Danfoss Sustainability Paper No. 1

Decarbonization Explained

Reduce Reuse Re-source

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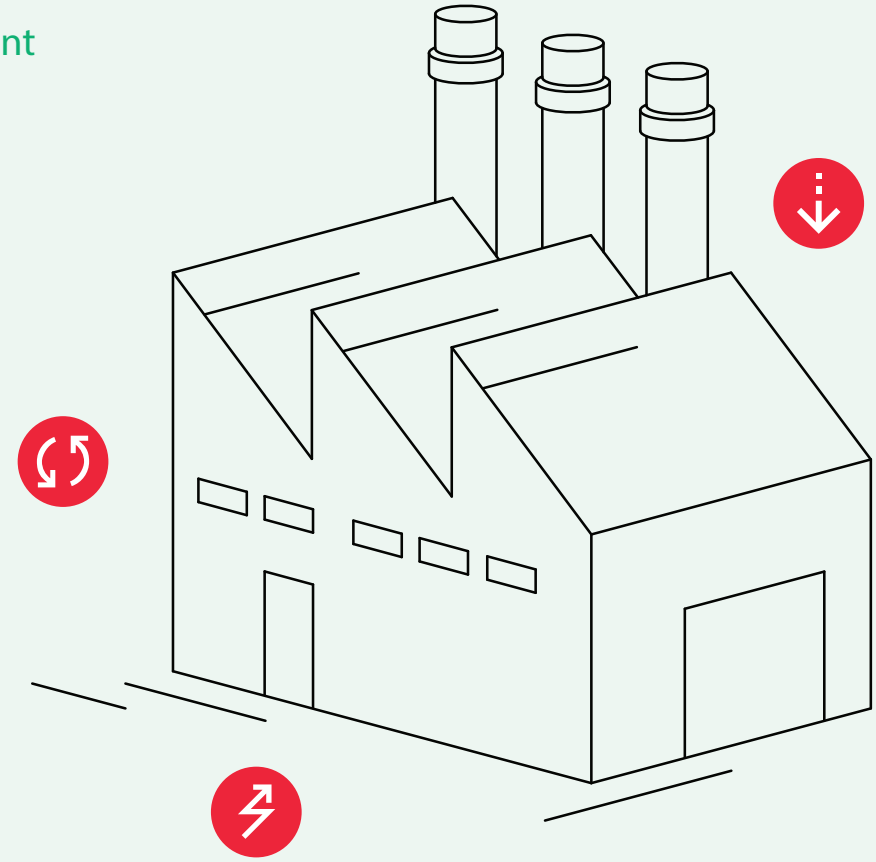
An intelligent and cost-efficient decarbonization approach



Executive summary

We can accelerate the decarbonization of the industrial sector in a rapid and cost-efficient way, but only if we work together and learn from each other. At Danfoss, we have proven solutions and a cost-efficient, stepwise approach to decarbonization. When decarbonizing our own operations globally, we apply the same approach as we bring to our customers.

Our stepwise approach has already enabled us to decarbonize five of our factories – with the rest on track to become carbon neutral by 2030. We have coined this approach: 'Reduce, Reuse, Re-source'.

Sequence matters. To decarbonize and grow the role of green electricity in the energy mix, it is a fundamental, yet often overlooked fact that we must first strive to reduce the demand for energy in industry. We do this by scaling energy-efficient technologies and increasing machine productivity to avoid energy waste. Secondly, we must reuse energy through energy recovery and sector coupling. And thirdly, we must re-source energy by replacing fossil fuels with electricity powered by renewables.

Only in this sequence can we achieve a rapid and cost-efficient decarbonization. Already, we have many of the solutions available to support this three-step approach – solutions with short payback times and attractive returns.

But seeing is believing. This is why we are publishing the first edition in the Danfoss Sustainability Paper Series. In the paper, we introduce you to our stepwise approach and show how proven energy-efficiency solutions, when implemented in the right sequence, can drive decarbonization within an organization. We also provide guidelines and recommendations for how companies and sustainability professionals can implement this approach to decarbonize their own operations.

Actions speak louder than words. Let's get started!

