SECTOR INTEGRATION

The local supermarket, the power of excess heat

The challenge:

Buildings

28%

of all global energy-related CO_2 emissions come from buildings

Industry

39%

of all global energy-related CO_2 emissions come from industry

Transport

27%

of all global energy-related CO2 emissions come from transport

Sector integration

Source: IEA (2021). Greenhouse Gas Emissions from Energy

In 2018, heat accounted for **50%** of global final energy consumption.[1]

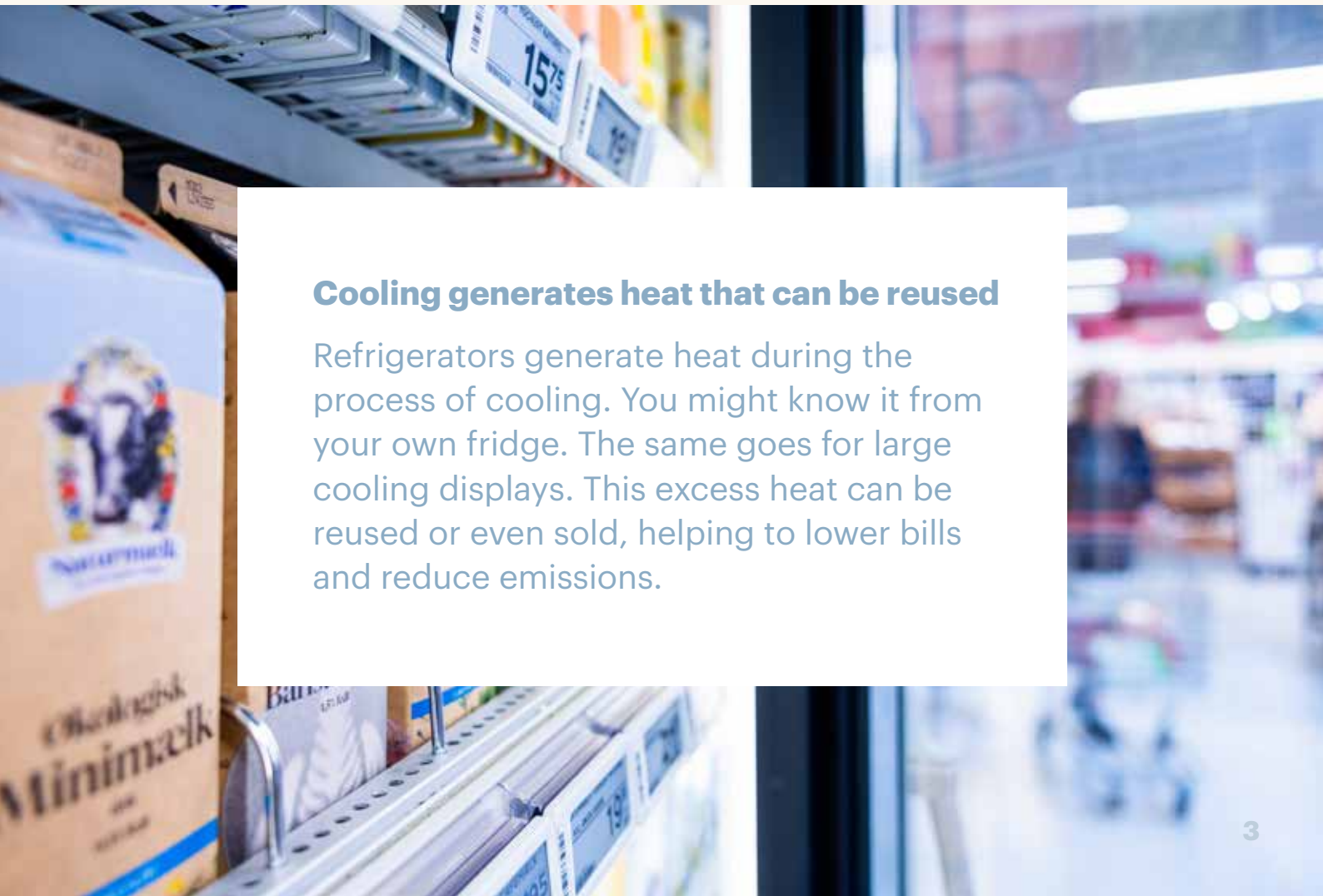
Energy is being wasted everywhere. In the US, 65% of all the energy produced is squandered in the form of waste heat.[2] There is tremendous potential in reusing heat that would otherwise be wasted, also known as "excess heat."

