the carts seem robust and reliable easily navigating around any obstacles.

The carts, brand-named Gopher IQ, fulfill California startup Vinergy’s goal: to increase profitability for farmers of hand-picked specialty crops – table grapes, blueberries, peppers, and others – with new, rechargeable electric machines.

The company was founded in 2019, launching a semi-automatic version of the cart the same year, then developed the self-driving version.



One of the First

The autonomous cart is one of the first ever autonomous vehicles in the specialty farming market. "I am extremely proud. With our Gopher IQ cart, we can improve productivity for an average picking crew as much as 30 percent. This translates into real savings for the farmer. It also frees up available hands. And this is key right now as farmers across the US wrestle with labor shortages and rising wages," said Justin Meng, President and CEO of Vinergy.

Danfoss Brain Inside

Vinergy teamed up with Berendsen Power to design the cart's electric drive and control system, which includes components such as batteries, electric motors, and advanced sensor technology.

Danfoss has supplied the intelligent display DM1000. It includes a powerful computer with the company's flagship software PLUS+1® Guide inside, customized to fit Vinergy's exact needs. The computer and software together make up the digital brain converting sensor signals to physical movements, thereby enabling the cart to navigate the grape rows autonomously.

"The software part of autonomous driving is difficult. Reliability and safety are incredibly important. It is relatively untrodden territory, and few companies master it. Danfoss does. Partnering with them, we were able to bring this solution to market fast. And we are ready for a ramp up," said Mike Kelley, mobile sales director, Berendsen Fluid Power.

Vinergy already has several customers among fruit growers across California using their semi-automatic grape cart – and are negotiating with potential ones in Mexico and Peru. A handful of California farmers are currently testing the autonomous version, including Parminder Brar.

"We are impressed by the cart's effectiveness and plan to lease several of them next harvesting season. There is no doubt in my mind that autonomous machines will play a growing role at our farm in the future," he said. ■

"I AM EXTREMELY PROUD. WITH OUR **GOPHER IQ CART**, WE CAN IMPROVE **PRODUCTIVITY FOR AN AVERAGE PICKING CREW AS MUCH AS 30 PERCENT.**"

– Justin Meng, President and CEO of Vinergy

AUTOMATIC SAFETY

The cart is equipped with a **LiDAR** sensor (Light Detection and Ranging) with a 270-degree field-of-view. The sensor uses laser light to monitor the area in front as it drives through the grape rows. If an obstacle or person is detected, the cart automatically finds a way around. If it cannot detect an alternative path, it stops. The **PLUS+1® Guide** software and the powerful computer inside the **DM1000** display constantly process sensor signals converting them to physical movements of the cart.

PRODUCT HIGHLIGHT

Danfoss **VLT®** Refrigeration Drive **FC 103** Increases **Efficiency** and Reduces **System Lifecycle Costs**

Saving energy and reducing the lifetime cost of refrigeration systems just got easier with Danfoss' VLT® Refrigeration Drive FC 103. Designed specifically for refrigeration systems, the EMC-compliant drive makes intelligent system pressure and capacity control possible. Its ease of installation and variable-speed control provide an intelligent solution for food retail and commercial refrigeration.

Among its features are refrigerant temperature conversion, multiple compressor PACK/RACK controller capability (up to six compressors), an oil recovery function and many others. It also provides a setup Wizard which uses common refrigeration terms. This makes installation and commissioning easy and safe for refrigeration technicians and installers.

With variable-speed control, the drive is able to balance capacity to the actual load, improving system-wide coefficient of performance, resulting in significant energy savings in a wide range of applications. A compressor cascade controller and flow compensation feature further reduce energy consumption and maintenance requirements. For condensers the drive offers intelligent condensing pressure control and the ability to easily program in a minimum condensing temperature set point.

The integrated DC link reduces harmonic distortion and the drive contains all modules needed for EMC compliance. Since these features are built into the drive at the factory, less cabinet space is needed on-site. With coated electronics, the drive, available in bypass and cabinet options, can operate efficiently in ambient temperatures up to 122 degrees Fahrenheit without derating.

To learn more, visit <https://bit.ly/3m0uLs9>





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