

# Think Denmark

White papers for a green transition

## ENERGY EFFICIENCY IN A COMPETITIVE INDUSTRY

unlocking the potential of the “first fuel”

### INSIDE IN THIS WHITE PAPER

- Creating the right framework conditions to promote energy efficiency in industry
- Key challenges and solutions across the value chain
- Energy efficiency potentials in various industries
- The key role played by the public authorities

**ENERGY EFFICIENCY IN A COMPETITIVE INDUSTRY**  
- unlocking the potential of the "first fuel"  
Version 2.0

**Front page picture**

The photo is made by Kollision and illustrates the hidden opportunities in energy efficiency in industry.

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# A EUROPEAN PERSPECTIVE ON ENERGY EFFICIENCY IN INDUSTRIAL PROCESSES

**Energy efficiency is a win-win situation for all. Improving energy efficiency will save money, help protect the environment, create new jobs, spur economic growth and improve security of supply**

By Günther Oettinger, Commissioner for Energy, European Union (2010 - 2014)



Energy is an important driver of industrial productivity growth. It is a key production input in industrial processes. Energy, on average, represents between 1% and 10% of total production costs. For energy intensive industries, such as steel, chemical, paper, pharmaceutical, cement and construction materials, the share of energy costs is even higher, between 15% and 40% on average.

**Energy efficiency is key to security of supply and competitiveness**

For a long time Europe has known that energy efficiency is the most cost-effective way to reduce greenhouse gas emissions and that it is key to security of supply and competitiveness. There is a growing awareness of the wider socio-economic benefits of energy efficiency coming from price reduction, job creation, poverty alleviation, increased disposable income, health effect etc., and, in particular, of its central role in safeguarding Europe's global competitiveness and industrial leadership.

**Energy efficiency performance as a strategic first priority**

EU has made energy efficiency a key pillar of the EU energy policy. Improving the EU's energy efficiency performance is a first priority in the Europe 2020 strategy. Energy efficiency in the EU industry has already improved by 29%, at an annual average rate of 1.7% per year over the period 1990-2010. Nevertheless, more can be done. Ongoing analysis under the Energy Efficiency Directive and the 2030 Climate and Energy Framework shows that even in industrial processes further improvements in energy efficiency could be achieved.

**Making energy efficiency an integral part of industrial policy**

More focus is needed on the supporting framework to make energy efficiency an integral part of industrial policy, to remove the barriers and drive industry to improve its energy performance. There are a multitude of formidable monetary and non-monetary barriers, such as scarcity

of external infrastructure, limited access to funding, deficits in information and expertise, need for behavioural changes and prioritising energy efficiency in managerial decisions.

**How to harvest the benefits**

This White Paper offers an important contribution to the debate on how energy efficiency can increase the competitiveness of industries in Europe as well as globally. It is inspirational reading for policymakers and industries alike.

### About this White Paper

The aim of this White Paper is to share some of Denmark's experiences on how to maximise the potential of and benefit from the first fuel, which is energy efficiency. We have gathered the potentials and lessons learned from different industrial sectors, supported by state-of-the-art case examples showing how to harvest the so-called low hanging fruits with energy efficiency and thereby strengthen the competitiveness of companies and industries.

This White Paper can be used as a tool for inspiration to spot the potentials and promote or implement energy saving measures in companies on a global level.

It uses cases to illustrate the potential in the different industries, however, it also addresses the political landscape needed to create an incentive and push energy savings in industries.

The first part of this White Paper will mainly address the political agenda in the EU as well as in Denmark concerning energy efficiency policies and describe some of the energy saving schemes introduced by the Danish government.

The second part is divided into chapters covering different industrial sectors by focusing on selected cases.

We hope you will be inspired.

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# 1. THE FIRST FUEL

## Discovering the hidden opportunities

**Regional price gaps for resources and concerns over competitiveness are here to stay, but there are ways to react. With efficiency first in line the transition to a more efficient, low-carbon energy sector is an excellent investment**

*Dr Fatih Birol  
Chief Economist  
Director Global Energy Economics  
International Energy Agency*

Energy efficiency - which means providing the same output with a lower energy input - is becoming increasingly obvious as a way to reduce production cost in industry. Improvements in energy efficiency minimise the consequences of high energy costs and increase competitiveness while at the same time addressing security of supply and environmental concerns. Furthermore, energy efficiency is crucial in order to reach a sustainable energy future based on a variety of more intermittent energy sources.

### Unlocking hidden potential

Global energy intensity - the amount of energy used to produce a unit of GDP - declined by 1.5% in both 2011 and 2012, compared to an annual average decline of 0.4% between 2000-2010. Global industrial energy intensity decreased 3% in 2005-12, thus a bit better than the global average according to the International Energy Agency. However, there is still ample potential for increasing energy efficiency in the industry. The industrial sector uses more delivered energy than any other

end-use sector, consuming about half of the world's total delivered energy and the global estimate is that energy efficiency could reduce industrial energy use by more than 25 % according to the global Institute for Industrial Productivity.

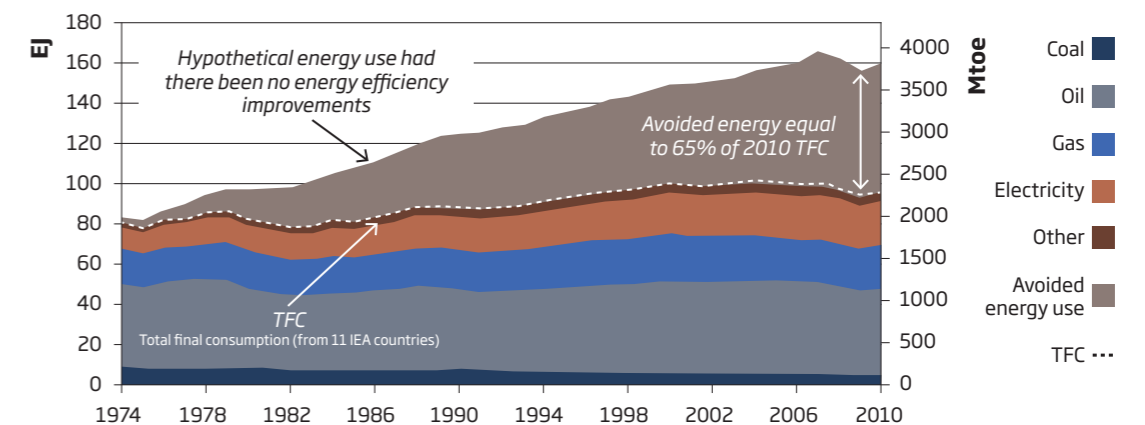
### Energy efficiency as a competitive advantage

Competitiveness as an aspect for getting involved in energy efficiency has in recent years also gained more awareness on the political agenda. Increasing energy prices in most of the world increase the value of energy saved. Technological innovation and the fact that low hanging fruits reappear due to changes in e.g. production volume or input mix, underline the hidden opportunities of investing in energy efficiency measures. Furthermore, investments in energy saving projects in the industry often offer a surprisingly short payback time. This paper highlights the direct impact of increased energy efficiency on the competitiveness of industries and argues that policy measures aimed at improving the energy effi-