A proven approach to decarbonization

We stand at a pivotal moment in the fight against global climate change. With the world's population on course to reach nearly 10 billion people by 2050,[1] we need to use 8% less energy than we do today to achieve the global goal of reaching net zero emissions.[2] In 2023, global leaders agreed that to keep the goals of the Paris Agreement within reach, we must triple renewables and double energy efficiency globally by 2030.[3]

At an industry level, we can all help make this a reality by using the intelligent and cost-efficient approach created and applied to our own operations at Danfoss – 'Reduce, Reuse, Re-source' – and combine it with technology solutions that are already available today.

We have implemented our stepwise approach across our global campuses since 2007. In 2022, our headquarter campus spanning 250,000 m^2 of indoor floorspace became carbon neutral. In 2023, our Graasten, Kolding, and Sunds campuses in Denmark and our Vaasa campus in Finland also became carbon neutral.[4]

We use the same stepwise approach when we decarbonize with our customers, and we bring the solutions to the market in a responsible way - all with short payback times.

Decoupling growth from emissions

"One of the most difficult and necessary challenges for our industry and the industries we serve to solve is to reduce carbon emissions and, at the same time, continue to grow and invest in technologies needed for the green transition. Using the 3 R's, Danfoss has begun to decouple our growth from the carbon emissions from our operations."

Frances Iris Lu
Vice President, Head of Sustainability & ESG

What are the 3 Rs?

To decarbonize our operations, we must first think about obvious ways to **reduce** energy consumption. Within industry, machine productivity immediately comes to mind as an obvious lever. Also, electrification itself is a highly impactful form of energy efficiency, as most electric technologies have a lower rate of energy loss while performing the same function as a fossil-driven equivalent. In fact, by transitioning from a fossil energy system to a fully electrified one, it is possible to cut up to 40% of final energy consumption.[5]

Then imagine that we start to **re-use** the energy that has already been produced. Currently, we are not nearly utilizing the full potential of the world's largest untapped energy source: excess heat. In 2030, up to 53% of the global energy input will be wasted as excess heat[6] from a wide range of sectors and machinery, such as supermarket freezers, data centers, industrial machinery, and wastewater treatment plants. But by capturing and reusing it, excess heat can replace significant amounts of electricity, gas, or other fuels that are otherwise needed to produce heat.

Finally, after we lower emissions and become more efficient through electrification and excess heat reuse, we need to find ways to **re-source** our energy supply to renewable energy sources. If the goals of the Paris Agreement are to remain within reach, renewable energy must make up 70% of the energy mix by 2050.[7] But unless we first reduce energy demand and reuse what has already been produced, renewable energy production will not be near sufficient to meet the energy demand in an electrified energy system serving a population of 10 billion in 2050.

Step 1

Reduce
Improving energy efficiency

Step 2

Reuse
Utilizing energy recovery

Step 3

Re-source
Sourcing renewable energy

The current path is too costly and slow

To achieve net zero emissions by 2050, we must undergo a full-scale transformation of our energy system. In fact, according to the International Energy Agency, renewable energy must represent roughly 70% of the global energy mix by 2050 (Figure 1).[8] But only by reducing our energy demand will it be possible to produce enough renewable energy to increase its share of the energy mix.

A revised understanding of energy efficiency

In the future energy system, energy efficiency and electrification must take center stage alongside the build out of renewables if we are to reduce fossil fuel dependency, ensure affordable energy security, and transform the way energy is consumed. This revised understanding of energy efficiency is the fastest and most cost-efficient way to turn a 2050 net-zero scenario into a reality. The good news is that we already have the necessary technology. We must simply implement it in the right places at the right time.

For instance, many industrial actors already know that electric technologies like industrial heat pumps, variable speed drives, and electric vehicle fleets are a powerful way to reduce Scope 1 and 2 emissions. But to close the remaining gap, they must also re-source their electricity demand to renewable energy sources. This is the only way to ensure they are holistically decarbonized. This shows that energy efficiency, electric technologies, and renewables are intimately intertwined and must all be considered together if we are to fully decarbonize our energy system (see Figure 2). None can be successful without the others.

Energy efficiency, electrification, and renewables must be considered together to reach net zero by 2050.

