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SUSTAINABLE INDUSTRIES

An efficient and sustainable use of energy, water and resources

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SUSTAINABLE INDUSTRIES
An efficient and sustainable use of energy, water and resources
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Editor in Chief
State of Green

Technical Editors

Confederation of Danish Industry	Hans Peter Slente, HPS@DI.DK
Danish Agriculture & Food Council	Jeppe Søndergaard Pedersen, jspe@lf.dk
Danish Energy Agency	Anne Svendsen, ansv@ens.dk

Contributors

Aalborg Portland	Henriette Charlotte Nikolajsen, henriette.nikolajsen@aalborgportland.com
Aquaporin	Søren Robenhagen, sro@aquaporin.com
Aquarden	Tore Svendsen, ts@aquarden.com
Carlsberg Breweries	Egle Gintautaite, Egle.Gintautaite@carlsberg.com
Danfoss	Mikkel Thrane, mikkel.thrane@danfoss.com
Danish Agriculture & Food Council	Morten Andersen Linnet, MAL@lf.dk
DMRI at Danish Technological Institute	Laurits Beck Nielsen, LABN@teknologisk.dk
FLSmidth	Michal Krsek, Michal.Krsek@flsmidth.com
GreenLab Skive	Thea Lyng Thomsen, info@greenlab.dk
Grundfos	Emil Svaneborg Mathiasen, emmathiasen@grundfos.com
Healthcare Denmark	Anne Katrine Greisen, akg@hcd.dk
Kalundborg Bioenergy	Erik Lundsgaard, el@bigadan.dk
Kalundborg Symbiosis	Lisbeth Randers, lirs@kalundborg.dk
Kamstrup	Kamilla Wied, kwi@kamstrup.com
Marine Ingredients Denmark	Anne Mette Bæk, amb@maring.org
NIRAS	Thomas B. Olsen, THBO@niras.dk
NIRAS	Jonas B. Borrit, JBBO@niras.dk
NIRAS	Søren Nøhr Bak, snba@niras.com
Novo Nordisk	Emil Linnet, eiln@novonordisk.com
Rambøll	Søren Hvilshøj, SRHS@ramboll.com
Silhorko - Eurowater	Jens O. Gjerløff, jgj.dk@eurowater.com
The Danish Association of the Pharmaceutical Industry (LIF)	Jakob Bjerg Larsen, jbl@lif.dk

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ENERGY EFFICIENCY LEADS THE WAY

Implementing efficiency measures to ensure energy and water savings is necessary if we are to significantly reduce our emissions.

By Kadri Simson, European Commissioner for Energy, European Union

If we are to deliver on the Paris Agreement, we need to focus on resource and energy efficiency. It is a key instrument towards a low-carbon economy and a core part of the EU Energy Union. Energy efficiency can save energy, reduce bills, lower air pollution and improve quality of life. In the Clean Energy for All Europeans Package, the European Union and member states agreed to commit to an ambitious energy efficiency target of at least 32.5 percent by 2030 compared to projections of the expected energy use. The revised 2018 Energy Efficiency Directive will continue guiding Member States towards increased energy efficiency. According to the requirements of Article 7 of the Directive, EU countries must achieve every year new end-use energy savings of 0.8% and cumulate such savings until 2030. Over the 10 years period this would lower their energy consumption on average by 4.4 percent every year. In September 2020, the European Commission proposed to speed up the decarbonisation by decreasing the greenhouse gas emissions by 2030 by at least 55% as compared to 1990. The contribution of energy efficiency, including the headline target, is being reviewed.

Deliver on Paris Agreement through energy efficiency first

Our energy policy's key objective is to put energy efficiency first. Energy efficiency is the easiest and most cost effective way of reducing our greenhouse gas emissions. Thus, energy efficiency is a natural part of EU's long-term strategy towards carbon neutrality in 2050. The "energy efficiency first" principles entails realising all energy efficiency improvements when they are more cost effective than equivalent supply solutions.

Energy efficiency in industries

Industries account for 26 percent of EU's energy demand. Even though large industries have been saving energy as a part of optimizing the productivity, the reduction potential is continuously large in many companies and sectors. By implementing crosscutting technologies and energy saving measures in the entire value-chain, this potential can be utilized. With the energy efficiency regulatory framework, EU provides tools for increasing energy efficiency in industries, such as the energy audit requirements.

Water Energy Nexus Better together: the need for cross-sectoral collaboration

Energy and water are inextricably linked: we need 'water for energy' for cooling, storage, biofuels, hydropower etc., and we need 'energy for water' to pump, treat and desalinate. Without energy and water, we cannot produce goods and meet growing food demands, as well as achieve economic growth. When implementing measures in production and value chains, it is therefore inherent to look at both water and energy resources to ensure a robust European industry.

Enabling a green energy system

When discussing the future energy system, energy efficiency and renewable energy sources are both competing for large investments. However, renewable energy and energy efficiency can work as mutually supportive technologies and it is equally important to address both our consumption and our energy sources. With energy efficiency, we can decrease consumption and reduce costs for heating, production and electricity, thus, allowing a better integration of renewable energy sources in the energy system. By combining them, we could enable a lower peak demand, which would broaden the potential for integrating various clean energy sources.

ENERGY EFFICIENCY ENABLES A GREEN TRANSITION

Denmark is pioneering within the green sector and we aim to inspire, develop and support green solutions across borders. Reconciling economic growth with ambitious green policies has been Denmark's hallmark for decades.

The Danish Minister for Climate, Energy and Utilities, Dan Jørgensen

Since 1980, Denmark has managed to decouple economic growth from its overall energy consumption: Danish GDP has increased by 100 per cent, while Denmark's energy consumption has only increased by 6 per cent and water consumption has decreased by 40 per cent. This proves that it is possible to create growth without a corresponding increase in energy use. The cheapest energy is the energy you don't use.

Instruments to support efficiency
The case demonstrates that we have been able to keep our energy consumption to a minimum despite immense growth in our GDP over the past three decades. From the Danish government and public institutions' side, we have three primary efforts to ensure that we keep our energy consumption to a minimum:

- Economic instruments: through taxes on energy and subsidies for energy-improving measures, an increased incentive can be created to improve energy efficiency.

- Normative actions: legal requirements and regulation can directly affect energy consumption through either a ban or an injunction that sets outs minimum standards.

- Informative measures: several measures are based on increased information to end users about energy consumption. Increased information is designed to influence users' behaviour and alert them to the potential for energy savings.

Energy efficiency in industry
Deep diving into the Danish industry, we can see that our energy consumption has decreased by about 24 per cent over the past two decades. This is partly due to the change in the Danish business composition, with a shift away from a reliance on energy intensive industry and partly because existing production has shifted over to less energy intensive production processes. Introducing energy efficiency measures decreases the marginal cost of energy. With energy consumption representing up to 40 per cent of the total production cost in industries, this constitutes a huge potential for businesses. These savings will be visible on the company's bottom line in terms of reduced production costs, but they will also have a positive impact for citizens and the climate.

A green transition
When looking at our future energy systems, it is equally important to address our energy consumption patterns as well as the kind of energy sources we use. Energy efficiency makes it possible to decrease energy consumption, which has a positive impact on the climate, while at the same time reducing the marginal cost for heating, production and electricity. In Denmark, we have an ambitious goal. In Denmark, we have set an ambitious goal to reduce our greenhouse gas emissions by 70 per cent by 2030 compared to 1990 levels. To reach this goal, we have to support both renewable energy and energy efficiency measures.

Through this we can create a viable green energy system for society, business and our citizens.

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INDUSTRY DEEP DIVES

1. RESOURCE EFFICIENCY IN INDUSTRIES

Efficient use of energy, water and other resources in industry

As the world's resources are becoming increasingly scarce, companies must learn how to produce more from less - not only to limit their environmental footprint, but also to leverage the competitive advantages of improved production efficiency.

A global resource challenge

The intense increase in both energy and water consumption is linked to a growing global population and rising income levels. Energy is used to heat and cool our homes, power our systems and as a vital input in the production of most goods and services. Similarly, water is a vital resource for survival, development and production across all sectors.

Energy, water and other resources are necessary, but scarce inputs for the manufacture of industrial goods. The challenge for industry is to reduce the vast amounts of energy, water and other scarce resources used daily in industrial processes across the globe. Today, the industry is responsible for 20 per cent of total greenhouse gas emissions and industrial consumption places sizeable pressure on energy and water resources. This may lead to increased costs and increased risks on the security of supply for industry.

The potential of efficiency in industry

Energy is an important input in manufacturing activities - both energy intensive sectors such as steel, cement and chemical as well as less energy and water intensive ones, such as food and pharmaceuticals. Industries are major energy consumers in most countries, being responsible for a sizeable share of society's energy consumption and CO_2 emissions. Efficiency - which means providing the same output with less input - is increasingly being studied and applied as a way to reduce production costs in industry and alleviating pressures on the supply of resources.

In energy intensive industries, the cost of energy can constitute up to 40 per cent of production costs, which means significant economic gains can be made from increased energy efficiency. Due to their size and organisation, companies can achieve sizeable efficiency gains by investing in energy and water efficiency, providing a positive business case for the company while also protecting the climate.