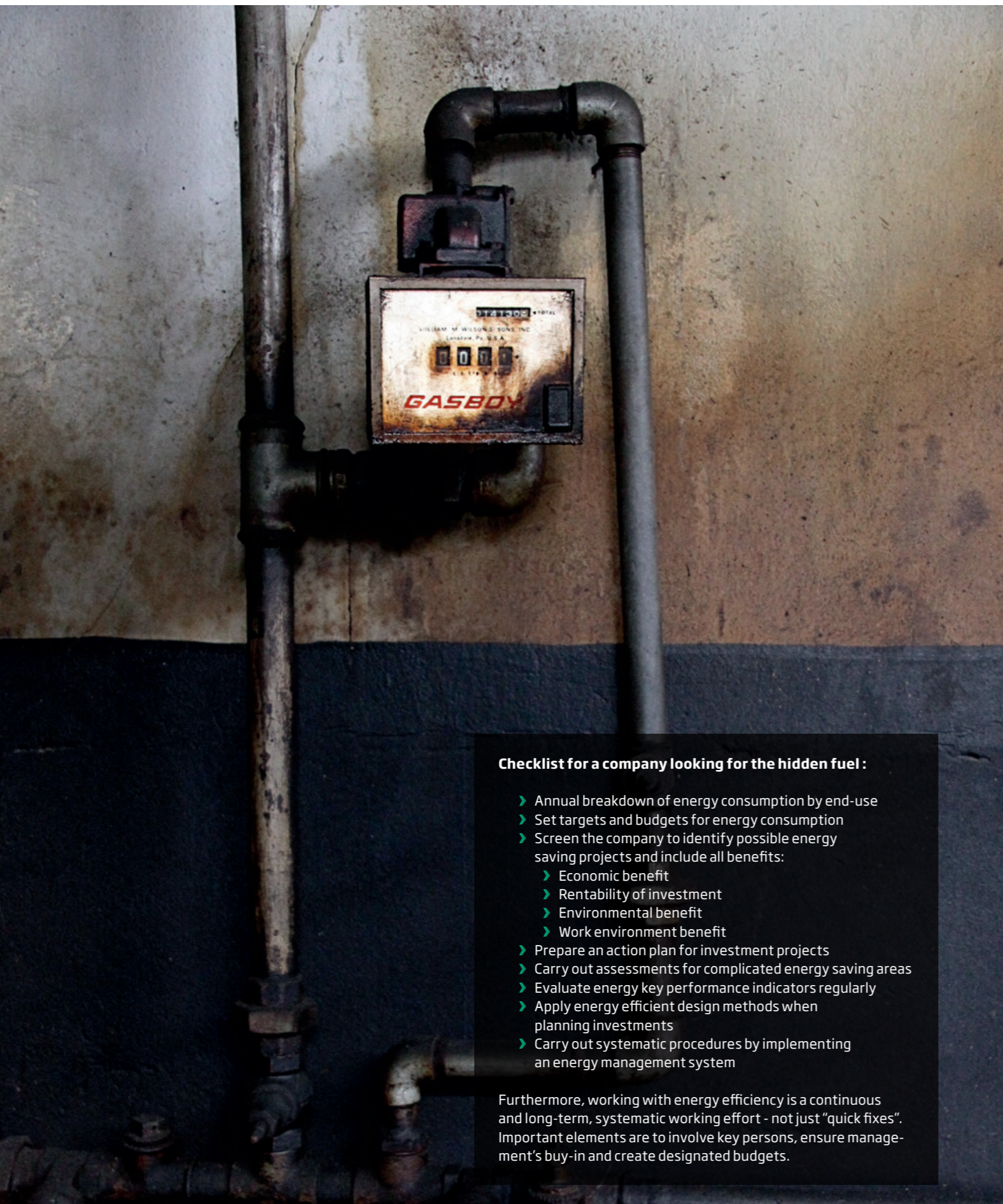
ciency in industries are an important cornerstone in future energy, resources and climate policy.

### Sharing solutions for increasing energy efficiency in industrial processes

Denmark is one of Europe's most energy efficient economies, reflecting a decade-long history of cooperation between the public and private sectors in terms of development of technologies, solutions, know-how and policies within energy efficiency. In this White Paper, State of Green has gathered Denmark's experiences from a wide range of industrial sectors in collaboration with leading stakeholders in the sector, aiming to include valuable insight into the already existing possibilities of industrial energy efficiency. Showing the global potential in each sector, highlighting tools and tips on how to unlock this hidden fuel, underpinned by state-of-the-art case examples from all over the world, and proving that solutions are already there and ready to be implemented.



**From "hidden fuel" to "first fuel"?** The graph shows estimated energy use, calculated on the basis of how much energy would have been required to deliver the actual levels of activity reported each year for all sub-sectors had 1974 levels of energy use per unit of output persisted. (Based on data from IEA indicators database © OECD/IEA 2013 Energy Efficiency Market Report 2013, Market Trends and Medium-Term Prospects, IEA Publishing; modified by State of Green. License: [www.iea.org/termsandconditionsuseandcopyright/termsandconditions](http://www.iea.org/termsandconditionsuseandcopyright/termsandconditions))



#### Checklist for a company looking for the hidden fuel:

- › Annual breakdown of energy consumption by end-use
- › Set targets and budgets for energy consumption
- › Screen the company to identify possible energy saving projects and include all benefits:
  - › Economic benefit
  - › Rentability of investment
  - › Environmental benefit
  - › Work environment benefit
- › Prepare an action plan for investment projects
- › Carry out assessments for complicated energy saving areas
- › Evaluate energy key performance indicators regularly
- › Apply energy efficient design methods when planning investments
- › Carry out systematic procedures by implementing an energy management system

Furthermore, working with energy efficiency is a continuous and long-term, systematic working effort - not just "quick fixes". Important elements are to involve key persons, ensure management's buy-in and create designated budgets.

## 2. FINDING THE HIDDEN FUEL

### How to get started?

*Energy efficiency is at the core of Denmark's green energy transition strategy and has proven highly profitable. Since 1990 our national energy intensity has decreased by 26.2%, adding to the competitiveness of industry. And we have seen significant export growth in this expanding global market area*

Morten Bæk  
Director General  
Danish Energy Agency

Many energy efficiency measures in industry are cost-effective. Not only do such measures reduce energy costs and improve competitiveness on companies, they may also make costly investments in generation capacity unnecessary and contribute to less pollution at a societal level.

#### Key challenges to overcome

Deployment of energy efficient technologies and processes are often constrained by several financial, technical, behavioural and institutional barriers. A key barrier is a lack of both strategic priority of energy efficiency at company level and willingness to invest in energy efficiency measures. In general, there is a need for improved knowledge and experience regarding energy saving potentials.

#### Stick and carrot can initiate energy saving investments

Governmental actions can be a way to address these barriers. Denmark's experience is that with a systematic focus on energy efficiency and a combination of stick and carrot measures, it is possible to spur energy saving investments.

Denmark intensified its approach towards improved energy efficiency in the 1990s by introducing different programmes; tax on energy, energy saving through legislation, subsidy schemes and development of a number of supportive measures. The programmes were developed in close collaboration with the industry and have contributed to a decrease in energy intensity within the industry by 24,5% from 1990 to 2012.

#### Stimulating energy efficiency investments in end-user sectors

Since 2006 a governmental focus on energy efficiency in Denmark has included stimulating energy efficiency investments in end-user sectors, including the industrial sector, via an "Energy Efficiency Obligation Scheme". The general objective of the scheme is that Danish energy companies are to help increase the overall savings efforts, focusing on achieving energy savings in final consumption.

#### Energy companies as drivers

This scheme is a market oriented approach, where energy companies through the energy bill are allowed to recover the costs of the savings via the tariffs on the consumer energy bill. The energy companies involved are under an obligation to use these funds to identify, implement and finally report

a certain amount of energy savings to the Danish Energy Agency each year.

#### Voluntary agreement scheme for energy-intensive companies

Since 1996 the Danish Energy Agency has made agreements on implementation of energy efficiency measures with large, energy-intensive companies in Denmark. To take part in the voluntary scheme, the companies agree to implement energy management and energy efficiency measures in their production, in return for getting a substantial part of their CO<sub>2</sub>-taxes reimbursed.