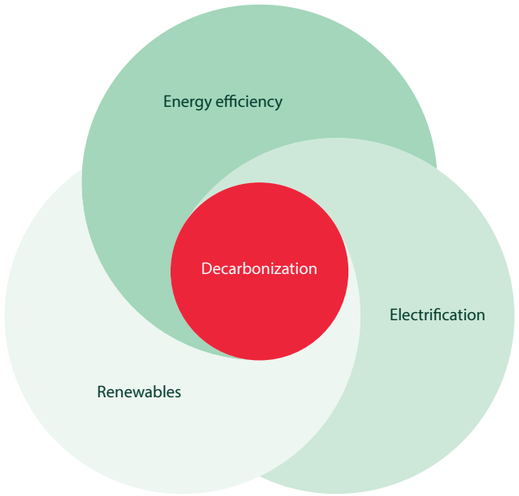


Figure 2: Interdependence between energy efficiency, electrification, and renewables must be considered to deliver decarbonization.

The transformation of the world energy supply

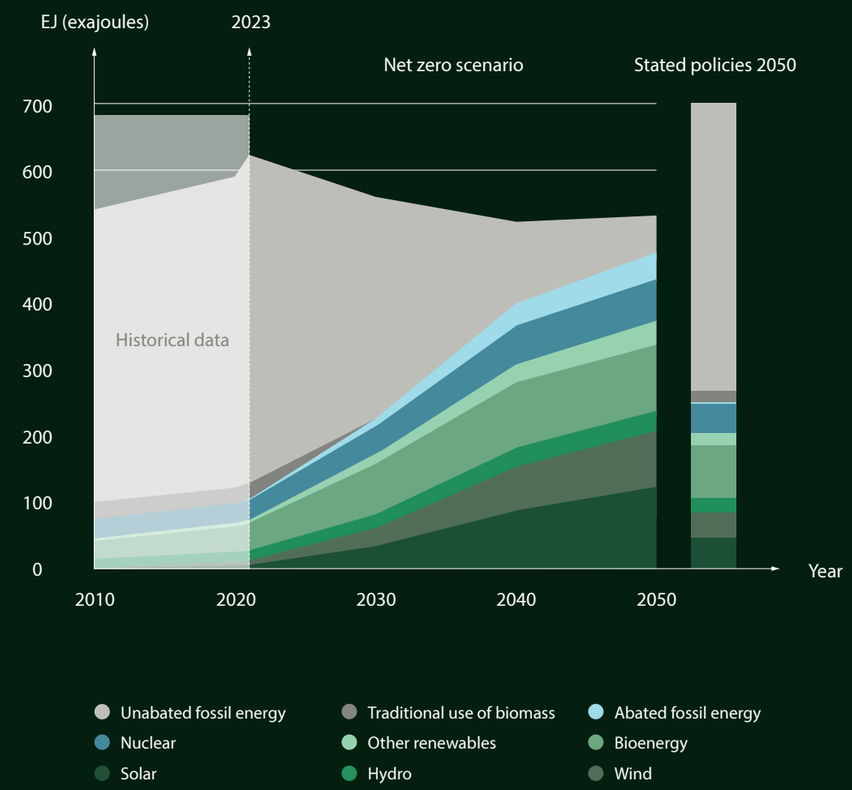


Figure 1: The necessary transformation of the world energy supply if we are to reach net zero, and where we will be in 2050 if we continue at the current trajectory with the stated policies. Source: IEA Word Energy Outlook 2022.

Sequence matters in decarbonization

To decarbonize, we must reduce, reuse, and re-source our energy. However, the order of these steps is critical to reducing emissions in a rapid and cost-efficient manner. By first reducing the energy demand through energy efficiency and electrification, and then reusing excess energy to the greatest extent possible, it is possible to increase the share of renewables in the energy mix, hereby lowering total emissions.

Reduce
Improving energy efficiency

Reducing energy waste is possible across all sectors. Energy efficiency is the quickest and most affordable way to decarbonize. It can improve the fuel economy of machines and reduce demand for diesel, while simple and smart technologies for heating and cooling buildings can reduce energy consumption significantly. Likewise, implementing better energy management in industries can deliver significant energy savings. Energy efficiency is a major opportunity to drive the world towards an ambitious and cost-efficient green transition.

In the industrial sector, look at the things that run continuously in many factories. Fans. Pumps. Motors. Assembly lines. They don't need to run all the time, but they often do. In fact, most factory productions today keep their systems running 24 hours a day, 7 days a week. However, reducing superfluous energy consumption such as this is quite simple. For example, through variable speed control, we can make industrial systems run only when they need to, increasing energy efficiency and reducing waste. Variable speed drives make this possible in a wide range of applications.