Competitiveness depends on marginal costs

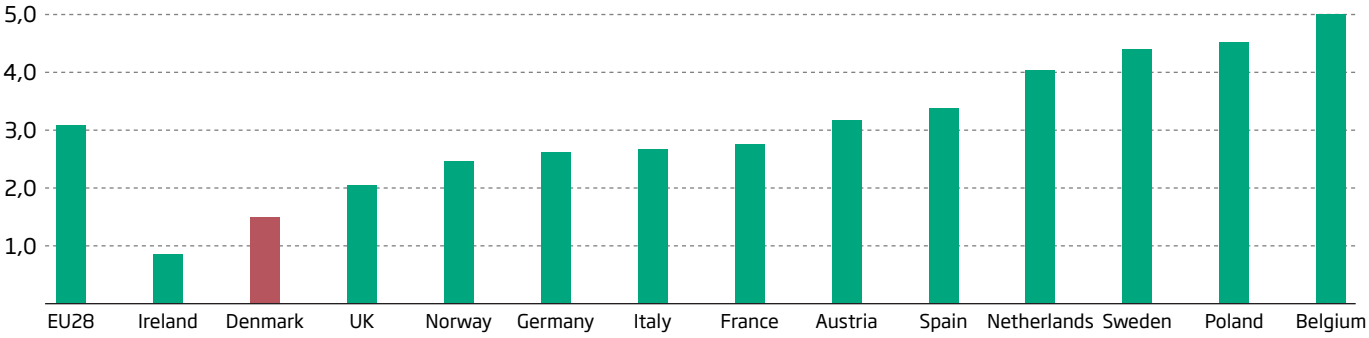
Competitiveness as a key motivating factor for instituting energy efficiency policies and initiatives is becoming more visible politically. Technological innovation and the fact that low hanging fruits appear due to changes in e.g. production volume or input mix, underline the hidden opportunities of investing in energy and water efficiency measures. Furthermore, investments in energy saving projects in the industry often offer a surprisingly short payback time.

Efficient solutions are available to reach global climate goals

In Denmark, energy intensity in industry has more than halved from 1990 to 2018 and decreased by approximately 40 per cent in the EU as a whole. Therefore, industry stands out as a frontrunner in energy efficiency compared to other sectors of the economy. Experience shows that large efficiency improvements can be achieved through optimised production equipment, buildings and workflow, by realising the full potential of digitisation and by behavioural changes and a strong focus from management's side. Further improvements are obtained from switching to a greener energy supply and by harvesting the potentials in surplus energy and water resources that would otherwise have been wasted.

The solutions needed for a green transition of global industries are in many cases already available and the potential for saving energy is tremendous. Improved efficiency of energy, water and other resource consumption will allow industry to realise substantial economic gains now while contributing to the realisation of the Paris Agreement and the Sustainable Development Goals, especially as regards to the goals focusing on clean energy, clean water, industry, sustainable cities and climate action.

Energy intensity in industry, TJ per million Euro (2019)



Danish industry boasts one of the lowest rates of energy intensity among European countries at approximately half the intensity of the EU28 average. This is in part due to concerted efforts by industry – incentivised through regulation, financing and increased awareness. This effort has reduced energy intensity in industry by 50 per cent since 1990, by 16 per cent since 2010 and the quest for improving energy efficiency continues.

2. THE REGULATORY FRAMEWORK DRIVING ENERGY EFFICIENCY

Investing in energy efficiency improvements is often a strong business case for private enterprises, the environment and for society.

Energy efficiency is an essential part of any governmental strategy to guarantee sustainable economic growth. Denmark is a showcase for energy efficiency policies and instruments that can contribute to enhancing security of energy supply, to boosting competitiveness and welfare, and to reducing the environmental footprint of energy systems all over the world.

Efficient use of scarce resources such as energy

Energy efficiency will be an essential part of the green transition globally. This is also the case for the Danish energy system's transition. Energy efficiency improvements will reduce the need for investments in new renewable energy capacity and energy infrastructure, as well as reducing the space required for new wind turbines and solar panels, thereby minimising the costs for society. Furthermore, energy efficiency improvements in the industrial sector (e.g. by minimising and utilising waste heat from industrial processes) may contribute substantially to the abatement of greenhouse gases.

Energy policies in Denmark

Like all nations, energy efficiency policy in Denmark has been driven by a range of considerations over the years. Earlier, energy independence and national security of supply was a decisive factor, while greenhouse gas abatement and cost optimisation are currently in focus. More than 40 years of active energy efficiency policies in Denmark prove that decoupling economic growth from an increase in energy consumption is possible and that it is still possible to harvest low hanging fruits from conducting energy efficiency improvements. In industry, energy intensity has been reduced by more than 60 per cent since 1975. High energy efficiency in production and operations enables a lower marginal cost, which supports the competitiveness of industries.

Different instruments and one shared goal

Energy efficiency policy can be divided into three different types of instruments.

1 Normative: Rules and regulations such as "Obligatory Energy Audits for Large Energy Users"
2 Informative: Guidelines and advice such as Sparenergi.dk
3 Economic: Subsidies, tax deductions such as the "Energy Efficiency Obligation Scheme" or the "Voluntary Agreement Scheme for Energy Intensive Industry".

An important lesson learned from the case of Danish energy efficiency policies is that a multipronged effort, with several instruments and mechanisms pursuing the same objective, could have the biggest impact in reducing the use of energy.

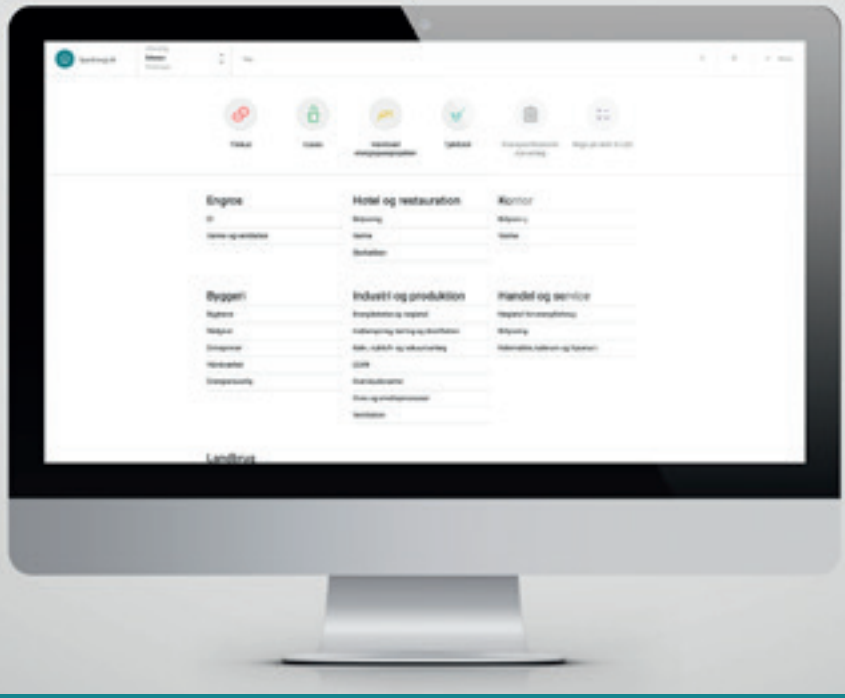
Voluntary agreement scheme for energy intensive Industry

Since 1996, the Danish Energy Agency has entered into agreements regarding the implementation of energy efficiency measures with large, energy-intensive companies in Denmark. To take part in the voluntary scheme, the company agrees to implement energy management and energy efficiency measures in their production. In return, a substantial portion of the energy consumption taxes they pay are reimbursed. The scheme has proven highly successful in promoting energy efficiency improvements in industry and under the auspices of government-to-government cooperation, Denmark is now exporting best practices and knowledge about how to design a successful industrial mechanism for energy efficiency .

Sharing Denmark's lessons learned

The Danish Energy Agency has gathered lessons learned for governmental action on energy efficiency in a policy toolkit. Please find the Policy Toolkit for Energy Efficiency in Industries here:

https://ens.dk/sites/ens.dk/files/Globalcooperation/ee_in_industries_toolkit.pdf



Informative instruments to reduce energy consumption
Targeted and coherent information on energy savings is important when wanting to implement efficiency measures across sectors and industries. The Danish Energy Agency has gathered its information activities regarding energy efficiency on the website, SparEnergi.dk. A one-point entry to all the agency's information regarding energy savings, SparEnergi.dk is organised into landing pages and theme pages, including facts, cases, guides and digital tools. The purpose is to create synergies between the various regulatory initiatives and make it easy for users to find impartial, quality content on the subject. For industries, the website provides guidelines and best practices for companies' energy management, as well as free campaigns that can be rolled out to reduce energy consumption among employees.