#### Doubling production while maintaining energy consumption

The scheme has proven highly successful in achieving energy savings. Many of the participating companies have been able to expand their production without proportionally increasing their energy consumption, and many companies have even doubled their production while at the same time keeping the energy consumption almost unchanged.

#### Sharing Denmark's lessons learned

The Danish Energy Agency has gathered Denmark's experiences in the policy toolkit below.



**Policy Toolkit for energy efficiency in industries, Denmark.** Denmark has a long tradition of active energy policy, initiated by the first oil crisis in 1973. Over the years, numerous actions have been taken by broad consensus in the Danish Parliament to reduce energy consumption by increasing energy efficiency and to increase the share of renewable energy. The experience Denmark has gained on the role of government in the process of using energy more efficiently in industry has been gathered by the Danish Energy Agency in an energy policy toolkit sharing Danish knowledge and experience about handling barriers and improving energy efficiency in the industry. If you want to know more about developing a successful policy tool addressing energy efficiency in industries, you can find a toolkit in the following link. [www.stateofgreen.com/Profiles/Danish-Energy-Agency/Solutions/The-Low-Carbon-Transition-Unit](http://www.stateofgreen.com/Profiles/Danish-Energy-Agency/Solutions/The-Low-Carbon-Transition-Unit) (Courtesy: The Low Carbon Transition Unit)

**Project challenges:**

- › The solution had to comply with Kaolin AD's energy efficiency strategy
- › Poor heat recovery efficiency
- › Pay-back time less than 3 years
- › Financing

**Project results:**

- › Estimated savings of EUR 240,000-375,000 p.a.
- › Natural gas consumption reduced by 1-1.5 mill. Nm<sup>3</sup> p.a.
- › Reduction of CO<sub>2</sub> emissions by 2,000- 3,300 tons p.a.
- › 3 years' repayment schedule
- › 1.5 years' simple payback time



**Behind energy savings is a strong value chain, Bulgaria.** Kaolin AD is a leading mineral extracting and processing company who has been able to reduce their energy consumption in a project which has engaged energy consultancy, suppliers and investors from Scandinavia. Kaolin AD was searching for a partner to comply with their ambitious energy efficiency strategy. EnergiMidt presented a solution for the replacement of an existing boiler from the early 1970's with a new boiler that utilises the waste heat from a rotary kiln to produce steam, which can then be used as a complementary heating source. Professional advice on opportunities, equipment, energy savings and the provision of financing, supported by the Danish Export Credit Agency and financed by the Bank of Nordea, made it clear to Kaolin AD that EnergiMidt was the right partner. The investment resulted in estimated savings of EUR 240,000-375,000 p.a. and broke even within two years. (Courtesy: EnergiMidt)

## 3. ENERGY-INTENSIVE PROCESSES

### Investing in energy efficiency is a simple business case

*Danish energy companies hold experience of vital importance in energy efficiency to reduce the energy intensity of the European industry.*

*Elena Markova  
International business development manager  
EnergiMidt*

Energy intensive industry accounts for 25% of global industry jobs and 70% of industry energy use. Energy intensive processes include the use of evaporator plants (for instance concentration of milk products), drying processes (for instance drying of paper/pulp, proteins and chemical products), distillation columns (for instance for concentration of alcohol and hexane), kilns (for instance for production of cement, chalk and clay products), furnaces (for instance for melting of glass, metals and minerals), and refinery (for instance production of oil and gasoline products). As energy accounts for a significant share of total production cost in energy-intensive processes, minimising energy use is essential to maintain and improve the competitiveness of energy-intensive companies.

#### Improved competitiveness

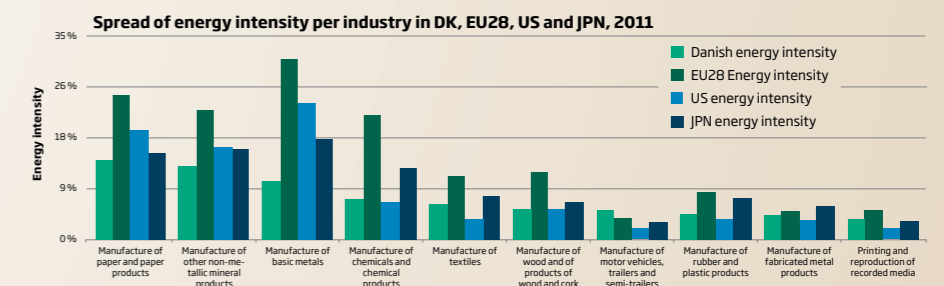
Countries such as US, Japan, Denmark as well as the EU have increased their focus on the importance of energy efficiency within the last decades, which has led to a decline in energy intensive production

and improved competitiveness in certain industries. Certain industries are greatly affected by high energy consumption, manufacturing of metal being one of them. The energy intensity for each country is calculated on the basis of Eurostat Structural Business statistics, as the purchase of energy products' share of gross value added.

#### Visualisation is first step

Often, energy efficiency is not visible to the eye and neither easily measured, but the 1990's introduction of ambitious energy policies addressing the industrial sector helped create a market for energy

efficient products in Denmark, motivating Danish companies to improve the energy performance of their products and services in order to respond to domestic demand. The decade-long Danish expertise with integrating energy efficiency measures in energy intensive processes is now increasingly being sought after globally. This expertise includes not only the technologies and products that are essential to reduce the energy use in the energy intensive unit operations but also the consultancy that enables companies to map their energy use and visualise the potential in investing in energy efficiency measures. The following cases exemplify some of the possibilities.



#### Low-Energy CEMents for sustainable concrete, Denmark.

Cement, concrete and other cement-based materials are the world's most widely used construction materials and global consumption is growing steadily. Concrete is the world's most durable, reliable and economical construction material with an annual consumption in volume by society only surpassed by water. Currently, no alternatives for concrete exist which can be supplied at a sufficient scale globally. Cement is the essential "glue" in concrete with an annual world-wide production of about 3 billion tonnes. The reduction of energy consumption and CO<sub>2</sub> emissions in cement production are one of the most challenging research fields within industry. Denmark has a strong focus on research and development. The LowE-CEM project is a good example of a joint research collaboration between universities, laboratories and leading companies, aiming to achieve a significant energy and CO<sub>2</sub> reduction associated with the production of cement materials. (Courtesy: Aalborg Portland & Aarhus University)



**Visualisation of energy use in heat curing, Denmark.** Bodycote Heat Treatment is the world's largest supplier of heat curing and has 180 factories in 26 different countries. As a business with significant energy consumption, there is also focus on energy optimisation. At Bodycote in Funen in Denmark, energy represents 14% of total costs and therefore it was natural to map out where and how the energy was used.

Schneider Electric supplied the components and solutions for Bodycote Heat Treatment, and this has made it possible to map the company's energy consumption and how costs were distributed to each department. Bodycote gained an effective overview of specific energy saving measures which quickly translated into specific savings. It turned out, among other things, that the idle running of the large gas ovens was unnecessarily high. This meant that the system was turned on even though production was stopped. The overview also allows Bodycote to manage the production plant optimally by using the facility that best matches a given task.

