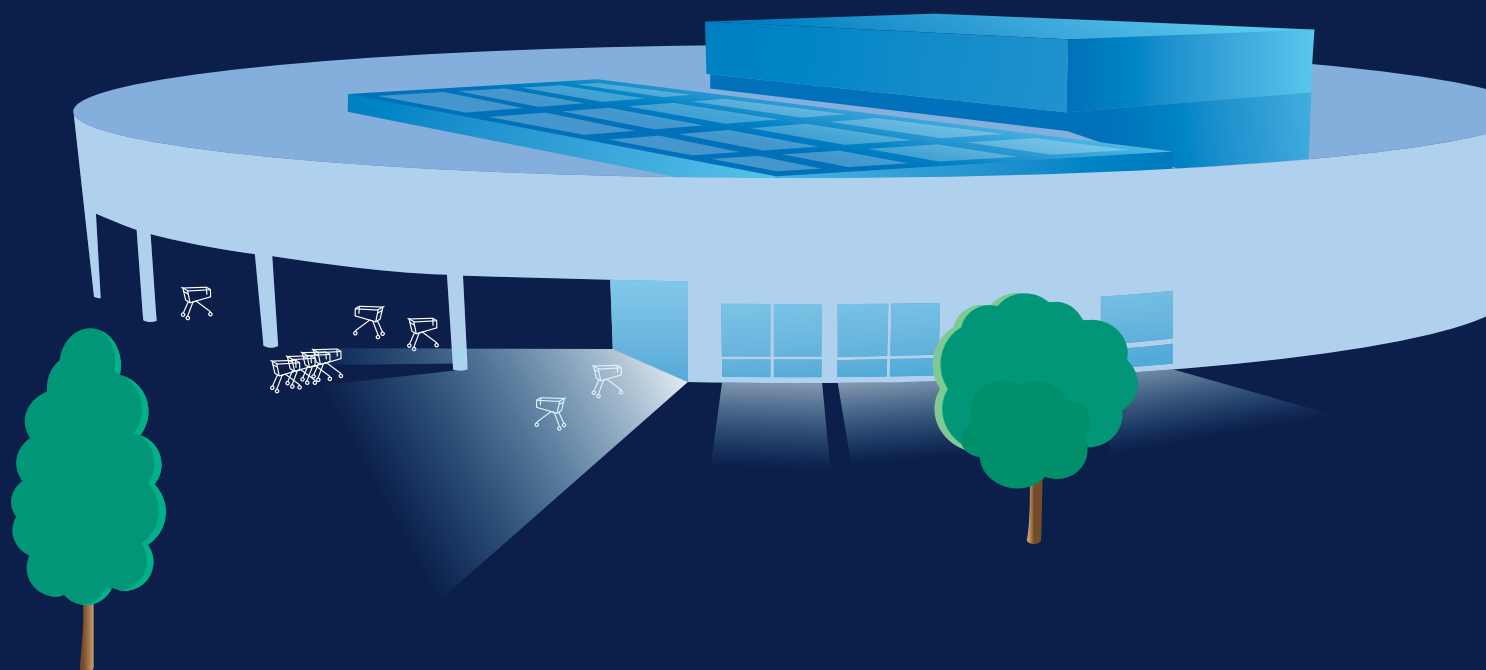


Building better supermarkets for the world



Getting supermarkets to net zero

Foreword by Jürgen Fischer

With the world's population expected to reach 10 billion people by 2050, sustainable food retail and storage are more important than ever. Yet this is an often-overlooked step in the decarbonization of society. Already today, supermarkets account for around 3% of the total electricity used in industrialized countries and refrigeration systems represent by far the highest share of the total energy consumed within supermarkets.¹ Climate-friendly and efficient heating and cooling can therefore make a major difference.

In a world of unpredictable energy costs, combined with the commitments made by many countries and regions in the world to become carbon neutral, there is huge potential for supermarkets to reduce their operational costs while contributing to decarbonization and reducing food loss.

As an example of what can be achieved, a new flagship Smart Store supermarket is opening close to the Danfoss headquarters campus in Nordborg, Denmark.

We have developed this new Smart Store supermarket with partners and customers to demonstrate that it is possible to build a climate

friendly and super-efficient facility, using world-class heating and cooling technology. Most importantly, the solutions used are scalable everywhere, from the smallest convenience stores to the biggest hypermarkets, leading to significant savings with payback times of typically less than 3 years.