Courtesy: Danish Energy Agency, www.sparenergi.dk

Photo credit: Danish Energy Agency

Danish experience contributes to significant energy reductions in the Ukrainian industry
Denmark and Ukraine have established a government-to-government cooperation which aims to ensure solutions for an independent and more sustainable energy sector in Ukraine. The Danish Energy Agency has supported the Ukrainian State Agency's ambitions as regards energy efficiency and energy savings by designing a mechanism for industrial energy efficiency based on Danish experiences with Voluntary Agreements. Through the scheme, businesses will gain access to financing on attractive terms and partial investment support in exchange for saving energy. In the intergovernmental cooperation, new initiatives within energy efficiency in industry can, when implemented, reduce CO_2 emissions in Ukraine by at least 9 to 12 million tonnes of CO_2 over five years. This is equivalent to about one-third of the annual Danish CO_2 emissions from energy consumption.

Courtesy: Danish Energy Agency, Viegand Maagøe

3. WATER EFFICIENCY – SECURING A VITAL RESOURCE

Sustainable water consumption in water stressed communities

Increasing water efficiency in industrial value chains can decrease costs, increase competitiveness, and reduce societal risks by using less water in water stressed communities.

The availability of water is a critical issue and will continue to be so with a swelling global population and rising living standards. Its importance as a global issue is reflected in the United Nations SDG 6, which highlights the need for "Efficient Water-Use and Sustainable Withdrawal" in target 6.4. This increased focus on sustainability is driven by the risk of shortages of a key resource for production and industry, namely water. The challenge is particularly illustrated by the fact that it takes approximately 50 litres of water a day to satisfy one person's basic water need, but it takes 2,500 litres to produce that same person's daily food intake. Therefore, to solve the global water scarcity challenge, it is imperative to look at water usage in industries.

Water stressed areas

As more and more regions experience water scarcity, often in combination with deteriorating water quality of available sources, there is an increased focus on the division of available water resources between domestic use and industrial processes. From Cape Town to California, water scarcity results in water stressed areas, where water is a valuable resource needed for both the population as well as agriculture and other industries. For instance, in California almond farming alone uses about 10 per cent of the state's total water supply annually and overall agriculture claims 80 per cent of California's water consumption. Despite significant reductions in water consumption of 33 per cent over the last two decades, the water footprint still averages around 12 litres water consumption per Californian almond. Several initiatives are being taken and the California almond community has committed to a goal of achieving an additional 20 per cent water reduction by 2025, but it will still be around 10 litres per Californian almond.

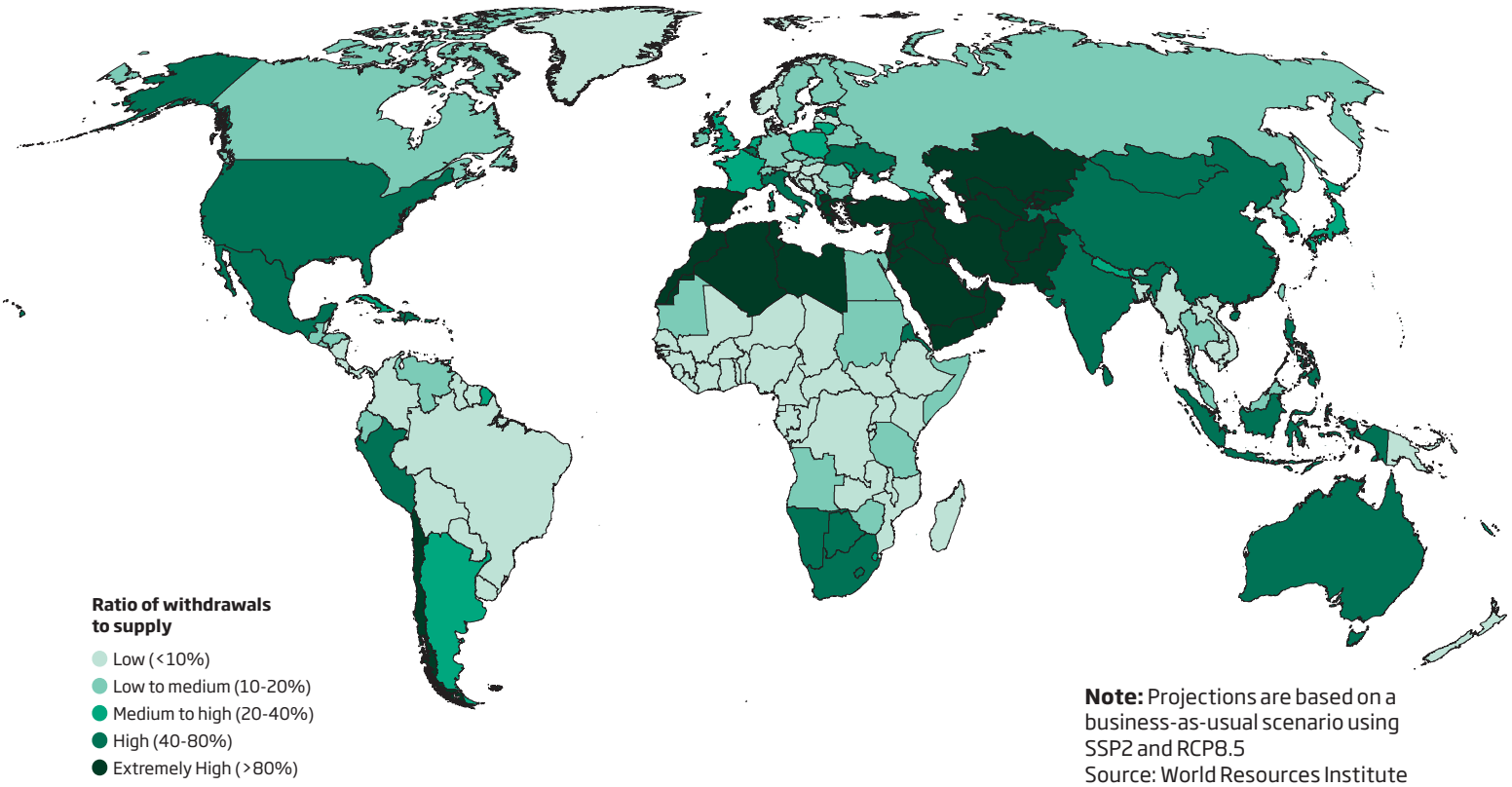
If a production facility is located in a water stressed area, industry needs to manage water in a smart and efficient way in order to balance water withdrawals against the needs of the local community, be it ground or surface water based. A dedicated effort will lessen the global strain on water resources and in a local context, benefit the total water system and supply for local citizens and domestic use.

Making every drop count

With the pervasive challenge of water scarcity, industries are looking at solutions to decrease water withdrawals and maximise the possibilities for its reuse in production and throughout the entire value chain. Not only to positively impact society and local communities, but also to enhance their own competitiveness. A high water price in Denmark (8.8 EUR/m^3) has created incentives for the industry to decrease water usage and thus decrease marginal costs spent on water. Equally, the ever-present risk of rising water rates and wastewater discharge fees invoke continuous developments for efficient water use and sustainable withdrawal in industries.

It is important to optimise the wastewater treatment on-site to clean at source as much as possible, reuse wastewater in processes and where possible, review possibilities for reinfiltration in forms of managed aquifer recharge. Photo credit: Rambøll

Water stress by country, 2040



Note: Projections are based on a business-as-usual scenario using SSP2 and RCP8.5
Source: World Resources Institute

Examples of water solutions and efficiency measures in industry

- Set reduction targets for water abstraction/consumption and wastewater discharge in terms of both quality and quantity.
- Focus on water efficiency and increasing water re-use and recycling
- Pollution abatement and control measures enabling reliable water accounting
- Infrastructure maintenance and reduce unnecessary water consumption and water loss
- Water stewardship and governance including engaging with policymakers and integrating water into long-term business objectives. Ensure close coordination with water management authorities.
- Water risk assessment, increase current water resources through managed aquifer recharge of cleaned effluents, or surface waters, or identify alternative water supply sources
- Optimise water consumption at all facilities as well as throughout the entire value chain.

4 . THE FOOD AND BEVERAGE INDUSTRY

Sustainable solutions that conserve resources while ensuring high product quality

Population increases, growing demand for food and climate change have created an immense challenge. If we are to feed the world's growing population while solving climate challenges, there is a need for innovative solutions and new technologies.

A growing population increases demand

By 2050, the world's population will number approximately 10 billion. With 10 billion hungry mouths to feed, the demand for food will increase sharply. Projections from The Food and Agriculture Organization of the United Nations, FAO, indicate that by 2050, a 70 per cent increase in current food production will be necessary. Already today, the global food industry faces an important task as, according to the IPCC, food production accounts for 24 per cent of the world's CO_2 emissions. The solution is to find ways to produce more food and beverages whilst using less resources such as water and energy. In essence, to develop new methods that ensure food production leaves a smaller climate footprint.

Pressure to reduce water usage

The food industry and the beverage industry in particular, are major consumers of water, responsible for approximately 20 per cent of industrial water consumption worldwide. This sector will therefore face growing pressure from politicians and other groups to reduce their water usage in order to preserve good quality freshwater. Increasingly, the situation will be that water is not available in the quality and quantity required for food processing and cleaning processes.