Bodycote Heat Treatment now continuously measures 80% of their energy use, with no less than 91 individual meter units. Visualisation of the energy use is the core here. - It is not just big gas ovens that have attracted attention with regards to their potential for energy efficiency. Bodycote Heat Treatment has also installed drives on the cooling system, which previously ran at full speed regardless of load. Now, the energy-intensive pumping rate adjusts for actual consumption. Data from the energy meters is picked up on one central computer, so it is easy to follow the consumption of individual machines and processes. (Courtesy: Schneider-Electric)

**Efficient Energy Integrated Solutions for Manufacturing Industries, Europe.** This project is made up by participants from 11 countries, Denmark being one of them. The countries cooperate to facilitate and accelerate a move to low carbon manufacturing processes and site management by deployment and demonstration of innovative energy management systems and enabling efficiency technologies, which extend the scope of energy management outside the boundaries of a single plant to total site and then beyond the total site to district heating/cooling systems. The potential is demonstrated across a selection of the EU's most energy intensive sectors - thereby enabling integration across industries and processes. The project will significantly advance the state-of-the-art solutions, with regards to site optimisation and Energy Management Systems. (Courtesy: Vestas Industrial Cooling)





**New frequency converter cut a third of the electricity bill, Denmark.** Dairies in Denmark focus on efficiency. In one year, the Scandinavian dairy company Arla Foods saved nearly EUR 400,000 on its electricity bills for cooling towers by creating intelligent control of compressors and blowers by implementing Siemens' frequency converter. The payback time for the investment was just six months. (Courtesy: Siemens)

## 4. SUSTAINABLE INTENSIVE FOOD PRODUCTION

### Producing more with less

*By a continued development of sustainable intensive food production we can create jobs and economic growth, enrich nature and provide answers to some of the major global challenges that we all face. The transition requires new ways of thinking, political will and strategic investments. Tomorrow's winners will be those who can produce more with less, keeping in mind the circular approach to production.*

Jan Laustsen  
Director, Trade & Market Relations  
Danish Agriculture & Food Council

The global food sector currently accounts for around 30% of the world's total energy consumption. In Denmark agriculture takes up approximately 10% of the total energy usage in industry and therefore a major source of total CO<sub>2</sub> emissions. Projections from the The Food and Agriculture Organization of the United Nations, FAO, indicate that by 2050, a 70% increase in current food production will be necessary to meet the expanding demand for food.

#### **Reduce the environmental impact, improve efficiency and increase recycling**

Sustainable intensive food production is about utilising resources efficiently and lowering environmental impacts. The Dan-

ish agriculture and food cluster is undertaking this transformation, demonstrating that increased food production is possible whilst at the same time significantly reducing the impact on the environment and the climate.

Examples are applying manure to farm land, using the energy potential of manure by degassing it in biogas plants, breeding efforts, feed optimisation and turning slaughterhouse waste into biogas and biodiesel and less food waste.

#### **Water is a driver for energy control**

As food and agriculture are the largest consumers of water, requiring one hundred times more than we use for personal needs, the industries are interested in

solutions to reduce water expenses. When implementing control systems and working systematically with water usage, it creates a spill-over effect leading to awareness of energy consumption, which again is often followed by energy saving measures.

#### **Real life solutions to learn from**

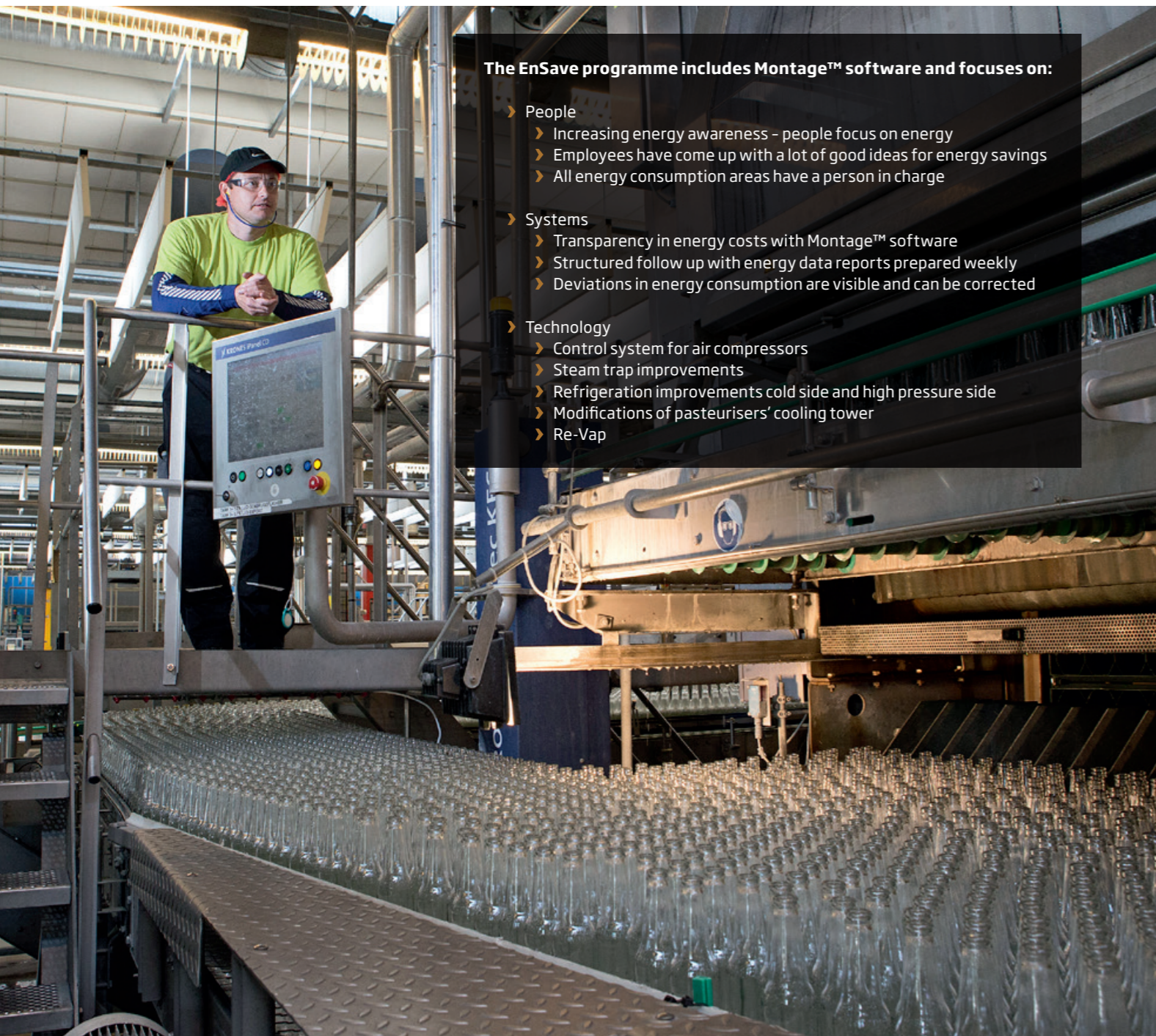
Denmark is known for its high food quality and we are continuously improving and innovating ways of how to produce more with less. Concrete examples of the Danish agriculture and food sector show that increased food production is possible while at the same time significantly reducing the use of energy and the environmental impact.



**State-of-the-art energy-conscious slaughterhouse, Denmark.** Danish Crown opened a new and modern pork slaughterhouse in Horsens in 2005. In the process of building the slaughterhouse, resource and energy efficiency were optimised in cooperation with COWI consultancy, while at the same time taking due consideration to both working environment and surroundings. This state-of-the-art facility has set new standards for energy efficiency and environmental responsibility in food production. It has since developed and expanded considerably, now handling 103,000 pigs per week.