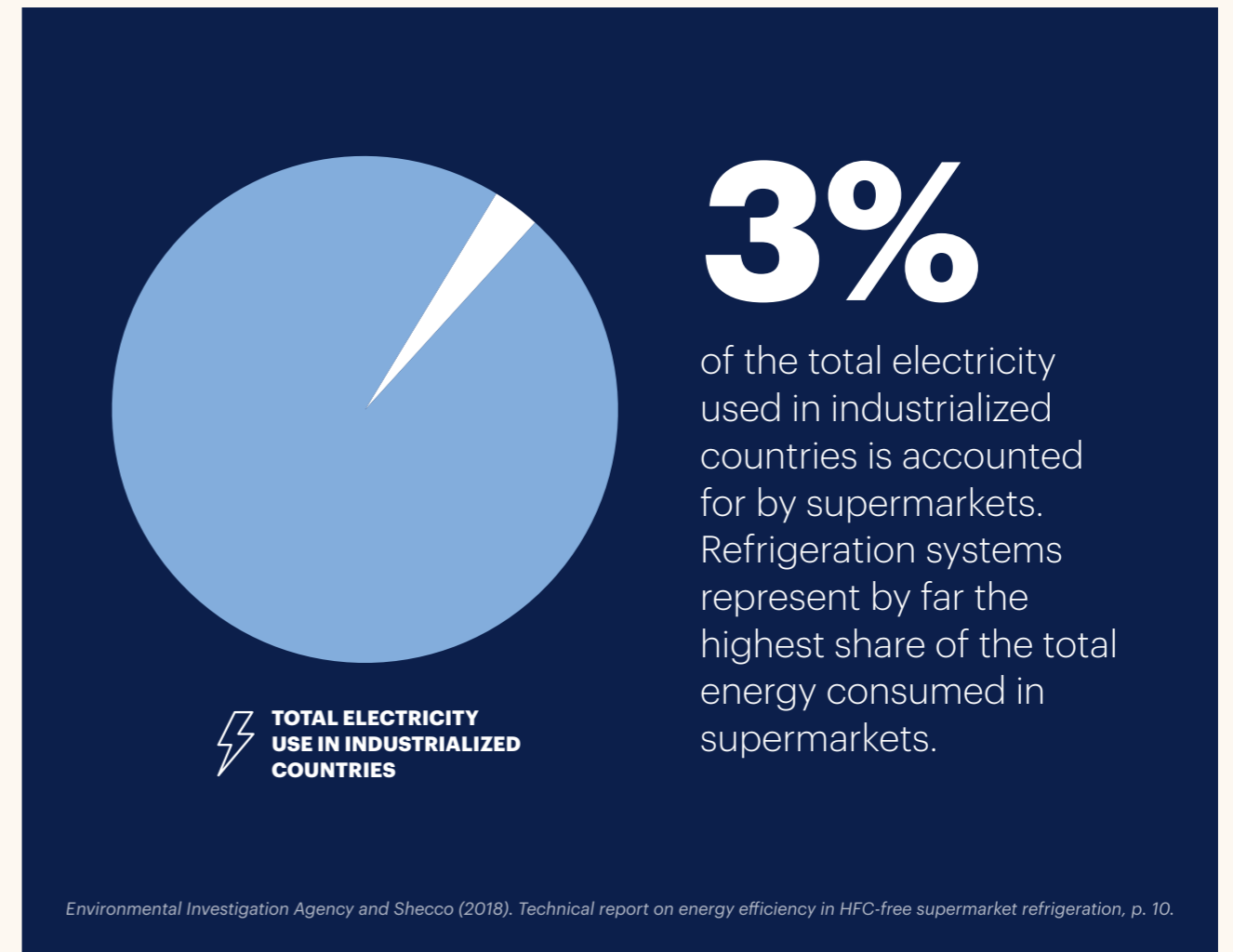
The Danfoss Smart Store Nordborg is expected to be approximately 50% more energy efficient compared to a typical supermarket with a first generation CO₂ refrigeration system, and 20-30% more efficient than an equivalent local store already fitted with multiple energy efficiency solutions.²

Yet this supermarket is not the end of the journey. The new Smart Store supermarket will also serve as an Application Development Center, a 'live' testing site for new technologies which we hope will inspire food retailers around the world to move towards zero emissions supermarkets – while making economic sense.