Water-energy-food nexus

Water, energy and food production are inextricably linked. Food and agriculture are the largest consumers of water, requiring one hundred times more than we consume for personal needs. Industry is interested in solutions to reduce water and energy consumption. When implementing control systems and working systematically with water usage, it creates a spillover effect, leading to awareness of energy consumption, which in turn, is often followed by energy savings measures. The aim of sustainable production design is to ensure each unit of production consumes less water and energy, resulting in lower CO_2 emissions.

Competition driving efficiency

An energy and water efficient food industry is not only important for climate reasons. Internal and external pressures on the food and beverage industry to reduce prices and marginal costs means instituting efficiency measures can create a tangible competitive advantage. Many food and beverage companies started to implement energy efficiency measures years ago and an increasing number of companies regard their energy efficiency efforts as ongoing activities for continuous improvement. In Denmark, the food sector's energy consumption fell by almost 32 per cent from 1973 to 2017. In the same period, production value increased by 60 per cent, demonstrating it is possible to produce more with less.

DRIP - Danish Partnership for Resource and Water Efficient Industrial Food Production

DRIP is a public-private partnership focused on water efficiency in the food industry - one of the largest water consuming industries in Denmark and globally. The partnership gathers a number of food sector companies, technology providers, universities and RTO institutes to produce more food with less water without compromising product quality and food safety. The partnership is realised due to a deep commitment on behalf of the Danish Food Authorities, who monitor and assist with safety aspects. The ultimate goal is to reduce water consumption by 15 - 30 per cent, moving from a food safety regulatory demand of using drinkable quality water for all purposes to the use of upgraded water sources, i.e. operating from a water-fit-for-purpose paradigm. The business rationale is not only to achieve water savings but also associated energy savings, as well as the possible recovery of resources in processing and wastewater. New innovative water solutions have been developed in a number of lighthouse projects; and best practice solutions will eventually be implemented in large-scale operations.

TripleNine - Cutting the water footprint in half

TripleNine, a Danish fishmeal and fish oil factory in Western Denmark, has cut their water footprint in half with the introduction of new technology. With this new flotation technology, the discharge water passes through a tank of nozzles that blows small air bubbles into the water. This process causes the fish residues and oil to accumulate on the surface in a foam fraction. The foam can then be scraped off and used, and the water thereby can be reused many times. The implementation of the new technology is a result of TripleNine's partnership with DRIP. Based on the results of the pilot project, the new technology is estimated to save 50 - 70 per cent of the 16,000 m^3 of water TripleNine discharge annually, which amounts to an annual saving of EUR 130,000 as well as reducing Triple Nine's CO_2 emissions by 955 tonnes.

Courtesy: DRIP Partnership, Danish Agriculture & Food Council, Marine Ingredients Denmark. TripleNine , Teknologisk Institut, BIO-AQUA, Insatech, Lemvig Vand & Spildevand

Photo credit: Eurowater

Demineralized water for brewery at low water and energy consumption

Water is one of the primary ingredients in beer. Consequently, a brewery is a large-scale consumer of high-quality water. So is Harboe's Brewery, located in Skælskør, Denmark. Harboe has a strong corporate culture emphasising responsibility, collaboration, quality and results. When it was time to replace the existing water treatment plant, it was a matter of course to adopt new and efficient water technology. SILHORKO-EUROWATER has supplied, installed and commissioned this solution built around reverse osmosis units designed for high water utilisation, compromising neither reliability nor water quality. The upgrade has resulted in more than 200,000 EUR in yearly savings as well as less environmental impact due to reduced water and energy consumption. The yearly savings add up to 89 MWh, equal to 45 tonnes of CO_2, 98,000 cubic metres of water, and 49 tonnes of salt for water softening. The return on investment (ROI) was approximately one year.

Courtesy: Silhorko-Eurowater, Harboe Brewery

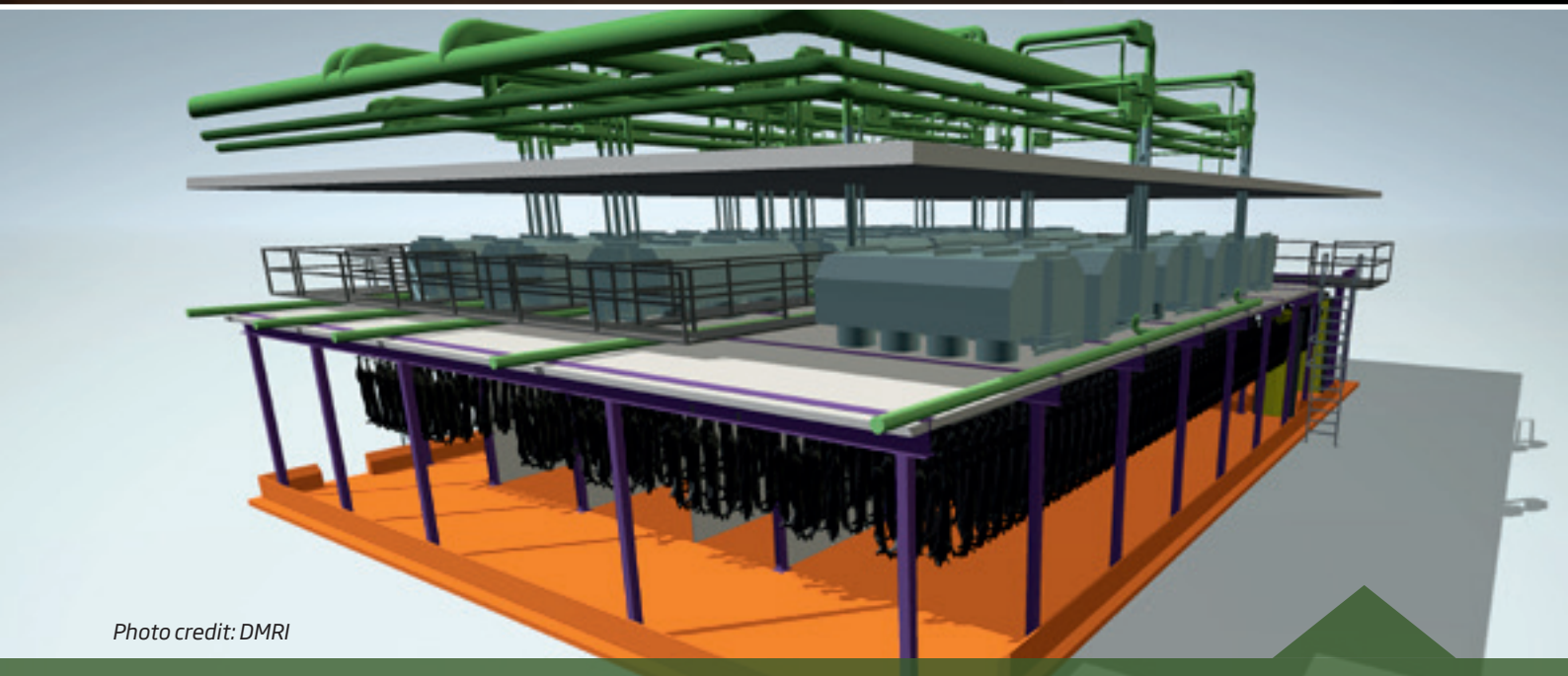


Photo credit: DMRI

New, improved design of the quick chill tunnel at slaughterhouses with reduced energy consumption

In meat production, one of the major energy consuming elements is the chilling and defrosting process. DMRI has introduced an intermediate deck in our chill tunnel design, which provides the tunnel with less process room volume and easier access for service and regulation during operations than is the case for the present tunnel. Improved access to the mezzanine floor with a catwalk for inspection and optimisation of evaporator defrosting cycles means that maintenance staff can access and closely inspect defrosting cycles. Without the mezzanine floor and catwalk, it is close to impossible to safely and thoroughly inspect the evaporators' defrosting performance in a fully loaded tunnel by use of e.g. a ladder. Optimal defrosting can reduce the electrical power consumption by more than 10 per cent from the compressor and fans (which is equivalent to a saving of EUR 65,000 annually) and eliminating prolonged blockage/icing of evaporators can reduce the evaporative chill loss by more than 0.15 per cent, resulting in savings of more than EUR 180,000 annually.

NB. Calculations based on 500 pigs/hour of 90 kg, 1 shift operation, 250 workdays/year and EU electricity prices.

Courtesy: Danish Meat Research Institute - DMRI

Photo credit: NIRAS, Thise

Organic dairy saves time, money and CO_2 emissions with new warehouse

Thise is an innovative Danish dairy specialising in organic products. Due to increased demand, Thise decided to build a new high bay warehouse and enlarge parts of its existing facilities. In 2017, the Danish consultancy company NIRAS started conducting assessments and analysing logistics. NIRAS' experts designed the warehouse to be as logistically efficient, environmentally friendly and considerate of its' neighbours as possible. The new warehouse is partly embedded in a raised mound and the chimneys' paint emulates the sky to make the site less noticeable. A new biofuel boiler provides energy while emitting less CO_2, and a fully automated crane system stores and retrieves packing materials. Water and heat consumption have been lowered due to water and heat metres that were installed and monitored remotely by Kamstrup, a leading supplier of intelligent energy and water metering solutions. The project also includes better facilities for its personnel and an area that allows visitors to get close to the production without risking the food safety or the quality of the products. Thise has reduced its use of diesel for transport by 2.3 per cent and its CO_2 emissions from 4,200 tonnes in 2018 to 2,300 tonnes in 2019.