Another key way to reduce energy demand is to electrify wherever possible. This is because electric technologies are in most cases more efficient than their fossil-driven counterparts.[9]

Reuse
Utilizing energy recovery

Energy reuse has a large, untapped potential in the green transition. Industries, supermarkets, data centers, and wastewater facilities all produce large amounts of excess energy – often in the form of heat. Think of the heat behind your refrigerator, but on an industrial scale and at much higher temperatures. By 2030, up to 53% of the global energy input will be wasted as excess heat.[10] However, with technologies such as heat exchangers and heat pumps, this heat can be reused in multiple ways, lowering energy demand for heating.

One way to reuse excess heat is to repurpose it onsite, either for space and water heating or for other industrial processes. Another is to sell it back to the grid, either through nearby district energy networks or industrial cluster microgrids. By more deeply integrating sectors in this way, heavy energy consumers can become major energy suppliers.

Every unit of energy that we can reuse means one less that needs to be produced. Currently, since most heat globally is produced from fossil fuels, excess heat reuse also converts directly into emissions savings. However, even once we have fully re-sourced energy supply to renewable electricity (i.e., Step 3), maximizing energy reuse means less demand on electricity grids, leading to a cheaper and more stable supply of electricity.

Re-source
Sourcing renewable energy

Once we have reduced our energy consumption and reused as much energy as possible, all remaining demand must be sourced from renewable energy sources. Through electrification, we can lower emissions and become more efficient, enabling a future energy grid powered by renewables.

Re-sourcing means that we transition away from fossil fuels and draw the majority of our energy from renewable sources, such as solar, wind, and green hydrogen. This is a big step for the industrial sector, because it requires operations to run with all processes electrified. Wherever direct electrification of industrial processes is not possible – such those requiring extremely high temperatures – we can electrify parts of the process through hybrid solutions or indirectly electrify through use of green hydrogen.

If we cannot scale industrial electrification, re-sourcing to renewable energy will not work. But it's not an insurmountable task: up to 78% of industrial sector energy use can be electrified with technology already available today.[11]

"Our three-step decarbonization approach has proven to be an effective roadmap for industry to decarbonize their growth quickly and cost-effeciently with our solutions readily available."

Torben Christensen, Chief Sustainability Officer & Head of Global Services, Danfoss

Applying the three-step approach at Danfoss

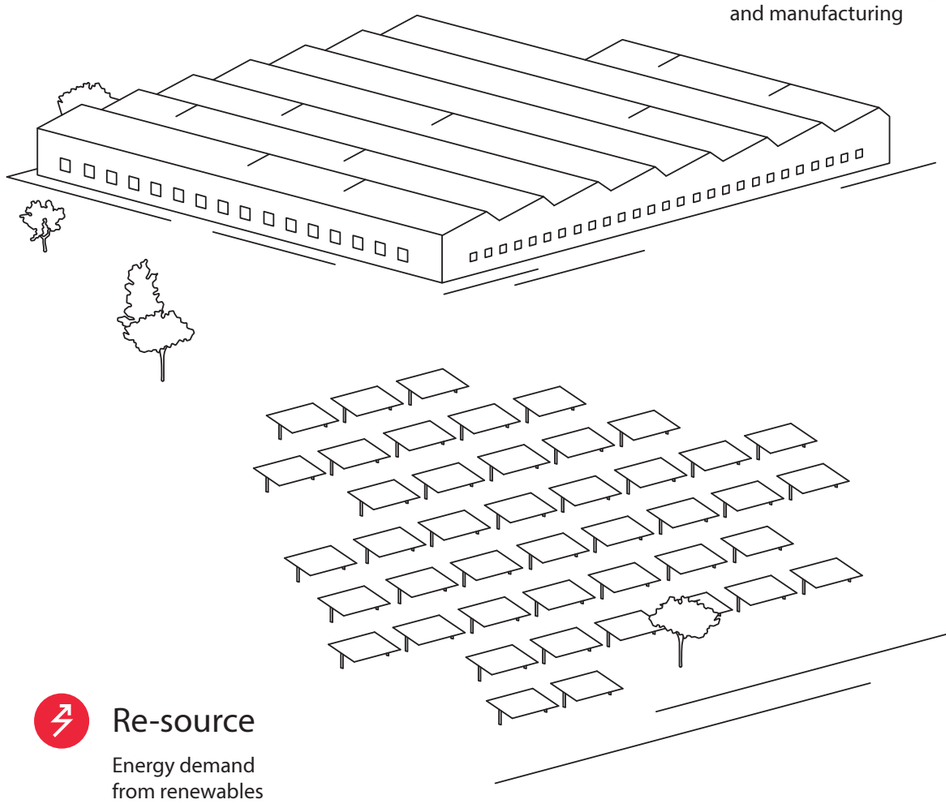
The Danfoss headquarter campus in Nordborg, Denmark achieved CO_2 neutrality in December 2022 (Scope 1 & 2) by applying our 'Reduce, Reuse, Re-source' approach to decarbonize our operations and facilities.