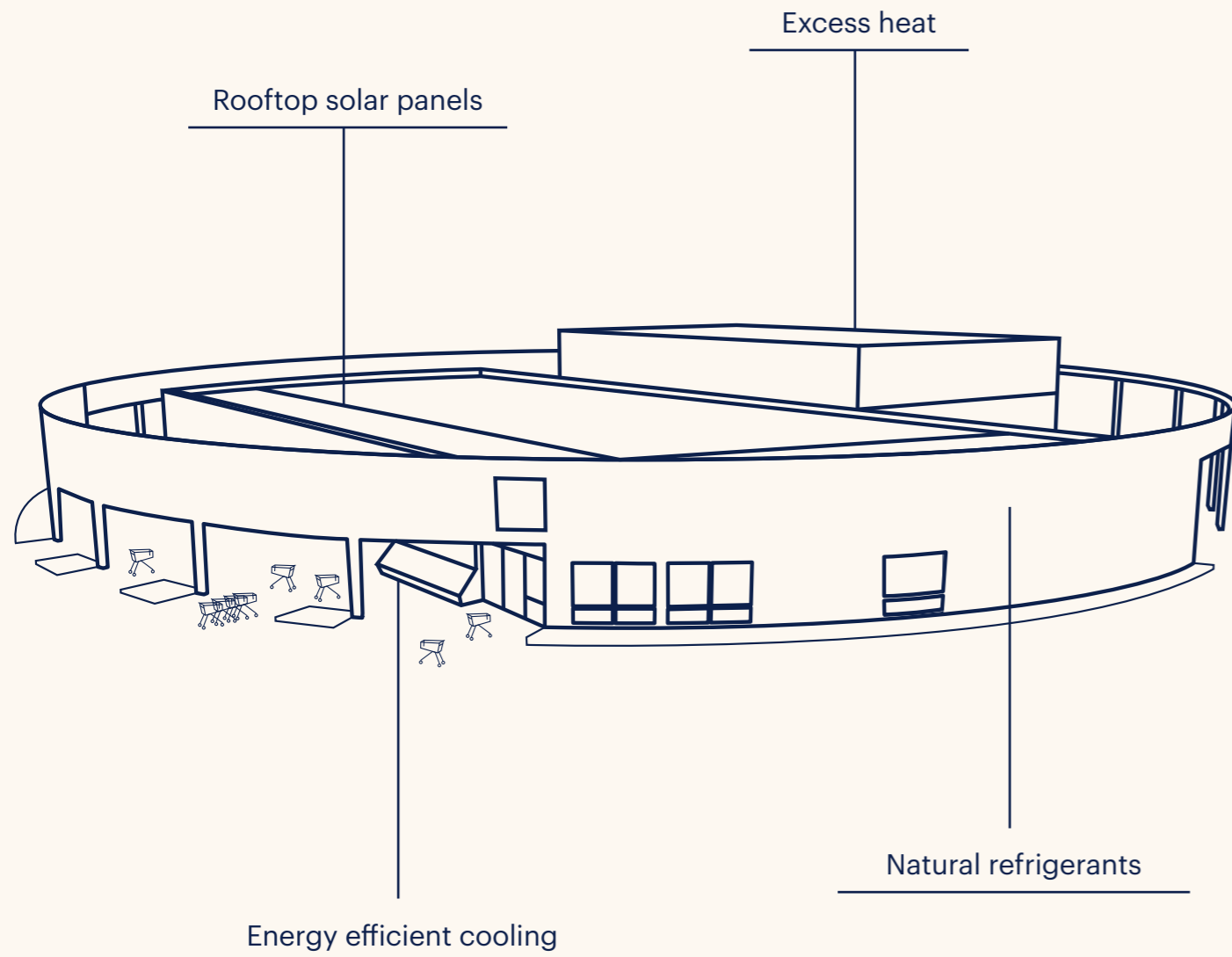
This launch is only the beginning. Join us as we reimagine what true energy efficiency for food retail stores could look like in the 21st century.

// The new Smart Store supermarket will also serve as an Application Development Center, a 'live' testing site for new technologies which we hope will inspire food retailers around the world to move towards zero emissions supermarkets – while making economic sense. //

Jürgen Fischer, President, Danfoss Climate Solutions Segment



A 50% more energy efficient supermarket



These are the key takeaways

- ✓ **Reimagining food retail stores for the 21st century**
Danfoss has reimagined what food retail stores could look like in the 21st century. For the first time, all of Danfoss' most cutting-edge technology and energy efficient food retail solutions are being brought together into one retail site.
- ✓ **50% more energy efficiency is possible**
The new flagship Smart Store in Nordborg is expected to be approximately 50% more energy efficient compared to a typical supermarket with a first generation CO₂ refrigeration system, and 20-30% more efficient than an equivalent local store already fitted with multiple energy efficiency solutions³ providing inspiration for food retailers around the world.
- ✓ **Powering with renewables**
The supermarket will utilize solar power as its primary energy source with energy efficiency solutions employed to reduce the overall energy needs of the store. Energy is an area where significant savings can be achieved by food retailers with relatively low investment and good payback times.
- ✓ **Excess heat can deliver 90% reduction of heating costs**
Excess heat is the world's largest untapped source of energy. Different heat recovery systems in the supermarket showcase - in different ways - how easy it is to recover heat from the refrigeration systems and reuse it.
- ✓ **The key to reducing energy demand**
Energy efficiency programs are run to ensure long-term efficiency. Cooling systems will be monitored, technical parameters fine-tuned, and regular services improved to promote energy efficiency and lower energy consumption even more.

Supermarkets contribute significantly to global energy consumption

Supermarkets and retail food stores are an integral part of communities around the world. They are also big energy consumers. In the UK for example, supermarkets consume approximately 3% of the nation's electricity production.⁴

Meanwhile, in the US, supermarkets on average use approximately 50 kilowatt-hours (kWh) of electricity and 50 cubic feet of natural gas per square foot each year. For an average-size store around 50,000 square foot in size (approximately 4,645 square meters), this equates to more than US\$200,000 (EUR 180,000) annually in energy costs and results in 1,900 tons of CO₂ being emitted into the atmosphere.⁵

That's equivalent to the emissions from 360 vehicles in one year.⁶

The average profit margin for a large food retailer is just 1.7%, which puts every operating cost under scrutiny. Refrigeration and lighting account for over 50% of total energy use in the average supermarket making them an area where significant savings can be achieved with relatively low investment and good payback times.⁷ In fact, the US Environment Protection Agency (EPA) states that one US dollar (EUR 0.90) in energy savings is equivalent to increasing sales by US\$59 (EUR 54).⁸