Courtesy: Thise, NIRAS, Kamstrup

Photo credit: Danfoss

A new shade of green for grocery stores

Danfoss and SMA technology enables supermarket "Aktiv & Irma" in Oldenburg, Germany to store and generate electricity with an intelligent, two-way connection to the electricity grid, showing the energy-management potential of supermarkets.

The supermarket's refrigeration and cooling counters are key to making it function like a giant battery and contribute to creating a more flexible, sustainable and green energy system. In windy and sunny weather, the local power plant will typically have excess availability of sun or wind power. In that situation, the supermarket can cool down its counters a little more than necessary – drawing extra energy from the grid.

When the weather turns, and the power plant needs electricity, the supermarket's counters are colder than necessary. And then, it can consume less electricity for a while – without damaging food safety. The supermarket operates with an energy consumption level that is roughly 20 per cent lower than the average European supermarket.

Courtesy: Danfoss, SMA, Irma

Photo credit: Carlsberg Group

Carlsberg will halve water usage at its largest brewery in Denmark

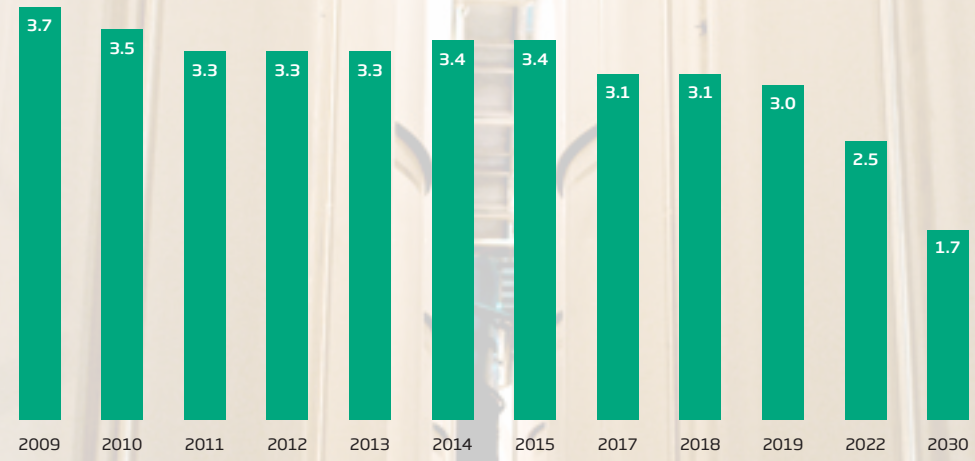
A new water recycling plant will turn Carlberg's largest brewery in Denmark into the most water efficient brewery in the entire Carlsberg Group, and probably also the world. Carlsberg's Fredericia Brewery has consistently focused on resource management and water reduction, but even more advanced water recycling technologies were required to reach the ambitious targets set in Carlsberg's 'Together Towards ZERO' programme. Carlsberg decided to develop a new water recycling plant in close cooperation with the Danish consultancy company NIRAS, who is managing the project.

The production facility will recycle 90 per cent of all process water and halve its overall water usage from 2.9 to 1.4 hectolitres of water per hectolitre of produced beer, making it Carlsberg's first brewery to virtually eliminate water waste. According to NIRAS' water experts, the construction of the water recycling plant is a major technical achievement that will have a huge impact on the sustainable use of water and energy.

The project will use advanced water treatment technologies such as the highly efficient Reverse Osmosis (RO) and Advanced Oxidation Processes (AOP) in order to deliver water of drinkable quality. Due to the production of biogas in the pre-treatment step, the plant will produce approximately four times the energy used for the processes. The project will serve as a learning platform for Carlsberg breweries worldwide. Carlsberg's aim is to halve its water usage globally from 3.4 to 1.7 hectolitres per hectolitre of beverage produced by 2030.

Courtesy: Carlsberg Group, NIRAS, Hydract, Tetra Pak Filtration Solutions, DRIP

Relative Water Consumption (hl/hl) Carlsberg



** The data is a reflection on the average performance of the sites Carlsberg had in the reporting year.*

5. THE RESOURCE-INTENSIVE INDUSTRIES

Supporting infrastructure growth through efficiency

Saving energy and water in traditionally resource-intensive industries is one of the most necessary steps in a green transition while at the same time creating growth and economic development.

Resource-intensive industries such as steel, refining, chemical and cement are critical and important suppliers to all industries; enabling activities in other sectors and society at large, including transport, construction and power generation.

The resource intensive industry today
In the European Union (EU), industry accounts for 15 per cent of total CO_2 emissions and energy-intensive industries account for more than half of this. Therefore, the EU's ambitions of becoming climate neutral by 2050 can only be realised with the active participation of the energy-intensive industry. The challenge is to decrease emissions while keeping the industries competitive and positioning them to exploit the huge potential of the global market for low-emission technologies and services. The energy-intensive industry is engaged and has realised significant reductions already.

Reducing emissions through several measures
In 2019, the Danish government initiated 13 so-called 'climate partnerships', representing all branches of the Danish private sector. The aim was to involve the private sector to contribute with concrete recommendations and solutions on how to reduce CO_2 and green house gasses in their respective sectors. The Climate Partnership for Energy Intensive Industry has reported on their contribution to the Danish climate target of 70 per cent CO_2 reductions by 2030 compared to 1990 levels. They point to reaching 30 per cent by own measures in the industry, such as energy efficiency measures, electrification of low-temperature processes and innovation directed at lower CO_2 emitting products and processes. Electrification of low-temperature processes will also contribute to future energy and CO_2 savings for two reasons; 1) Electric processes (where they are possible) are often more energy efficient 2) More than 50 per cent of the Danish electricity supply is based on renewable energy sources such as wind, biomass and solar. An additional 20 per cent can be reached through carbon capture, usage and storage (CCUS). Some of the required solutions are not yet commercially viable and their realisation will require public investments and a willingness among customers to prioritise low-carbon products. Finally, this sector can contribute significantly to further energy savings in society by making their surplus heat from processes available to others.

Knowledge is key
Although many energy efficiency measures have already been realised in industries with high-energy consumption based on a strong focus on energy costs, there are still many ordinary efficiency measures to be realised through information campaigns – particularly aimed at small and medium enterprises. For the large emitters, an individual approach must be pursued – aiming at realising significant potentials in each individual company.

European masterplan
In 2019, the High-Level Group of Energy Intensive Industries delivered a masterplan for a competitive transformation of EU Energy-intensive Industries Enabling a Climate-neutral, Circular Economy by 2050.

The presented masterplan identifies strategic priorities within three areas:

- Creation of a market for climate-neutral, circular economy products
- Developing climate-neutral solutions and financing their uptake
- Access to resources and deployment

Eight initiatives from the industry to reduce CO_2e-emissions

Energy efficiency improvements
Optimization of processes and investments in more energy efficient machinery to reduce use of natural gas and electricity

Electrification and room heating
Electrification of machinery, that run on natural gas and shift from gas boiler to district heating and heat pumps

Shift to biogas
Shift from fossil fuels to biogas in high temperature-processes, which cannot be electrified

Production and demand of sustainable solutions
Production of and demand of sustainable solutions and products, that emit less CO_2e

CO_2 capture among largest CO_2-emitters
Pilot project to expand knowledge about the carbon capture technology

Increased use of surplus heat
Further utilization of the large amounts of CO_2-neutral surplus heat, which is not used today

Shift to green transport
Accelerated shift to green transport and demand to suppliers on CO_2-footprint

Global reduction of Danish green technologies
Distribution of Danish solutions that can reduce the CO_2-footprint of others

The climate partnership on Energy Intensive Industry stipulate eight action areas for reducing CO_2 emissions and a total of 61 concrete recommended actions to reach the goal of achieving a 70 per cent CO_2 reduction by 2030. Source: Climate Partnership – Resource Intensive Industry

Photo credit: Aquaporin, Forward Technologies

Reuse of industrial wastewater at a low cost

As a result of water scarcity, many industries today are under increasing pressure from consumers, regulators and investors to shift towards a more sustainable use of water. One of the strategies is Zero Liquid Discharge (ZLD), in which all wastewater is cleaned and reused within a factory. ZLD strategies for minimising waste streams are already possible but extremely resource consuming. By using forward osmosis, it is possible to extract very high quality water by only using a small fraction of the energy associated with evaporators and reduced CapEx via the utilisation of non-exotic materials for construction. This can, in some cases, lead to under 2 years payback.

The company Forward Water Technologies has developed an industrial wastewater treatment pilot plant, which uses Aquaporin Inside® forward osmosis membranes to clean and recycle water. Doing so has allowed them to demonstrate a wastewater volume reduction typically of 70 per cent and greater than 92 per cent in some applications. The pilot plant is currently operating with streams from oil & gas production. However, the learnings from this application can be transferred to other industries - e.g. the textile industry, which is one of the most water consuming and polluting industries.