1. IEA (2019). Renewables 2019: Heat.
2. World Economic Forum (2018). Visualizing US energy consumption in one chart.

The solution: The power of excess heat

In a small town outside Sønderborg, Denmark, a local supermarket reuses the excess heat that is generated from cooling displays and freezers.

- The local supermarket covers 78% of their heating bill by reusing heat from its cooling displays.
- The supermarket sells green excess heat to nearby homes and companies through the district energy system.



Cooling generates heat that can be reused

Refrigerators generate heat during the process of cooling. You might know it from your own fridge. The same goes for large cooling displays. This excess heat can be reused or even sold, helping to lower bills and reduce emissions.

A local supermarket shows the green potential in excess heat

District heating offers a path for decarbonizing the heating sector

Supermarkets 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. [3]

Keeping food fresh in cooling displays and freezers accounts for most of the energy consumption in a supermarket. It might sound counter-intuitive, but cooling displays, freezers and fridges produce a significant amount of heat. Anyone who has ever felt the warmth behind their fridge can confirm that. These cooling systems generate significant amounts of excess heat, which is often released directly into the atmosphere and wasted.

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

Since 2019, 78% of SuperBrugsen's heat consumption has been covered by reused heat from cooling processes. And the supermarket has sold 133.7 MWh to other local buildings through the district heating grid, which is equivalent to the energy needed to keep 7 family houses warm over a year.[4]

Three interlinked initiatives have driven the results.

3. Environmental Investigation Agency and Shecco (2018). Technical report on energy efficiency in HFC-free supermarket refrigeration, p. 10.
4. Dansk Fjernvarme (2022). Varmeprisstatistik.

First, like many other supermarkets, SuperBrugsen has converted from chemical refrigerants to a natural refrigerant – namely CO_2 – which is a reliable, environmentally friendly refrigerant.[5] CO_2 is also a highly efficient refrigerant, which requires less energy to perform.[6]

Second, a heat recovery unit is installed at SuperBrugsen, and it is designed to recover the waste heat from CO_2 refrigeration systems. The recovered heat is reused to heat up the store and produce domestic hot water.

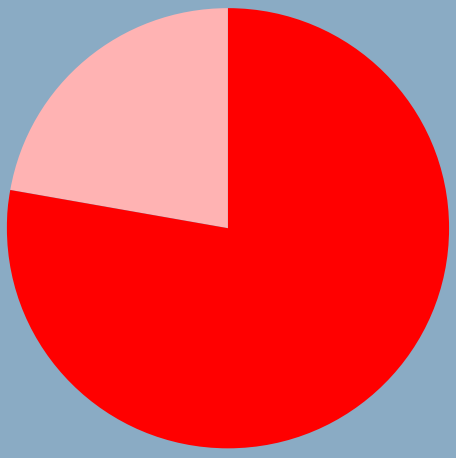
Third, SuperBrugsen runs energy efficiency programs. Cooling systems involving high pressures, liquids, and thermodynamics as well as frequent monitoring, adjustments and service have improved energy efficiency and lowered energy consumption at the supermarket even more.

Several supermarkets with different owners are following the example of SuperBrugsen by reusing excess heat to lower their energy bills. And, at times, by selling excess heat to neighboring buildings through the district energy system.

5. Environmental Investigation Agency and Shecco (2018). Technical report on energy efficiency in HFC-free supermarket refrigeration, p. 13.
6. Danish Environmental Protection Agency (2002). Bilag 2 - Kølemiddelgrupper.

Results from SuperBrugsen in Høruphav, Denmark

Since August 2019, when the energy efficiency installations were in place, Superbrugsen Høruphav, Denmark, covered most of its heating demand by reused energy.



78%

of heat demand is covered by reused energy

133.7 MWh has been sold to the district energy system.

Results in the period from August 2019 to April 2022

	Total heat consumption	Reused energy	Sold energy
Super Brugsen Høruphav	**668.1 MWh**	**523.1 MWh**	**133.7 MWh**

District energy provides a path to decarbonizing the heat and cooling supply

In 2018, heat accounted for 50% of global final energy consumption[7]. District energy systems enable a 100% green heat supply today. District energy systems therefore play a vital role in decarbonizing heating supply, which requires nearly half of global final energy consumption.[8] District energy systems offer a simple but effective solution. 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. District energy systems tap into heat from processes, such as at power plants, and distribute it through pipelines to end users in the form of water. 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.