In the abattoir 41% of the heat demand is covered by heat recovery. 2,000 electricity saving motors reduce the emission of CO<sub>2</sub> by 570 tons annually. Also, the cooling system that keeps the produce at -20 degrees Celsius has been optimised. The facility uses ammonia as a refrigerant instead of freon, along with an optimised operation of the system. It uses the least amount of energy, saving 4,100 MWh annually - equal to the power consumption of 820 families. (Courtesy: Danish Crown and COWI)





**The EnSave programme includes Montage™ software and focuses on:**

- › People
  - › Increasing energy awareness – people focus on energy
  - › Employees have come up with a lot of good ideas for energy savings
  - › All energy consumption areas have a person in charge
- › Systems
  - › Transparency in energy costs with Montage™ software
  - › Structured follow up with energy data reports prepared weekly
  - › Deviations in energy consumption are visible and can be corrected
- › Technology
  - › Control system for air compressors
  - › Steam trap improvements
  - › Refrigeration improvements cold side and high pressure side
  - › Modifications of pasteurisers' cooling tower
  - › Re-Vap

*“This is not just a project, it has become an integral part of our daily work”*

*Energy and maintenance manager at the Porto plant, Vasco Carvalho.*

**Making energy efficiency part of creating quality and competitiveness, Portugal.** Unicer wanted to cut unnecessary costs at Porto and Santarem breweries in Portugal to ensure its competitiveness in the market. Initially there was hardly any focus on energy consumption, with employees more dedicated to the production and quality of the beer. It was a challenge for Scanenergi to convince them about the importance of energy savings and channel their efforts towards it. By using Danfoss' Montage™ software to generate weekly reports, Unicer now has a complete and detailed overview of both energy consumption and energy costs. This transparency in the consumption and costs helped increase commitment to energy saving and produced exceptional results. Since 2009 Unicer in Santarém has saved 480,000 euro annually – equal to a 20% reduction of the total utility costs – while the facility in Porto saved more than €1 million on annual utility costs. Project payback was achieved in just two years. (Courtesy: Scanenergi)

# 5. THE BREWING INDUSTRY

## Continuous improvements in the brewing industry

*We have been able to save a lot of energy by optimising our existing technology and by motivating our employees to use their common sense and be aware of their impact on the energy consumption. And with the Montage™ software we can measure our energy consumption more precisely. You cannot improve, what you cannot measure*

*Víctor M. Treviño  
Engineering Manager  
Cuahtémoc Moctezuma*

Brewing is a dynamic industry with a long history rich in craftsmanship, tradition and innovations. From small craft brewers to large scale industrial brewing operations, energy is a key input across the whole value chain.

**4% of manufacturing costs**

It has been estimated that the global beer industry spends 4% of its manufacturing costs on energy. The internal and external pressures on the industry to reduce costs and the environmental impact have led to the brewery sector being progressive in terms of energy efficiency.

**Continuous improvement**

Many beer companies started to implement energy efficiency measures years ago and an increasing number of brewers regard

their energy efficiency efforts as ongoing activities for continuous improvement.

**Innovation through energy efficiency**

The majority of identified energy efficiency potential lies within the core production processes, the infrastructure and supply chain including insulation, heat recovery, load management and efficient electric motors. Some brewers are also starting to use a more circular approach to their production, reusing waste from the brewing process for biogas generation or fuel co-generation plants and creating up-cycled packing materials.

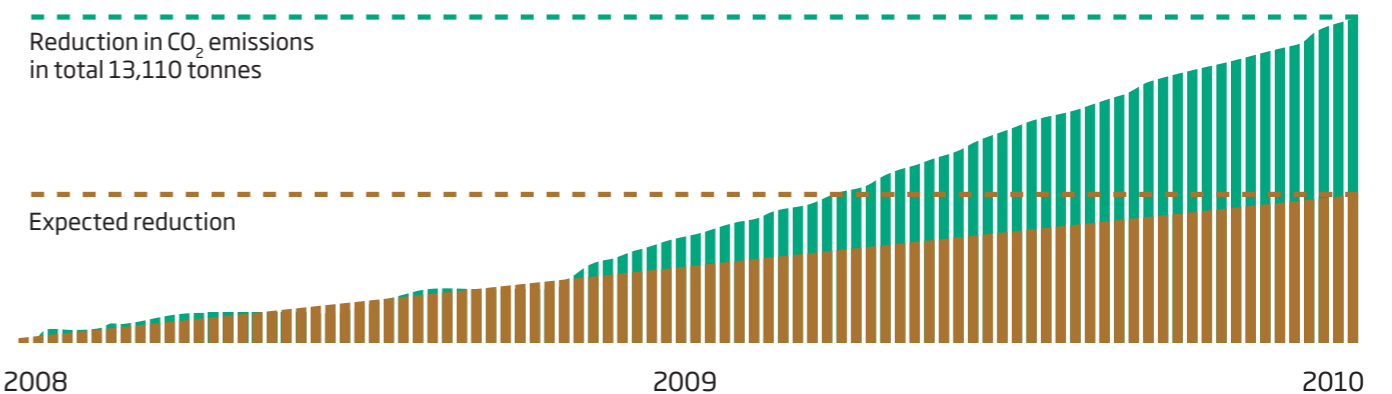
**People, systems and technology**

Ensuring commercial success in a highly competitive market whilst complying with increasingly stringent legislative require-

ments and being able to deal with continually rising costs of resources such as energy and water calls for an integrated approach focusing on people, systems and technology throughout the whole value chain.

**State-of-the-art solutions**

Denmark has a long and proud tradition of brewing beer, always focusing on the highest quality, but also on how to do it more efficiently. This has resulted in a number of companies offering state-of-the-art competencies and solutions which are already implemented around the world. Here are a number of cases exemplifying some of the tools and solutions ready to plug and play in your business.



**Keys to success, Mexico.** Collaboration between Scanenergi and Danfoss and the Cuahtémoc Moctezuma brewery in Mexico has resulted in a reduction of 13,110 tonnes of CO<sub>2</sub> emissions over 38 months, equal to 19 tonnes per employee. Effective management software (EnSave@), an upgrade of existing technology, and adaptable employees were keys to this success. For the Cuahtémoc Moctezuma brewery the EnSave® project has led to a significant reduction in the energy consumption, and even though the production level has increased almost 20% compared to the 2005/2006 level, the 2009 energy consumption has remained practically on the same level. (Courtesy: Scanenergi)

## 6. THE PHARMACEUTICAL SECTOR

### A business partnership to save energy and increase profit

*In Denmark many companies have identified energy saving opportunities, but only limited energy savings are realised. The primary reason is lack of dedication and unstructured organisation of the effort. A great number of companies have potential to save 15-20% on their energy bill through investments with a payback time of less than 4 years, if the effort is orchestrated in the correct way.*

Lars Sprogøe Bentzen  
Senior Director  
DONG Energy

Certain aspects of pharmaceutical companies' operations require significant energy use. The most notable processes driving energy use include heating, ventilation, and air conditioning (65%); plug loads and processes (25%), and task and overhead lighting (10%). In these areas there are significant opportunities for companies to realise energy savings.

#### Energy efficiency as a strategic focus area

In recent years, it has become a managerial goal for pharmaceutical companies around

the globe to improve their manufacturing processes in a sustainable way. One of the biggest challenges for the pharmaceutical industry is implementing highly-reliable energy solutions at their research and manufacturing facilities that can help them reach their sustainability goals and, at the same time, improve competitiveness by reducing costs in the manufacturing process.

#### Strategic partnerships

As a response to these challenges, some of the pharmaceutical companies in Denmark have formed successful partnership

agreements with Danish energy companies. Through their commitment to the national energy efficiency obligation scheme (as mentioned in Chapter 2), the Danish energy companies are interested in providing companies with energy consulting services, including guidance on energy consumption audits and energy efficiency improvements. Significant benefits, including innovations in the production processes, have been achieved through these partnerships. Explore some of the benefits and lessons learned in the following cases.