Reduce

Energy consumption from machinery and buildings

Reuse

Excess heat for buildings and manufacturing



Re-source

Energy demand from renewables

↓ 79%
heat consumption for manufacturing processes and buildings

↓ 41%
electricity consumption

3 years
or less estimated payback time for all investments related to carbon neutrality

The road to cost-efficient and intelligent decarbonizaton

Step 1: Reduce

The greenest energy is the energy we don't use

At our 250,000 m2 headquarter campus in Nordborg, we have reduced our consumption since 2007 by moving away from an "always-on" state. By matching energy need and consumption, we are using energy in a smarter and more cost-efficient way.

At each of our facilities, we apply our control and monitoring technologies to manage our use of cooling, heating, and lighting according to shifting energy needs. A key driver has been to optimize our ventilation system, which has enabled us to lower the need for heating significantly. Overall, we have been able to reduce heat consumption by 79% from manufacturing processes and buildings, and electricity consumption by 41%.[12]

Step 2: Re-use

Excess heat is the world's largest untapped source of energy

Energy savings related to the Step 1 activities have helped lower temperatures in the factory site's heating network significantly from 145°C to 67°C. In addition to fewer transmission losses, lower temperatures in the heating grid make it possible to recover and reuse a significant amount of excess heat from our supermarket, datacenter, and manufacturing processes across the campus.

As an example, we make sure that the heat generated by the servers in our datacenter can be captured and re-used to heat the building during the winter, ensuring that both the energy consumed, and the energy created by the datacenter is utilized in the most efficient way possible.

Step 3: Re-source

Sourcing renewables takes us the last mile

After reducing energy consumption and using excess heat to the furthest extent possible, we source renewable energy for the remainder of the demand. We do this through a mix of heat recovery from manufacturing processes and our Danfoss data center, green district heating, locally produced biogas, and grid balancing by help of an electric boiler.

Remaining electricity demand is covered primarily by solar panels and through corporate power purchase agreements with suppliers of carbon-neutral energy.

“We are leaving the fossil fuel era, but we haven’t prepared our energy system for the future because we are neglecting energy efficiency as one of the main tools to lower emissions.

We have entered a new era where the future energy system is electric and where improving energy efficiency in machines, infrastructure, and industry is critical to delivering an affordable, secure, and decarbonized future.”

Kim Fausing
President and CEO, Danfoss

Recommendations

Follow the sequence

Sequence matters in decarbonization. Firstly, reducing energy waste is possible across all sectors. Secondly, reusing energy is a large untapped potential in the green transition. Finally, re-sourcing from fossil fuels to renewables is the essential third step.

Use existing technology

To reach global sustainability targets, we need to implement existing technology and solutions that increase machine productivity, reduce emissions, lower energy consumption, and enable electrification. We do not need to wait for new innovations – we just need to implement available solutions.

Engage the whole company

It is not enough for executives, sustainability professionals, and procurement teams to act in isolation to drive the green transition; to truly decarbonize across a company, every employee must be on board. Fostering broad buy-in and soliciting input from employees will create a sense of purpose and shared ownership of the company’s decarbonization journey.

Share best practices across industries

At Danfoss, we decarbonize together with our customers and help companies make considerable progress towards net zero. By fostering strong relationships across sectors and industries built on a common vision about the need for ambitious decarbonization, we can all help ensure that the most innovative technologies and strategies are being implemented as widely as possible.

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Danfoss Sustainability Papers

A sustainability thought leadership series to provide insights into our sustainability projects and learnings and share best practice with industry peers and sustainability professionals.

We are committed to become our customers' preferred decarbonization partner, but we cannot do it in isolation. To systemically drive down emissions in the entire value chain for scope 1, 2 and 3, we need to learn from each others' sustainability journeys across industries and sectors.

We are all part of the same chain. Let's accelerate the green transition together.