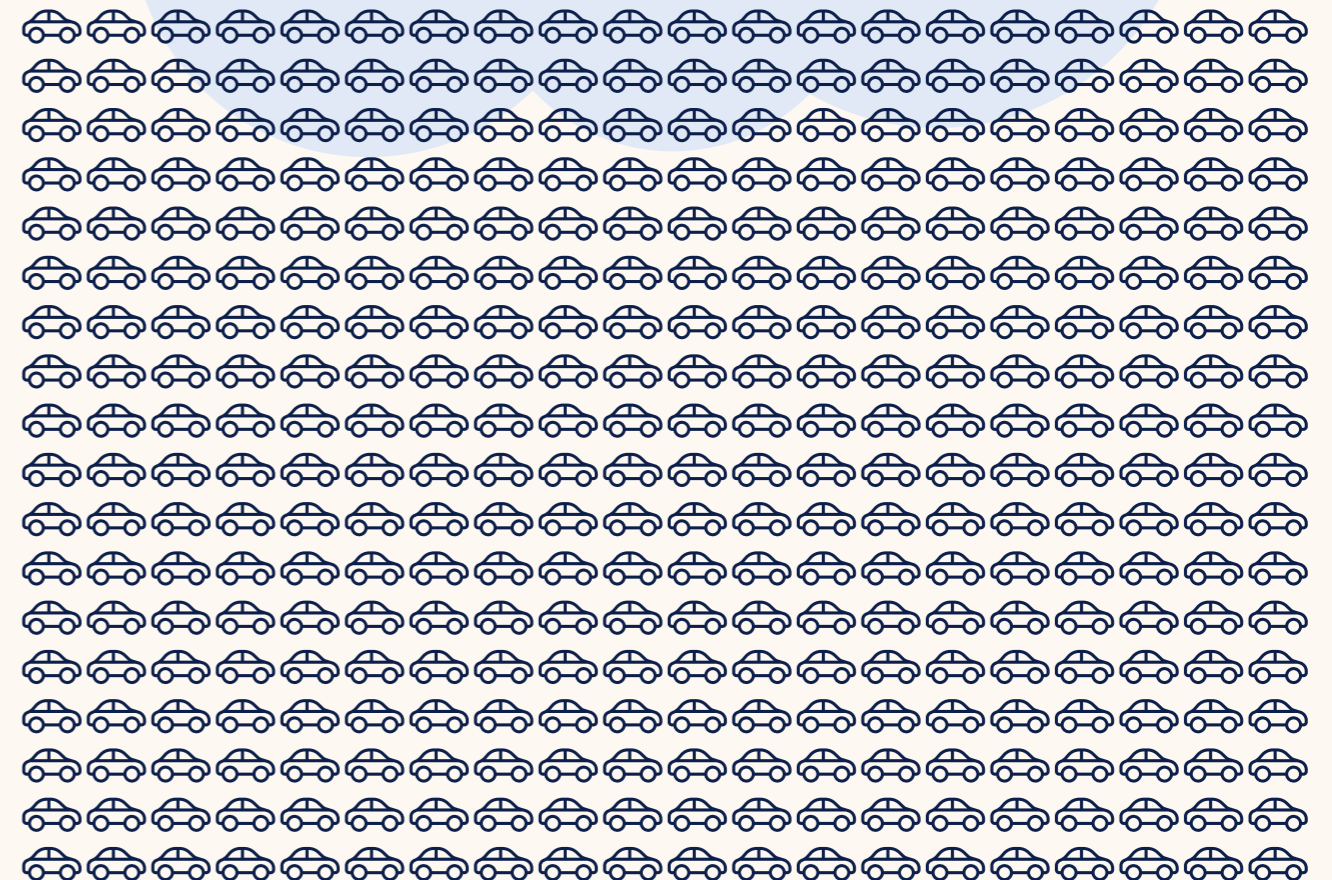
While supermarkets in Europe are much smaller in size than those in the US, the overarching logic remains unchanged. Significant energy savings can be made in food retail stores by prioritizing energy efficiency solutions. And while this may seem like a daunting prospect for store owners carefully watching the bottom line, our experience shows that these investments pay back in less than three years, making a strong business case for their affordability.

1,900

tons CO₂/year



An average-sized US supermarket emits 1,900 tons of CO₂ into the atmosphere. That's equivalent to the emissions from 360 vehicles in one year.



Introducing one of the world's most energy efficient supermarkets

Together with partners and customers, Danfoss has reimagined what true energy efficiency for food retail stores could look like in the 21st century. For the first time, all of Danfoss' most cutting-edge technology and energy efficient food retail solutions are being brought together into one retail site demonstrating the journey towards a zero-emissions supermarket.