#### The partnership model between Novo Nordisk and DONG Energy



DONG Energy helps Novo Nordisk save energy at Danish production sites



Novo Nordisk implements energy saving projects and achieves financial savings

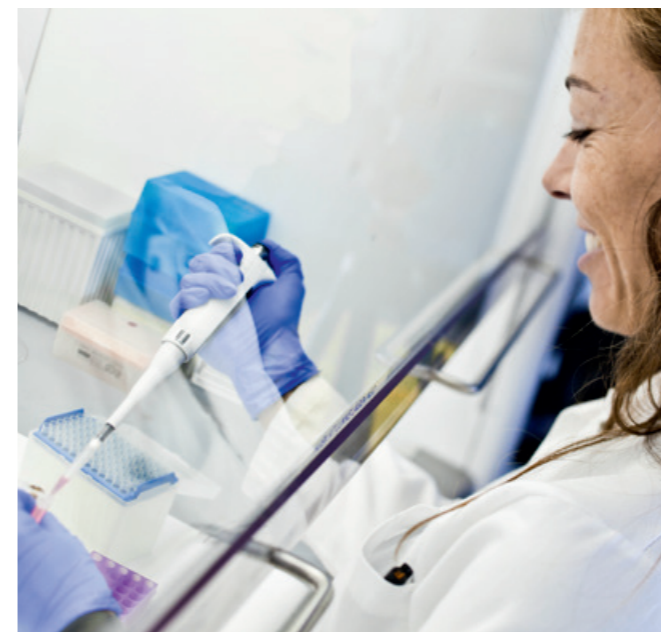


The financial savings are earmarked to purchase renewable energy certificates from wind farm Horns Rev II

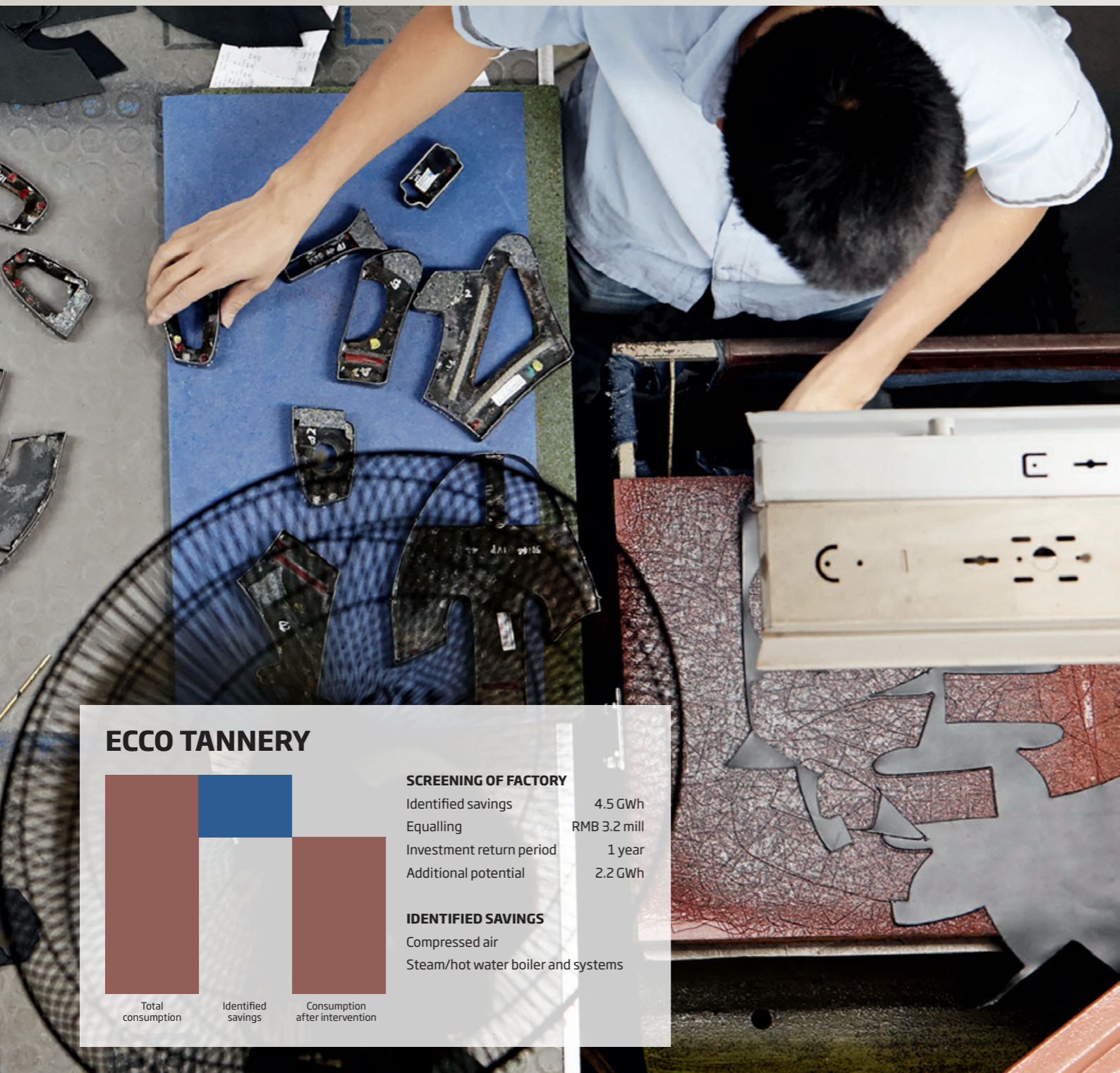


The electricity at Novo Nordisk's Danish production sites is covered by renewable energy certificates

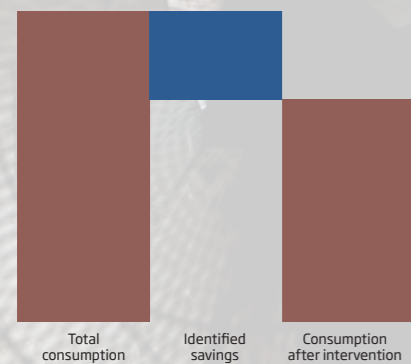
**Climate partnership between energy company and pharmaceutical company, Denmark.** In 2006, the pharmaceutical company Novo Nordisk made an ambitious commitment to reduce CO<sub>2</sub> emissions from global production by an absolute 10% from 2004 to 2014. In the quest to meet the goal, Novo Nordisk signed a landmark partnership with Danish energy company DONG Energy. The partnership was the first of its kind in Denmark to combine energy savings with renewable energy. The reduction was achieved through three levers: optimisation through the Novo Nordisk LEAN programme, cLEAN®, a global energy saving programme and conversion to renewable energy. For Novo Nordisk, the partnership has resulted in around 370 energy-saving projects since 2007. By the end of 2012, the partnership has generated annual savings of EUR 6 million corresponding to a 20% reduction of the company's energy consumption in Denmark. It has been justified that more than 65% of the achieved energy savings in the period 2007-2011 are caused by applying LEAN principles to review and optimize procedures, basic operating parameters etc. The average payback time for the specific energy-saving projects varies between 1.5 and 3.5 years. Novo Nordisk is now implementing energy saving programmes at their sites across the world. (Courtesy: DONG Energy and Novo Nordisk)



**Great savings potential at ventilation plants in laboratories, Denmark.** LEO Pharma aims to reduce its energy consumption in order to reduce both production costs and CO<sub>2</sub> emissions. Therefore, the company has asked ALECTIA to carry out energy screenings on a number of selected laboratory and production facilities. ALECTIA's primary focus in LEO Pharma's research laboratories has been the ventilation plants which typically account for 60-80 % of the total laboratory energy consumption. The energy screenings here have resulted in annual energy savings of approximately 2,500 MWh, similar to approximately EUR 1,5 million. The energy screening of LEO Pharma's tablet manufacturing facility has shown a large potential for savings through operation optimisations of the ventilation plants and compressed-air plants. The savings in the tablet manufacturing facility account for approximately 40% of the total energy consumption of the facility before the changes were made. The energy efficient changes and the subsequent requalification of LEO Pharma's GMP-critical installations and functions have been planned so that the work in the laboratories and the tablet manufacturing facility were disturbed very little and without long shutdowns. The main part of the costs for ALECTIA's consultancy has been covered by subsidies from LEO Pharma's energy utility company. (Courtesy: ALECTIA)