Courtesy: Forward Water Technologies, Aquaporin

Surplus heat from industry supplying heating to citizens

In order to produce cement, raw materials such as limestone and sand have to be burned at temperatures of up to 1500°C. Due to this high temperature process, the Aalborg Portland cement factory generates enormous amounts of excess heat. One of the main sources of waste heat is the flue gas streams from the white kilns. The solution to this energy loss was to implement a heat recovery system, in which the flue gases from the five white kilns are utilised in heat exchanger installations to transfer the thermal energy from the flue gas to the City of Aalborg's district heating network.

The Aalborg Portland cement factory supplies surplus heat from production in the form of district heating to the residents of Aalborg. In 2019, this surplus heat corresponded to the annual heat consumption of approximately 25,000 households. There are also other projects in the works to utilise excess heat, such as reusing the hot air from the grey kiln's clinker cooler as primary inlet air to all the white kilns and one of Aalborg Portland's coal mills.

Courtesy: Aalborg Portland

6. THE LIFE SCIENCE AND PHARMACEUTICAL INDUSTRY

Sustainable strategies at the core of the life science industry in Denmark

Sustainability is a managerial and strategic goal for pharmaceutical companies around the globe to improve their manufacturing processes in an efficient way.

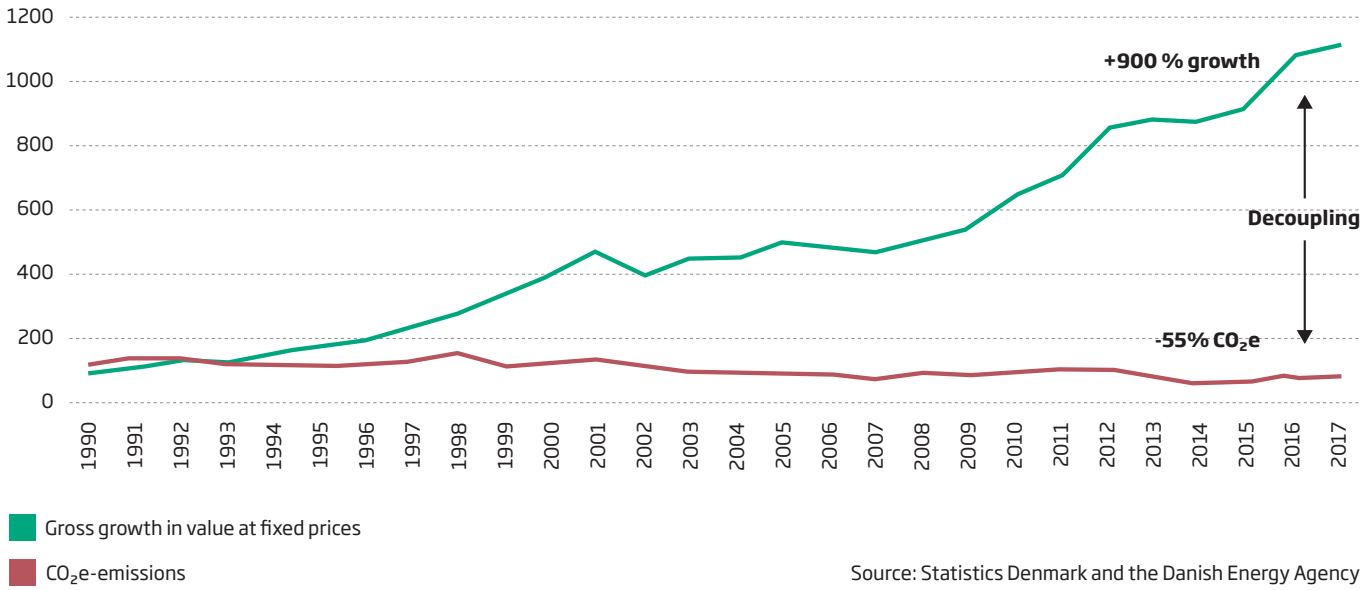
The Danish life science and pharmaceutical sector has been able to reduce its own emissions by 55 per cent since 1990, while production has increased by a factor of nine. This decoupling of emissions and value creation (green growth) is a prerequisite for continuous increases in growth and wealth in the sector, as well as in society as a whole.

Sustainability part of core strategies
An important part of implementing sustainable measures in the industry is to ensure a strategic priority from top management. In Denmark, the life science industry has historically incorporated this in business strategies, and today 9 out of 10 has set a goal to reduce greenhouse gas emissions. These efforts have resulted in the sector reducing its CO_2 emissions from 118,000 tonnes in 1990 to 53,000 tonnes in 2017 ,equivalent to a reduction of 55 per cent.

Solutions creating a smaller footprint
In the life science and biotech sector, the optimisation of manufacturing and buildings as well as a shift to utilising green energy have been the main contributors to the greening of the industry that has taken place since 1990. For instance, the focus on buildings has been to optimise the energy used. This has also been enabled by national building codes and standards. Ventilation systems in the pharmaceutical production process represent a major energy guzzler in the industry, as the industry has to enable high production standards to ensure safety of patients. Another focus has been on recycling and waste minimisation. This is for instance seen in what is known as industrial symbioses, where residues from production processes are reused in another company's or organisation's value chain.

Demand and requirements for global value chains
The largest part of the emissions from the life science industry stems from sub-suppliers and the value chains of the industry. Transport, energy supply, materials and packaging generate indirect emissions and the pharma industry thus has a responsibility to demand green technologies and solutions. This can and has created trickle-down effects, where sub-suppliers dare taking the risk of developing innovative green solutions, as there is demand from the pharmaceutical industry - a major and important customer.

Green growth in life science and pharmaceutical industry



Source: Statistics Denmark and the Danish Energy Agency

Photo credit: Aquarden

Efficient cleaning of wastewater from pharmaceutical production

The need to remove pharmaceutical residues in wastewater will increase in the coming years. Pharmaceuticals are designed to be biologically active ingredients (API). A large amount of antibiotics, painkillers and hormones currently end up in the aquatic environment, simply because municipal treatment plants are not built to purify these substances. The Danish company, Aquarden has developed a Supercritical Water Oxidation (SCWO) technology, a system which completely destroys hazardous substances below required limits. The end product is pure water cleaned of hazardous pharmaceutical substances, which can be sent directly to receiving water bodies (lakes, rivers, sea), sent to the sewer or can be reused as process water in the production facility. The process is energy efficient as 90 per cent of the process heat is recycled and used as input for SCWO process as well as heating the production facilities. Furthermore, Aquarden's SCWO technology offers a significant environmental bonus from a reduced CO_2 footprint and minimised combustion emissions with a 75 per cent reduction in CO_2 emissions.

Courtesy: Aquarden Technologies

Circular value chains - Recycling insulin pens as input for chairs and lamps

As a part of Novo Nordisk's environmental strategy, the company focuses on how they can integrate green principles into the product development, and also works towards increasing the amount of plastic waste being recycled. Even though Novo Nordisk strives to use environmentally friendly materials, an integral part of achieving its environmental goals is the ability to recycle insulin pens, as these consist of 77 per cent plastic which cannot be thrown into a regular recycling bin. To be able to recycle the insulin pens, the company invented a machine making it possible to sort the pen's many components, such as plastic and glass. Novo Nordisk then teamed up with a Danish design firm, so that the discarded plastic was used to make office chairs. Furthermore, the glass from the discarded insulin vials has also been given a new lease of life after being melted down to create lamps. In this way Novo Nordisk aim to reduce the number of pens ending up in landfills and use resources in a more circular way.

Courtesy: Novo Nordisk

7. THE MANUFACTURING INDUSTRY

Industry consumes resources and leads the way in efficiency

Manufacturing industries globally are responsible for a major part of economies' emissions and resource use. In Denmark, the example shows that decoupling production from resource use is possible.

Manufacturing industries are major consumers of energy, water and other resources in most countries - responsible for a large share of society's energy consumption and CO_2 emissions. Due to their efficient organisation and size, manufacturing companies can achieve sizeable efficiency gains by investing in efficiency measures, providing a positive business case for the company while protecting the climate.

The road to carbon neutral manufacturing

In Denmark, a wide range of instruments are used to accelerate energy efficiency in industry. They include information campaigns, sharing of best practices and consultancy. There are concrete financing instruments for pinpointed solutions or general efficiency investments. Target setting at company, industry or country level combined with voluntary or mandatory reporting and certification. Through these measures, the Danish manufacturing industry has been able to increase manufacturing output by 35 per cent while CO_2 emissions have been reduced by 65 per cent. This decoupling of emissions from manufacturing output is explained primarily by increased efficiency (55 per cent), electrification and fuel switching (15 per cent), and offshoring of production (30 per cent).

Experience shows that large efficiency improvements can be achieved through optimised production equipment, buildings and workflow, by realising the full potential of digitisation, by behavioural changes and a strong focus from management's side. Further improvements are obtained by switching to a greener energy supply and by harvesting the potentials in surplus energy and water resources that would otherwise have been wasted.