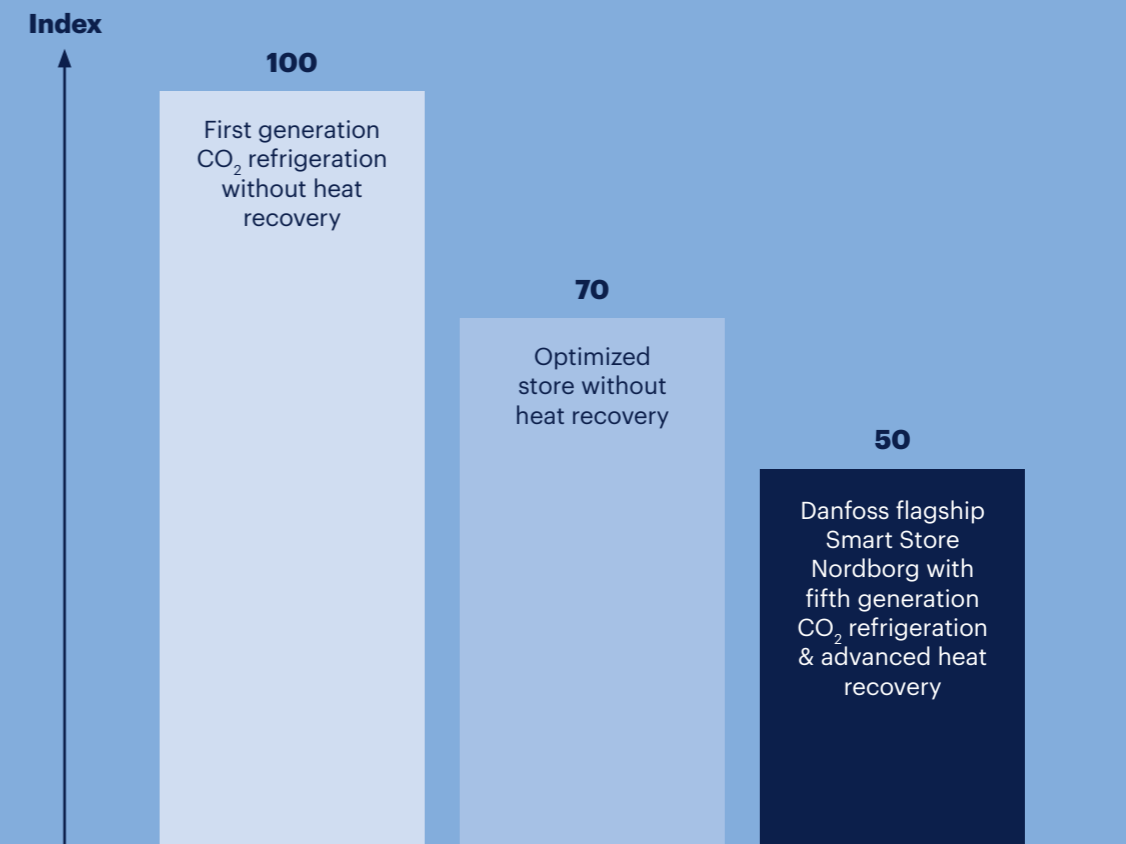
Importantly, the flagship Danfoss Smart Store Nordborg supermarket is expected to be approximately 50% more energy efficient compared to a typical supermarket with a first generation CO₂ refrigeration system, and 20-30% more efficient than an equivalent local store already fitted with multiple energy efficiency solutions⁹, and can inspire the creation of more energy efficient supermarkets and food retail stores globally.

The installations and technologies used in the supermarket are the most energy efficient solutions available on the market, and each typically has an average payback time of 2-3 years. Most importantly, these solutions are scalable. They can be applied in the smallest store up to the biggest hypermarket.

The Danfoss Smart Store supermarket demonstrates that it's not only possible to design and build an energy-efficient supermarket with solutions available today, but it also makes good business sense.

50%

more energy efficient



The installations and technologies used in the Danfoss Smart Store supermarket are the most energy efficient solutions available on the market, and each typically has an average payback time of **2-3 years**.

Towards an energy efficient store

The new Danfoss Smart Store supermarket in Nordborg features a complete portfolio of Danfoss Smart Store solutions, making it one of the most energy efficient supermarkets in the world.

The 1,500sqm Smart Store supermarket is filled with the latest and most energy-efficient refrigeration and heating technology. With Danfoss' smart energy systems applied to its design, the supermarket is expected to be approximately 50% more energy efficient compared to a typical supermarket with a first generation CO₂ refrigeration system, and 20-30% more efficient than an equivalent local store already fitted with multiple energy efficiency solutions, and will operate with lower operational costs.¹⁰

Each of the innovations focuses on saving on operating costs while increasing food safety and reducing food loss. It is built entirely with products and solutions readily available on the market today.

Solutions checklist

- Reuse of excess heat from cooling – Up to 90% reduction in supermarket heating costs**
The supermarket is equipped with a heat recovery unit that captures excess heat from the cooling systems to provide space heating for the entire store, as well as the surrounding community through the district heating network.
- Sustainable refrigeration – CO₂: the natural refrigerant**
The supermarket cooling systems run exclusively on the natural refrigerant, CO₂, which has a global warming impact of 1, roughly 4,000 times lower than traditional hydrofluorocarbon refrigerants (HFCs).
- Solar power as the primary energy source**
100 kW solar panels on the supermarket roof will provide green energy to support the supermarket operations.
- Energy storage – Adapting energy consumption to benefit from cheaper tariffs**
The supermarket's refrigeration system is utilized like a thermal battery, effectively storing or borrowing cooling capacity in the store freezers while energy is cheap or solar electricity is plentiful, then temporarily switching off the compressors during high-cost peak times until the peak has passed.
- Smart refrigeration case control – Saving 8-12% of energy use at system level**
To optimize refrigeration efficiency, it's important to match capacity to demand. Too much cooling, and you waste energy and risk system damage; too little, and you risk food loss.
- Integrating supermarket refrigeration, heating, air conditioning & ventilation**
Most retailers pay to run a heating and hot water system, while a separate refrigeration system releases heat into the atmosphere. Treating these facilities as an integrated solution can reduce a store's carbon footprint, while reducing installation and operating costs.
- Installing doors on refrigerator and freezer cases – Saving one third on energy**
The simple change of adding doors to cooling cases can cut electricity bills by 32%.¹¹
- Utilizing LED lighting – Using up to 85% less electricity than incandescent bulbs¹²**
LED lights do not emit heat, UVA or infrared rays, therefore favoring optimal preservation of food products, especially fruit, vegetables and fresh meat or fish.
- Building and energy certifications**
The store's unique 360-degree circular design and mega-pergola of greenery stands it apart from traditional rectangular supermarket designs. Rainwater collection and the use of solar energy as the primary energy source also reflect the design focus on sustainability.