### ECCO TANNERY



#### SCREENING OF FACTORY

Identified savings	4.5 GWh
Equalling	RMB 3.2 mill
Investment return period	1 year
Additional potential	2.2 GWh

#### IDENTIFIED SAVINGS

- Compressed air
- Steam/hot water boiler and systems

#### Optimized boiling and air compressing at ECCO shoe factory and tannery, China.

In 2012, ECCO engaged with an energy efficiency project with their partners in China in cooperation with the company SE Big Blue that offers consultancy on energy efficiency and sustainability. SE Big Blue carried out an energy screening on both the ECCO shoe factory and the tannery, located in the town of Xiamen, situated in the Fujian province, China. The energy efficiency experts found that there was substantial energy reduction potential in many of the processes, and investing in optimizing boiling and air compressing led to immediate energy reductions. Today the tannery is using a dryer system with two doublet regenerative air dryers, producing a high quality of compressed air – a quality normally only seen at food companies or in the pharmaceutical industry. Changing the start/stop set points further reduced the energy consumption with 82 kWh/day, equal to 25,500 kWh/year, and the factory was able to recover 80% of the waste heat from production and air compressing by heating up water for different purposes. Moreover, in the shoe factory new boilers have been installed and a schedule for heat recovery in a strategic manner has been implemented. The projects carried out in collaboration with the experts from SE Big Blue have been highly productive for both factories, where energy efficiency has not only led to energy and water savings and resulting financial savings. The initiatives have also led to a better working environment in the factories. (Courtesy: SE Big Blue)

## 7. RETHINKING THE TEXTILE & TANNING INDUSTRIES

### Savings potential in manufacturing processes

*The project with SE has opened our eyes for the huge benefits that come with a more efficient use of resources. We have taken some important steps towards a more sustainable production and we have improved our working environment as well as our ability to compete in the market.*

Neil Clarke Perrin  
Managing Director  
ECCO Tannery Xiamen Ltd

The textile industry is a fragmented and heterogeneous sector dominated by small and medium enterprises (SMEs). In general, the textile industry is not considered an energy-intensive industry. However, the sector comprises a large number of plants which all together consume a significant amount of energy, and energy therefore remains one of the main cost factors in the textile industry. Improving energy efficiency should thus be a primary concern for textile plants, especially in times of high energy price volatility.

#### Limited information on opportunities

The textile industry uses large quantities of both electricity and fuels, and every textile plant holds various energy efficiency opportunities, many of which are cost-effective. However, even cost-effective options are often not implemented due to the fact that many textile plants are categorised as SMEs and thus have limited resources to acquire the necessary information on how to implement energy efficiency measures.

#### The tanning industry

Energy is also one of the major operating costs in the tanning industry, along with the use of water. Energy is used for operating machinery, drying leather in different process phases, heating water to temperatures needed for chemical processes, producing compressed air etc. Significant factors influencing energy consumption in a tannery include the type of raw materials entering the tannery and the energy intensity of the different process phases carried out.

#### Savings potential in the manufacturing process

One approach to awaken energy savings in the manufacturing process is to install highly energy efficient machinery for the manufacturing processes and take a more systematic approach towards energy efficient manufacturing. Energy management is one of the tools which can lead to significant savings.

#### Decades of energy management

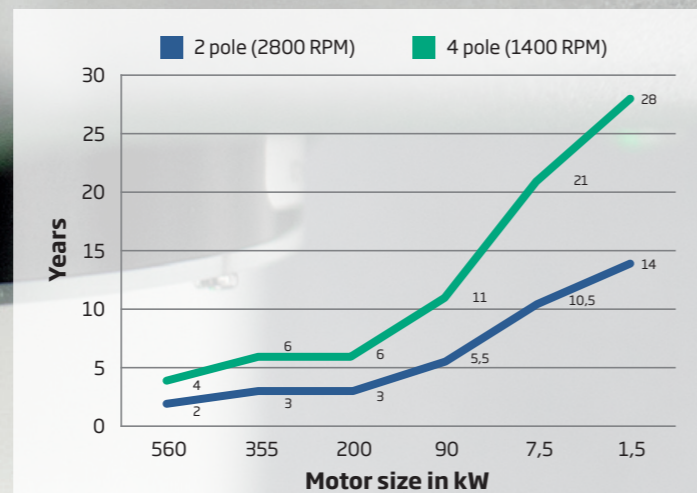
To make the manufacturing as resource efficient as possible a continued and systematic approach is needed. Since the 1990s, Denmark has used the tools in energy management focusing on long-term solutions instead of quick fixes, resulting in significant savings. For SMEs the Energy Management ISO 50001 can be too comprehensive, hence a "light" version has been developed focusing on target, team, energy mapping, action plan, monitoring, evaluation and annual procedures.

Explore the cases for more inspiration on how to rethink the production flow.

#### Climate considerations and good business go hand in hand at carpet manufacturer Ege, Denmark.

Ege is among the world leaders in climate-friendly carpets. DONG Energy is helping the Danish carpet manufacturer Ege develop and realise ambitious climate strategies through a climate partnership. In the past five years, Ege's energy consumption has been reduced by approximately 50 million kWh in total. This corresponds to a reduction of 21%. This target has been achieved through implementation of energy saving projects within ventilation, recycling of waste water, heating and lighting, among other things. The cost savings correspond to the electricity consumption of approximately 2,500 Danish households. DONG Energy's contribution to the development and realisation of Ege's climate strategies is based on three areas: A continuous process where DONG Energy suggests and implements energy savings, documents that part of Ege's electricity consumption comes from wind turbines and continuous visualisation of Ege's climate efforts internally and externally. (Courtesy: DONG Energy)





The figure shows a payback time via energy savings in years with ABB motors with CeramicSpeed bearings, continuous operation.

## 8. LOOKING ACROSS THE INDUSTRIAL SECTOR

### Cross-cutting efficiency

*The first pumps we installed delivered 51% energy savings, but that was actually the lowest efficiency improvement we recorded in all our installations there. Our next installation reduced the pumps' energy consumption by 54%, and the third one came in at 53%*

*Kenichi Hattori  
Chief Engineer  
Yokohama*

Some energy efficiency enhancements cut across sectors. Electric motor-driven systems are one example. They provide a large potential for improvement of industry-wide energy efficiency. The International Energy Agency estimates that electric motor-driven systems in the European Union, for example, account for about 70% of all industrial electricity consumption.

#### Potential in motor-driven systems

The IPCC has mapped the following opportunities for increased efficiency of motor-driven systems by improving the efficiency of the electric motor through reducing losses in the motor windings, ensuring appropriate motor size and type, using better magnetic steel, improving the aerodynamics of the motor and improving manufacturing tolerances.

Implementing high-efficiency motor-driven systems, or improving existing ones, in the EU-25 could save about 30% of the energy consumption.