Electrification of manufacturing industry

Electricity constitutes 32 per cent of total energy use in the manufacturing industry. This share has increased since 1990 but stagnated in recent years. However, further use of electricity in industry instead of fossil fuels is a viable method to decrease the carbon footprint of industry, bearing in mind that today electricity in Denmark is primarily sourced from renewables, with a share of wind energy close to 50 per cent and a total share of renewables above 60 per cent.

Studies suggest that most industrial processes can be converted to electricity from a technological point of view. The change is difficult for industries that require high temperature processes and thermal energy at high rates. A new Danish project identifies technologies and methods that allow the efficient use of electric power for process energy supply. The project has started out focusing on drying and evaporation processes. Furthermore, the case companies all undergo a thorough energy performance audit, enabling them not only to switch to electricity but also to realise overall energy savings through process optimisations.

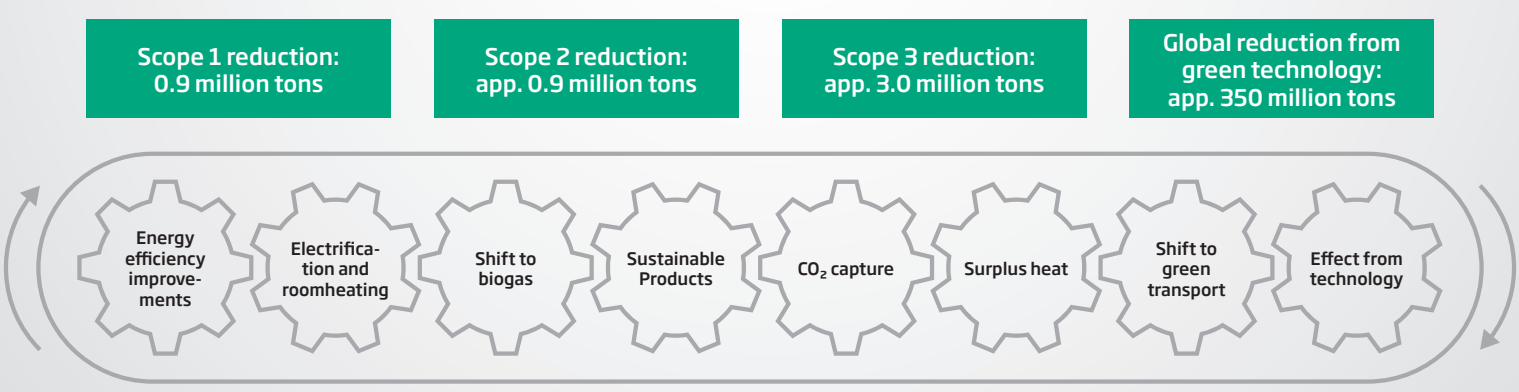
Increasing electrification will improve industry's competitiveness, as electrified processes often contain large economic savings which give a direct improvement in the company's competitive position in the form of lower costs. In addition, the process of electrification is an opportunity to optimise energy and resource use in general, yielding further economic and climate savings. The electrification resulting in lower CO_2 emissions is a marketable advantage over manufacturing companies – and will be even more so in the future with increased climate awareness.

Photo credit: Unsplash

CO_2 calculator for the private sector
For industry to decrease its CO_2 footprint, it will need to have an overview of it green house gas emissions from its own processes (scope 1), its energy consumption (scope 2) and the footprint from its inputs from suppliers (scope 3). To enable the calculations of scope 1 and 2 emissions, and thereby increase the awareness and motivation among companies for energy efficiency, the Confederation of Danish Industry has recently launched a simple web-based tool, the "CO_2 CALCULATOR" which enables companies to estimate their CO_2 footprint by realising just a few steps in a web calculator. This tool – and its benchmarking opportunities for participants – enables further progress in energy efficiency in industry.

Courtesy: Confederation of Danish Industry

Climate partnerhip on manufacturing: several measures can be implemented to reduce emissions and energy in the manufacturing industry



Source: Climate Partnership – Manufacturing Industry

Climate Partnership - Manufacturing Industry
In Denmark, 13 climate partnerships have been established by government and 13 business sectors to contribute with recommendations on how to reduce greenhouse gases by 70 per cent in 2030 (compared to 1990 levels). One of the climate partnerships consists of the manufacturing industry. The partnership has analysed the emissions from own production (scope 1) as well as from energy supply (scope 2) and supply chain (scope 3). The conclusion is that the major part of emissions in scope 1 stems from natural gas consumption and own transport vehicles. Through efficiency, electrification of processes and green transport, the partnership has concluded that it is possible and economically feasible to reduce emissions by up to 80 per cent by 2030. Furthermore, scope 2 emissions can be reduced by 95 per cent in 2030 through further energy efficiency measures in regards to electrical equipment and change to green fuels in the energy sector supplying industry. Overall, the manufacturing sector in Denmark can be practically CO_2 neutral by 2030 compared to 1990 and aim to become the first climate-neutral manufacturing sector in the world.

Rubber factory creates energy savings of 50 per cent through efficient pumps

At the Yokohama Rubber factory in Japan, an audit of their energy and water management revealed a huge potential for realising energy savings by instituting simple measures. By replacing 30-year-old pumps in the cooling system for the production process, the rubber factory has reduced their energy consumption by more than 50 per cent. This amount of energy saved also resulted in cost savings of more than JPY 4 million (around EUR 40,000) in the first year. The successful result of the project enabled further investments in Grundfos pumps in Yokohama's other factories in Japan. The initial installation of Grundfos pumps and their control systems paid for itself within 18 months through reduced energy costs. Payback time at the other plants showed payback time of one year at Hiratsuka, and the second Shinshiro installation was paid back within 15 months. The first step of the Yokohama efficiency project was the conduction of a pump audit showing the potential to save energy and costs in the production, which was the necessary business case to invest in the energy efficient equipment.

Courtesy: Grundfos, Yokohama Rubber Factory

Photo credit: FLSmidth

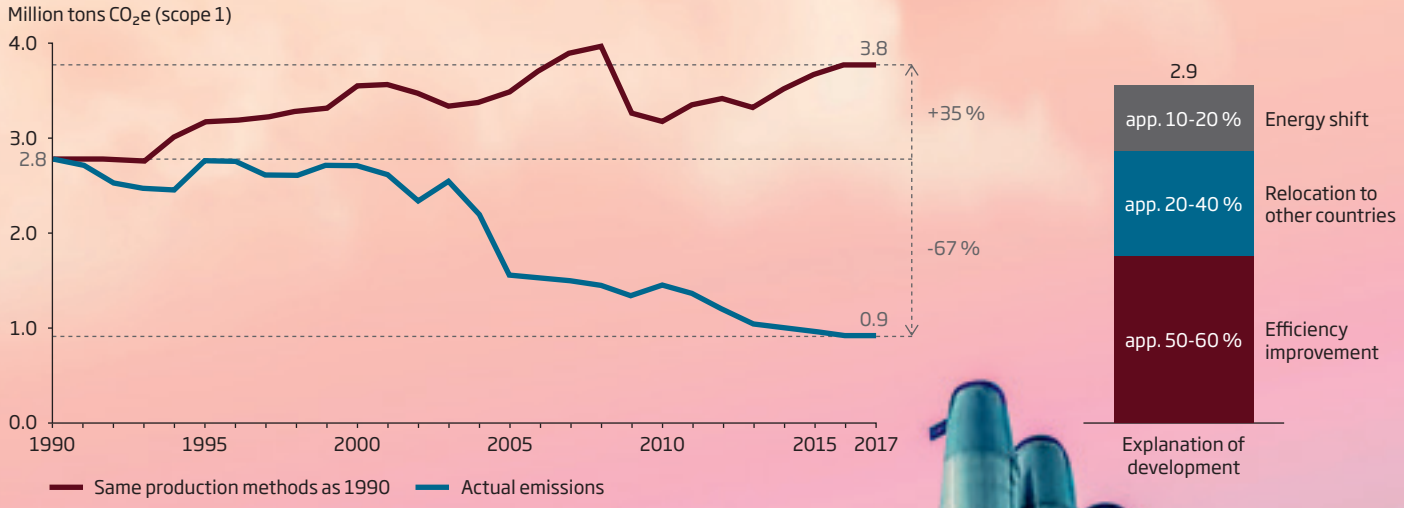
FLSmidth helps cement customers reduce CO_2 emissions through increased efficiency

Cement production accounts for 7 per cent of global CO_2 emissions. As the world's leading supplier of equipment and a service partner to the industry, FLSmidth has a massive opportunity to influence the decarbonisation of cement production. Clinker is the most carbon-intensive ingredient in cement. Optimising cement's clinker factor has therefore become a key target for cement companies looking to reduce their carbon emissions. At Holcim Germany's cement plant in Höver, FLSmidth has provided an automated sample preparation system, allowing Holcim to optimise their clinker factor and thereby their environmental footprint.