Today, the majority of global district heat production relies on fossil fuels.[9] 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.[10] **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.[11] In Denmark, 65% of households cover their demand for heating with district heating and more than 70% of the heat is from green sources such as waste, biomass, wind and excess heat from various commercial processes.[12]

7. IEA (2019). Renewables 2019: Heat.
8. EA (2019). Renewables 2019: Heat
9. IEA (2021). District Heating.

Sønderborg Municipality is no exception. Since 2007, carbon emissions from space heating and domestic hot water have dropped by 73% and the local district energy systems have been key drivers. Moreover, the share of natural gas-fired district heating has been reduced from 70% to 8% in the same period.[13]

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.[14] Excess heat from commercial process is one of the new heat sources that can tap into the district energy system. A laptop generates heat to operate, and a data center does the same on a large scale. Excess heat from data centers can be reused through the district energy system to supply heat to homes and companies. The same goes for supermarkets. A fridge generates heat when it keeps food and drinks cold, and the cooling displays in supermarkets do the same only on a much bigger scale.

Heat is a waste product from many daily processes, and it can be reused or sold, instead of simply being released into the atmosphere. The binding link is often the district energy system.

10 IEA (2021). District Heating.
11 Danish Energy Agency (2022). Danish Experiences on District Heating.
12 Dansk Fjernvarme (2022). Fakta om Fjernevarme.
13 ProjectZero (2021). Monitoring report 2020 Sonderborg Municipality, p. 38-39 & 41.
14 Thorsen, J. E., et al. (2018). Progression of District Heating – 1st to 4th generation.

Green supermarkets are possible all over the world

Every time an engine runs, heat is generated. That is true for basically all work processes. But much of the energy is wasted. In the US, **65% of all the energy produced** is estimated to be squandered as waste.[14] There is a great potential in reusing excess heat through existing and well-proven technologies. And there is great potential in selling excess heat through district energy systems. According to a recent estimate, excess heat from accessible sources in urban areas can cover **10% of the European Union's total energy demand.**[15] Supermarkets serve as an example of the potential in excess heat, but the potential is bigger. The cooling displays at supermarkets can also serve as batteries that can store energy that can be used in peak-periods when energy is expensive.

14. World Economic Forum (2018). Visualizing US energy consumption in one chart.
15. European Commission - Cordis (2019). ReUseHeat quantified EU28 urban waste heat potential.

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, during peak hours this energy is used to offload the grid and save the supermarket expensive energy peak costs – all without damaging food safety.

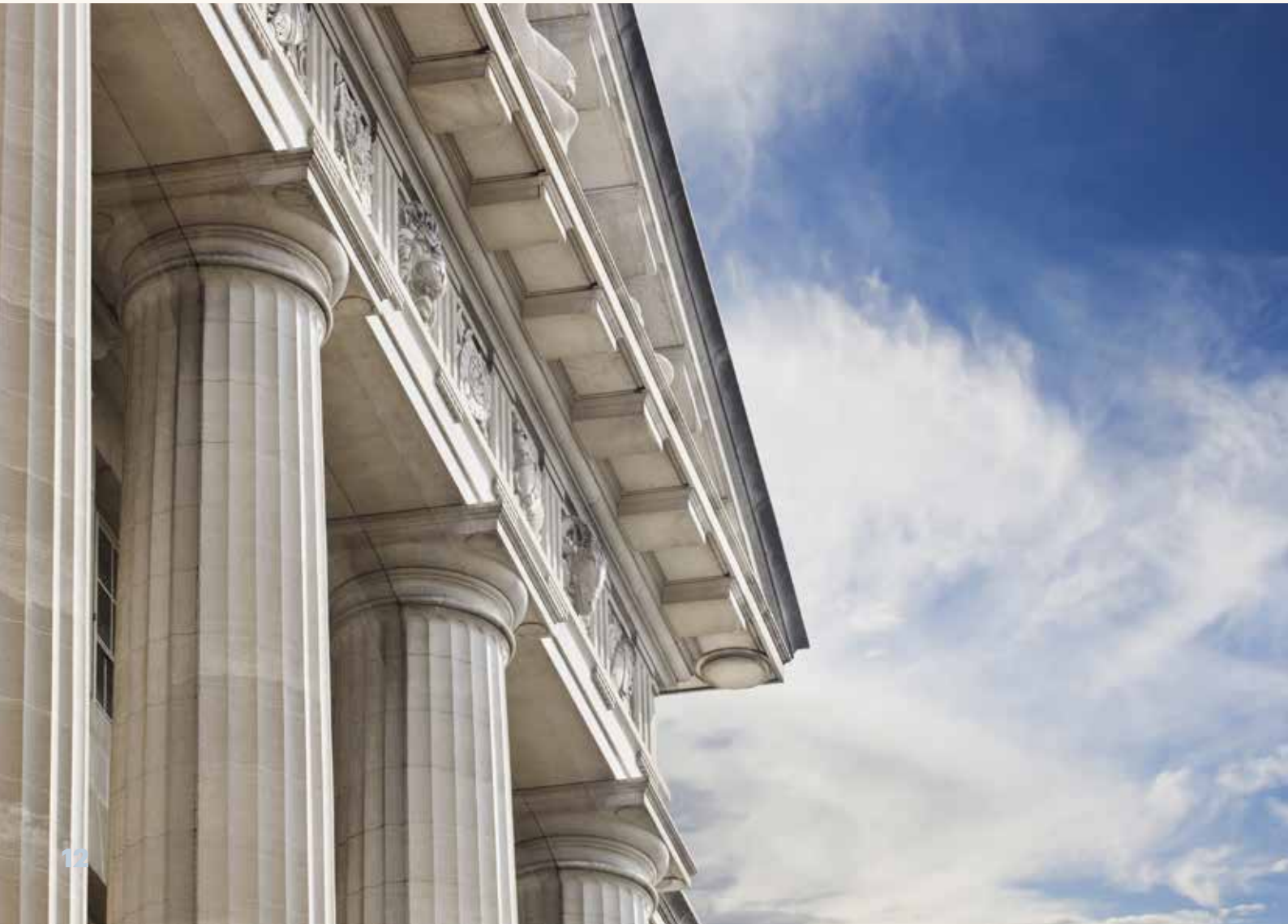
During off-peak hours when the weather is windy and sunny, the local power plant typically has plenty of cheap, renewable power. In that situation, the supermarket charges the batteries, drawing extra energy from the grid or photovoltaic system on the roof.