The potential of supermarket heat recovery – save up to 90% on heating costs

Excess heat is the world's largest untapped source of energy. In the EU alone, excess heat amounts to 2,860 TWh/y, almost corresponding to the EU's total energy demand for heat and hot water in residential and service sector buildings such as schools, hospitals, hotels, restaurants, offices and shopping centers.

Every time an engine runs, it generates heat. Anyone who has felt the warmth behind their refrigerator at home can confirm this. The same is true on a larger scale in supermarkets. Keeping food fresh in cooling displays and freezers generates significant amounts of excess heat.

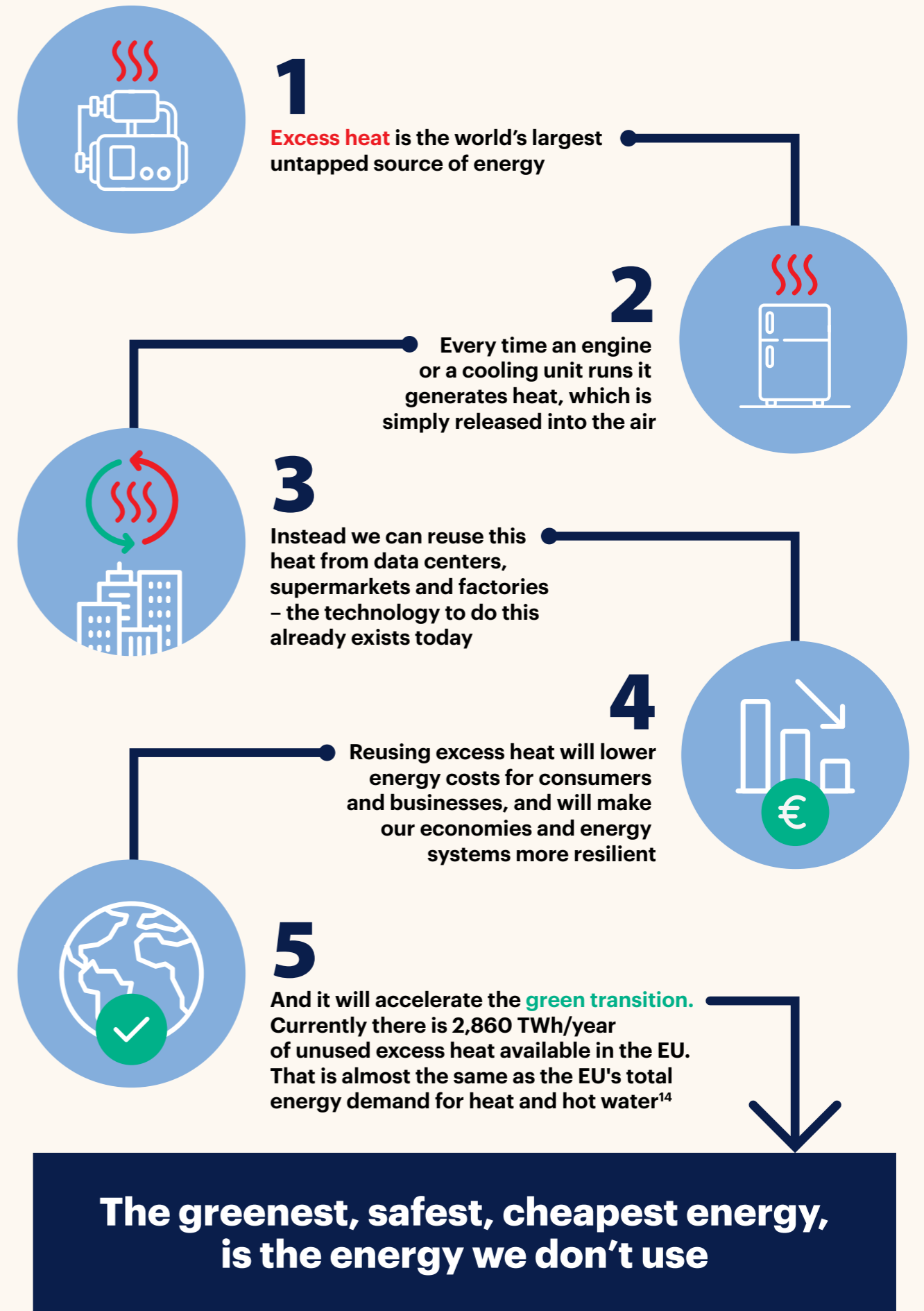
The Smart Store supermarket in Nordborg has the potential to save up to 90% on heating costs by recovering excess heat. A heat recovery unit captures heat from the cooling systems to provide space heating for the entire store, as well as the surrounding community through the district heating network.