Increasing sample throughputs with the QCX Centaurus (automated sample preparation system) has ensured better control of the kiln process and minimised the safety buffer in process control resulting in a higher efficiency - in the range of about 2 per cent – leading to lower emissions and fuel savings. For more information on sustainable cement equipment go to FLSmidth.com

Courtesy: Höver Cement, LafargeHolcim, FLSmidth

Production have increased by 35 % since 1990, while CO_2e-emissions has dropped by app. 65 %



8. INDUSTRIAL SYMBIOSIS

Reusing, sharing and providing resources are important parameters to secure sustainable production.

Industrial symbiosis is an important tool to create a circular economy and green growth. A look beyond the fence of your own production site can lead to a significant value proposition, by working together in local clusters, cross-sectoral or in public-private partnerships.

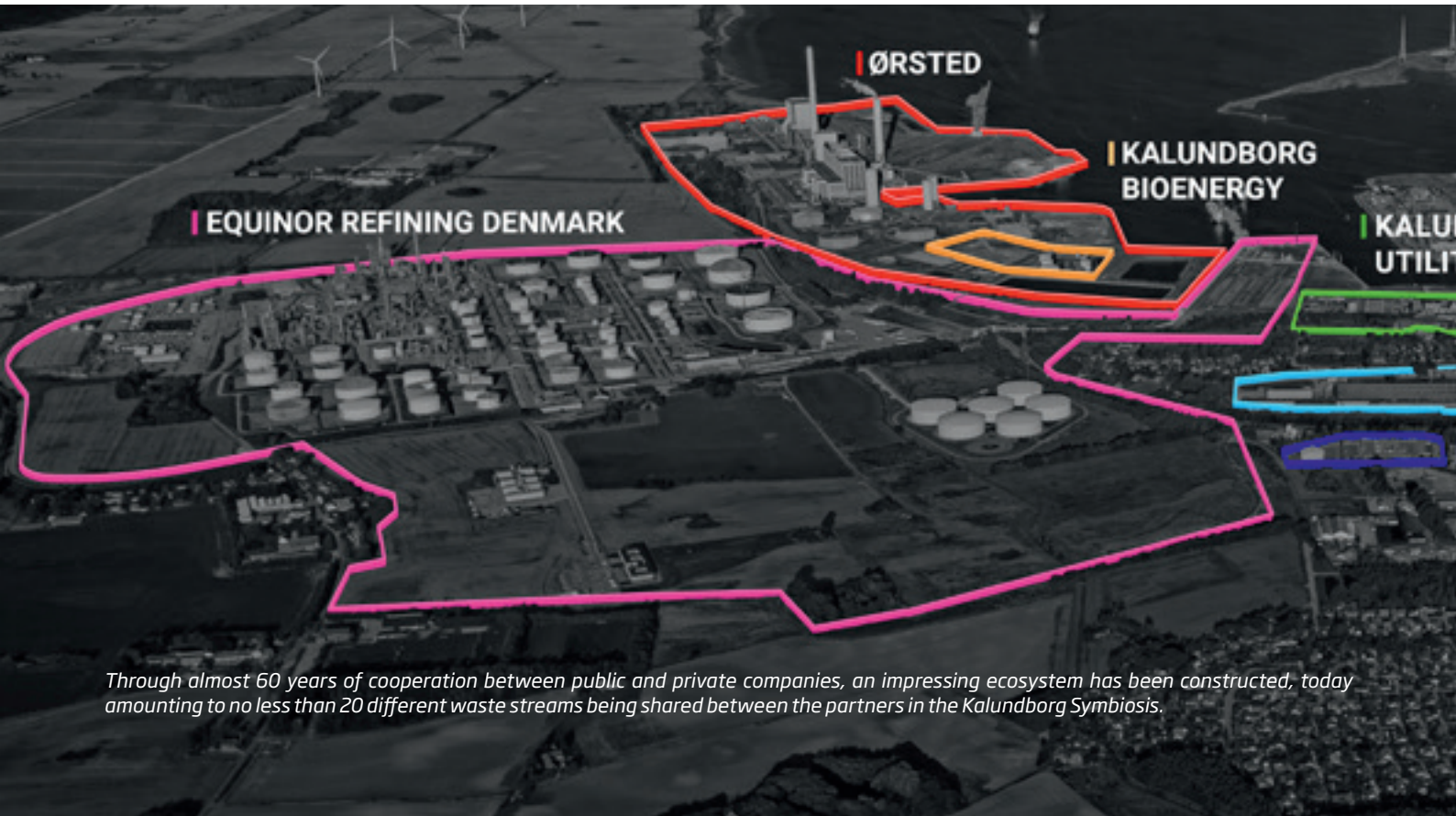
An industrial symbiosis is a commercial collaboration where the residual waste from one enterprise is used as a resource by another enterprise – resulting in mutual economic and environmental benefits through a sustainable usage of raw materials and a reduction of energy consumption.

Two types of symbioses
A green industrial symbiosis can take on two basic shapes: a "classic symbiosis", which is understood as collaboration between at least two companies in which a company's residual product or waste represents an input in another company's production. Often, public partners play an important role in building resilient local partnerships with a focus on sharing, reusing and providing resources to create mutual value.

The second type is referred to as a "symbiosis through the market" and is the exchange of resources between companies through collection and processing companies on the market. This kind of recycling is already widely used today, but there is potential for more resources to be recycled and at a higher quality, with a higher market value.

Financial incentives at many levels
By-products which appear as a residue to one company are very often associated with a financial burden to dispose of, but in an industrial symbiosis the same by-product can serve as an important input in the production of another company, and will often represent a cheaper and more environmentally friendly alternative to this company than the use of new raw materials. The optimised use of waste products has proved to be an efficient way of reducing the total energy and resource consumption of the companies involved in an industrial symbiosis. Furthermore, the reduced total energy and resource consumption may present a way for companies to meet regulatory requirements, thus additionally, saving companies the cost of adding end-of-pipe technologies to their plants. Co-funding local infrastructure is another good example on how an industrial cluster can create long lasting, resilient and attractive framework conditions to secure local growth.

Save money on the energy bill
Examples of higher energy efficiency through symbiosis collaboration are abundant. Excess heat in the shape of steam from one company's industrial production can be used as process heat by another company. Nearby water resources such as a lake or sea water can be used for cooling processes and the heated cooling water can later be fed into a surrounding district heating network. Or using the fermentation slurry from biotech industries for production of biogas. Applying a holistic approach to the use of energy and resources and exploiting the potential for collaboration with other enterprises will, in most cases, carry both financial and environmental benefits.



Through almost 60 years of cooperation between public and private companies, an impressing ecosystem has been constructed, today amounting to no less than 20 different waste streams being shared between the partners in the Kalundborg Symbiosis.

Photo credit: GreenLab Skive

GreenLab Skive - The green industrial park of the future
GreenLab is a green, circular, industrial park and intelligent energy platform ideally located in Skive, Denmark, where the national 40 bar gas and 150 kV electricity grids intersect. GreenLab wants to integrate those sectors and does so through an industrial symbiosis. All entities in the park are powered by 80 MW of wind and solar energy, and they share their excess resources such as heat, steam, electricity and gas through the SymbiosisNet™ - an intelligent energy exchange infrastructure. In essence, the symbiosis treats energy as energy – a natural resource – regardless of form, and converts, stores and distributes it as needed. The symbiotic infrastructure at GreenLab and embedded resource efficiency enables green energy at a lower cost and the ability to reach competitive price points. Simultaneously, distribution and offtake partners are secured centrally and collaboratively. The intelligent platform that GreenLab builds will enable the optimisation of green energy consumption "from prognosis to product" and will be the first software of its kind that considers the entire value chain.

Courtesy: GreenLab Skive

Kalundborg Industrial Symbiosis
The biogas and fertiliser potential in residual biomass from local biotech plants such as those of Novozymes' and Novo Nordisk's is utilised at a local biogas plant, called Kalundborg Bioenergy. At Kalundborg Bioenergy, biogas is produced, which is subsequently upgraded to natural gas quality through a refining process where, among other things, carbon dioxide and sulphur hydrogen are removed from the product, to be used as a resource for other companies. The natural gas is sent to local companies such as Gyproc Saint-Gobain and Equinor Refining Denmark, and further out to consumers through the natural gas grid. Sulphur from the hydrogen sulphide fraction is collected and recovered as a subcomponent in fertilisers produced on the basis of the biogasified residual biomass.

The case demonstrates the circular economy in real life: residue is used for energy production in a local set up, saving transportation costs on both biomass (supply) and fertiliser (output) over long distances. Manufacturing technology has been changed so that lime is no longer added to the same extent as before, not only saving money, but also resulting in a much more usable product for local farmers. The cooperation ensures local companies obtain a green energy supply at the same time as resources are being used, shared and saved in a sustainable way.

Courtesy: Kalundborg Bioenergy is established in partnership between Ørsted, Bigadan, Novo Nordisk and Novozymes. Kalundborg Bioenergy is owned by Bigadan.

Photo credit: Kalundborg Symbiosis


Learn more about sustainable industries, find more cases on efficient use of energy, water and resources, and connect with Danish expertise at
www.stateofgreen.com/industries
State of Green is a non-profit, public-private partnership founded by:
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wind denmark
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