Efficient supermarkets in Portugal and Italy

For supermarkets in warm climates, air conditioning is among the big energy consumers. 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 CO_2 technology, as 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 CO_2 system for refrigeration, air conditioning and heating can outperform HFC units both in terms of costs and energy efficiency.

Stakeholder toolkit

A more systematic use of wasted energy across all sectors presents a huge, unharnessed energy efficiency potential and constitutes a major opportunity for the industry, governments and citizens to save money, enhance competitiveness and reduce volatility of the energy system. The technologies exist – results depend on a continued and long-term, systematic planning effort supported by the right regulatory frame-work. Here are some of the key considerations and measures that regulators can use to push for a more energy efficient energy system.



Set minimum requirements

Raise the bar for effort by setting targets and performance standards – an example could be mandatory energy planning. In general, begin to consider waste as an energy resource instead of a problem to be disposed of. Almost all waste can be used for energy production – whether we talk about excess heat, excess cooling, sludge from wastewater systems or household waste. Energy planning begins with a strategic view on excess heat. For instance, in Denmark, municipalities were asked to map the existing heat demand, the existing heat supply method and the amounts of energy used. Furthermore, municipalities can also make an estimate of future demands and supply possibilities. Based on this information, overall energy plans can be prepared that show the priority of heat supply options in any given area and identify locations for future heat supply units and networks. Depending on the existing energy system, energy planning can reveal small-scale potentials (such as forming the right incentives to heat recovery or the potential of co-generation of heating and electricity) or it can reveal the potential of larger-scale opportunities, such as the rollout of district heating.

Address economic incentives

To further improve energy efficiency by using wasted energy, it is essential to remove both financial and legislative barriers. The current design of the energy market is, in many places, a barrier to sector integration technologies, either by hindering the participation of sector integration technologies in specific markets or by not internalizing all positive and negative externalities of respectively low- and carbon-intensive technologies. For instance, power-to-gas facilities may be treated as end consumers and face electricity input costs that include end-user taxes and levies. Therefore, it should be considered to make energy markets reflect positive and negative externalities in order to level the playing field for all technologies and carriers contributing to energy supply. Aspects such as cost-reflective energy price signals, adequate carbon pricing, market accessibility and liquidity, and appropriate network tariff structures should be considered.

Establish partnerships

A more systematic use of excess heat is, at its core, an exercise that spans sectors and stakeholders. Partnerships between local authorities, energy suppliers and energy sources such as supermarkets, data centers, wastewater facilities and industries can help to maximize the full potential of excess heat.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Combining multiple energy sources into an integrated system accelerates the path to zero. The solutions are here.

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