An average supermarket can deliver heat to 15 to 20 dwellings in the neighborhood on a yearly average.¹³

Excess heat from supermarkets can be tapped into very easily and reused in the supermarkets themselves in order to heat the space or to provide warm water. All that's required is supermarket owners deploying existing, proven technologies. If the supermarket utilizes a CO₂ refrigeration system, payback is typically within 1-2 years—sometimes sooner.

Danfoss has installed heat recovery units in 165 supermarkets across Europe; the majority in Denmark. The units capture heat emitted by the supermarkets' refrigerators and redirect it back into the stores' own heating systems.

Reusing excess heat not only reduces emissions by replacing significant amounts of electricity or gas that are otherwise needed to produce heat, but it can also contribute to significant energy bill savings. Imagine the cost savings and energy reductions if all supermarkets across the world reused their excess heat. The potential impact on a global scale warrants strong consideration from all governments and businesses across the world.



District energy provides a path to decarbonizing heat and cooling supply by integrating different heat sources that can push fossil fuels out of the energy mix

In 2021, heat accounted for 50% of global final energy consumption;¹⁵ district energy systems can therefore play a vital role in decarbonizing heating supply, offering a simple but effective solution. District energy is a collective system that supplies an entire area with heating or cooling. There are vast district energy systems in China and Europe, and more are expected to come.

Heat is a by-product from various processes and can be distributed to nearby buildings and industries. As the district energy technology evolves, more and more green heat sources can tap into the system, which will put district energy systems at the center of the green transition.

In many parts of the world, district energy systems supply buildings and industries with heating as well as cooling. For example, district energy systems can tap into heat from processes, such as at power plants, and distribute it through pipelines to end users in the form of water.

Today, the majority of global district heat production relies on fossil fuels.¹⁶ According to the International Energy Agency (IEA), the world needs to increase the share of green sources in district heating from 8% today to about 35% in 2030 to reach net zero. If we succeed, this will help to slash carbon emissions from heat generation by more than one third.¹⁷ The solutions are there to meet that goal and more.

Denmark is one of the world's most energy efficient countries, and the widespread use of district heating is one of the primary reasons why.¹⁸ In Denmark, 65% of households cover their demand for heating with district heating, and more than 70% of the heat is generated from sources such as waste, biomass, wind, and excess heat from various commercial processes¹⁹ – i.e. without burning fossil fuels.

One of the main strengths of district energy systems is their capacity to integrate different heat sources that can push fossil fuels out of the energy mix. As a result of improved energy efficiency, temperatures in the district energy systems have been lowered over time, which allows for even more green sources to be introduced into the system.²⁰

Excess heat from commercial processes is one of these alternative heat sources, and excess heat from supermarkets is a concrete example how this can work.

Why choose CO₂, the natural refrigerant?

CO₂ is increasingly being used in food retail applications, and the Smart Store supermarket's refrigeration systems run exclusively on CO₂.

CO₂ has a global warming impact of 1, which is roughly 4,000 times lower than traditional hydrofluorocarbon refrigerants (HFCs) used in retail applications.

Until recently, CO₂ was best used in cooler climates. But now, new technology makes it a realistic and efficient option everywhere – even in regions with higher ambient temperatures. This is possible because technology like the Danfoss Multi Ejector Solution™ significantly increases

energy efficiency during operation in hot ambient conditions. It offers 10% energy savings annualized over the year and, at peak times, is around 30% more efficient than a traditional system.²¹

Initiatives such as Europe's F-gas regulation and the Montreal Protocol Kigali amendment are driving the transition towards refrigerants with a lower global warming potential and are therefore having a direct impact on refrigerant availability and cost worldwide. Choosing an alternative with low global warming potential is a future insurance against market shortages.

Supermarket energy optimization and storage

Increasingly, the biggest potential saving in food retail isn't only in using less energy; it's in optimizing how it's used, and when. Worldwide, there's a growing need to manage fluctuations in energy generation – caused by the intermittent nature of renewable energy – and at times of peak demand.

Danfoss is working with supermarkets on both sides of the Atlantic to help them access bigger savings by shifting refrigeration patterns, while still providing ideal conditions for their food.

The simplest way to optimize energy consumption is to ensure that any energy-intensive maintenance – like defrosting and rail heating – is carried out away from peak energy times. This gives an immediate and recognizable improvement.

Additionally, the Danfoss Smart Store supermarket in Nordborg is using the refrigeration system like a battery, effectively storing or borrowing cooling capacity in the store freezers. For instance, when the supermarket is expecting a peak in energy demand, it will lower its freezer temperature while energy is cheap or solar electricity is plentiful, then temporarily switch off the compressors until the peak has passed. This is also a good way to prepare in advance for a demand response event while always keeping the temperature well within safe limits.


How smart refrigeration makes energy saving simple

As food retailers look to reduce energy bills, every incremental saving counts. Increasing price competition means operating costs have an immediate impact on competitiveness and profitability—and, after staff, energy is the biggest bill most supermarkets have.

Safe, efficient refrigeration is a delicate balance of managing capacity and demand. Retailers can't afford to waste energy on unnecessary cooling, but food and system safety must not be compromised.

At the Danfoss Smart Store supermarket in Nordborg, efficient new high-end case controllers have been a priority investment. Case controllers act as the brain of the refrigerated display case, analyzing and optimizing performance, and coordinating the various components to maximize energy savings while prioritizing food safety.

One solution alone, which ensures that the refrigeration evaporator – a critical component of refrigeration – is always fully utilized under all conditions, can save between 8-12% of energy use at the system level.



The natural CO₂ refrigerant has up to **4,000** times less impact on global warming

Integrating supermarket refrigeration, heating, and air conditioning

Every cost saving is valuable and yet most retailers pay to run a heating and hot water system while a separate refrigeration system releases heat into the atmosphere. At the Danfoss Smart Store supermarket we are treating these facilities as an integrated solution to reduce the store's carbon footprint, while reducing installation and operating costs. By integrating the store's refrigeration system, we have even eliminated the need for a boiler.

This integration was once difficult to achieve. However, the rising popularity of CO₂ as the preferred refrigerant is making it more common – while Danfoss' purpose-built Heat Recovery Unit helps to eliminate the technical challenge.

Additionally, by integrating the air conditioning into the refrigeration system, it's possible to get the additional cooling load at reduced cost.

Reducing food loss

The resources needed to produce the food that becomes lost or wasted have a carbon footprint of about 3.3 billion tons of CO₂.²² If food waste could be represented as its own country, it would be the third largest greenhouse gas emitter globally, almost equal to the EU-28.²³

Timely responses to issues in cooling units are critical to preventing food losses. To minimize food loss, improve data collection, and monitor refrigeration systems and individual products – detecting and addressing potential problems before they occur – we have installed Danfoss Alsense IoT Food Retail Services in the Smart Store.²⁴

Danfoss Alsense IoT Food Retail Services provides scalable, digital, and expert-managed services for optimizing the performance of food retail operations. Data is sent to the cloud in real-time for analysis and turns emerging problems into opportunities for greater efficiency.

By delivering real-time insights to supermarket store managers, Danfoss Alsense IoT Food Retail Services helps to prevent food loss. Without the Danfoss Alsense monitoring and alarm system, if a supermarket freezer case was to go down overnight then it's probable that the entire line of frozen foods stocked in that freezer would need to be disposed of as food loss. Preventing food loss at such scale is critical to preventing lost revenue and reducing emissions.

Building design and sustainability certifications

The 360-degree design of the Danfoss Smart Store supermarket uniquely stands it apart from the traditional rectangular shape of supermarket architecture.

A so-called mega-pergola with climbing plants will create a circular wall of greenery to surround the two key parts of the building – the supermarket and the Application Development Center. Additionally, a carpet of succulent plants will cover part of the store's roof.

The neutral colors of the materials chosen for the building's primary façade, alongside the greenery of the mega-pergola and roof garden, blend seamlessly with the surrounding parkland environment.

Sustainability is also at the heart of the building design with rainwater collected from the building roof utilized to water the plants growing on the mega-pergola. The 100kW solar panels installed on the roof will provide a green primary source of energy to the store.

Applications for building sustainability certifications DGNB Gold (EU) and LEED Platinum (US) are pending. Crucially, the Smart Store showcases that it does not require significant resources to ensure the building is future-proof and positively impacting the surrounding community.

Green supermarkets are possible everywhere

Efficient supermarkets in Portugal and Italy

For supermarkets in warm climates, air conditioning is among the biggest energy consumptions. A project funded by the European Union called MultiPACK recently concluded 5 years of research that aims at building confidence in integrated heating, ventilation, air conditioning and refrigeration (HVAC&R) packages based on CO₂ technology. This is an alternative to F-gases, installed in high energy demanding buildings.

Three supermarkets in Portugal and Italy participated in the project, and demonstrated that an integrated CO₂ system for refrigeration, air conditioning and heating can outperform HFC units both in terms of costs and energy efficiency, demonstrating the huge potential for improving energy efficiency in supermarkets.

SuperBrugsen in Høruphav, Denmark

In Høruphav, a small town in the south of Denmark, the local supermarket SuperBrugsen has saved a considerable amount of energy by reusing and selling excess heat from the cooling systems.

Since 2019, 76% of SuperBrugsen's heat consumption has been covered by reused heat from cooling processes. And the supermarket has sold 182.5 MWh to other local buildings through the district heating grid, which is equivalent to the energy needed to keep more than 7 family houses warm over a year.

The supermarket Aktiv & Irma in Oldenburg, Germany

The supermarket Aktiv & Irma in Oldenburg, Germany, is at the forefront of 'green supermarkets'. Not only does the supermarket reuse its excess heat from the cooling display cases to keep the store at the right temperature, but during peak hours this energy is used to offload the grid and save the supermarket expensive energy peak costs – all without damaging food safety.

During off-peak hours when the weather is windy and sunny, the local power plant typically has plenty of cheap, renewable power. In that situation, the supermarket charges the batteries, drawing extra energy from the grid or photovoltaic system on the roof.

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