#### Pump efficiency is constantly improved by new technology

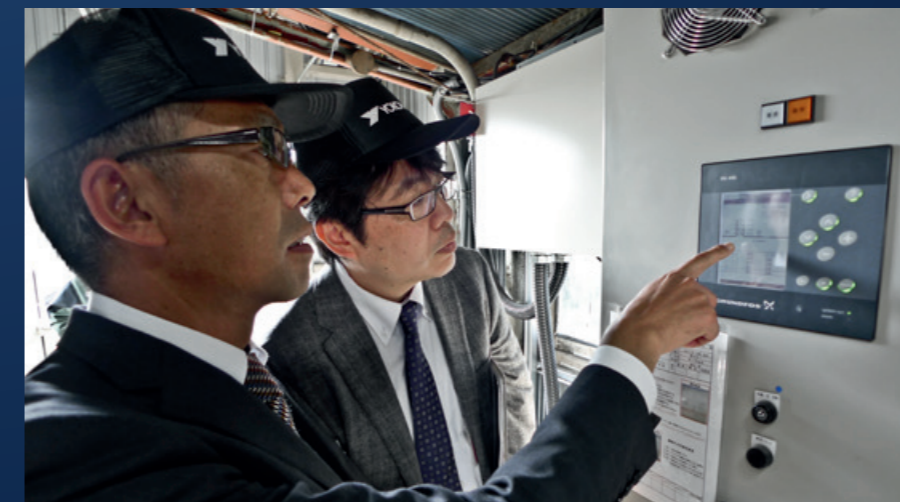
Pumps are one example of end devices used in many industrial applications. They play a vital role in dairies, breweries, slaughterhouses, textile and chemical production, power stations, shipping, and in the production of cars, yeast, juice and pharmaceuticals - to name but a few. Most people are unaware that every production industry is dependent on them. Over the years, the pump industry has changed greatly. Enormous progress has been made, and the pumps we have today are far more efficient than ever before.

#### Intelligent pumps

Still 2/3 of all pumps installed today are inefficient and use up to 60% too much energy. Replacement offers significant savings. Most pumps currently installed are larger than necessary and often run continuously at their maximum speed.

In reality, most pump motors only have to run at full-speed 5% of the time. This leads to massive energy waste. Replacing pump systems can make an immediate difference and in many cases return on investment will be reached within just a few years, after which the new system results in pure savings. Pump optimisation can pay for itself in less than 24 months. The cases show the hidden potential.

**Using energy efficient bearing solutions in industry, Denmark.** CeramicSpeed develops and produces ceramic bearings, which have much lower energy losses than conventional bearings. Energy loss is reduced by a combination of ceramic balls with very smooth surfaces and increased precision. Bearings are included in all electric motors and rotary machines. ABB installed CeramicSpeed LongLife Insulate bearings and experienced an additional benefit, as they already pay for themselves several times over as a result of their longer lifetime. The results were better than expected, as the energy loss in the developed bearings is reduced by 60-70 % compared to conventional bearings due to less friction. An investment in optimised bearings can be repaid in as little as 2 years. (Courtesy: CeramicSpeed)



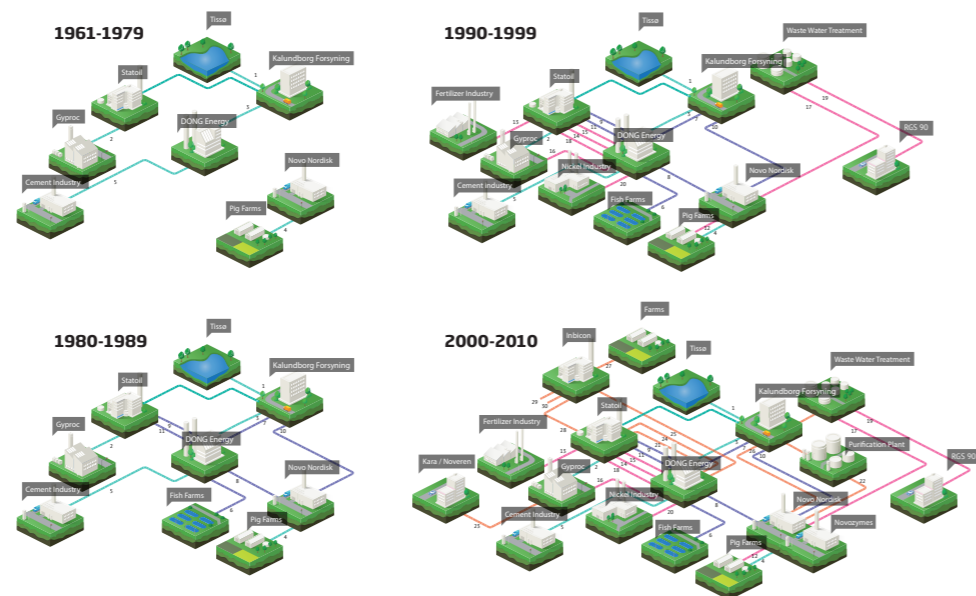
**High efficiency technology pays rewards, Japan.** The initial installation of Grundfos pumps and their control systems paid for itself within 18 months through reduced energy costs. Payback time at the Hiratsuka plant was one year, and at the second Shinshiro installation, 15 months. They have also helped the company contribute to Japan's national setsuden (electricity saving) movement. (Courtesy: Grundfos)



**Saving energy, water and materials in a resource collaboration through industrial symbiosis, Denmark.** Kalundborg Symbiosis has developed their approach over more than four decades. The Kalundborg Symbiosis began in 1961, when Statoil (then Vedol, later Esso) needed water for their refinery near Kalundborg. The first conduit pipes in Kalundborg Symbiosis were laid between Statoil, Kalundborg Utilities and the nearby lake, Tissø. In 1972, Statoil entered into an agreement with Gyproc Saint Gobain, that develops and manufactures gypsum-based elements for the construction industry, for the supply of excess gas from Statoil's production to Gyproc. Gyproc used the gas (today, natural gas) for the drying of the produced plasterboard in their ovens. Over the years, more and more businesses were linked into the Kalundborg Symbiosis, and today the symbiosis includes eight public and private enterprises in the Kalundborg area, among them the world's largest producer of insulin, the world's largest enzyme producer, the largest sewage treatment plant in Northern Europe, the largest power plant in Denmark and the largest oil refinery in the Baltic Region. The symbiosis covers exchanges of a range of resources: recycling of 150,000 tons of gypsum from desulphurization of flue gas replaces import of natural gypsum, and app. 3 million m<sup>3</sup> of ground water and surface water is saved through recycling and reuse. The collaboration between the enterprises through the industrial symbiosis results in a yearly CO<sub>2</sub> emission reduction of 275,000 tons. The illustration below visualises how the different companies use each other's resources. (Courtesy: Kalundborg Symbiosis)

**Kalundborg Symbiosis, 1961-2010**

1	Surface Water	1961
2	Gas	1972
3	Surface Water	1973
4	Biomass/NovoGro	1976
5	Fly Ash	1979
6	Heat	1980/89
7	Heat	1981
8	Steam	1982
9	Steam	1982
10	Surface Water	1987
11	Cooling Water	1987
12	Yeast Slurry	1989
13	Sulfur Fertilizer	1990/2001
14	Tech. Water	1991
15	Gas	1992
16	Gypsum	1993
17	Waste Water	1995
18	Drain Water	1995
19	Sludge	1998
20	Fly Ash	1999
21	Deionized Water	2002
22	Water	2004
23	Waste	2004
24	Sea Water	2007
25	Steam	2009
26	Condensate	2009
27	Straw	2009
28	Bioethanol	2010
29	Lignin	2010
30	C5/C6 sugars	2010



# 9. A SYMBIOSIS FOR SUSTAINABLE USAGE OF RESOURCES

**One company's surplus can meet another's needs**

*Since 1933, Danfoss has built up competencies to provide industries and homes with integrated heating and cooling in the most efficient way. Our solutions address two dimensions to the challenge: one is the need to reduce carbon emissions through greater use of renewables; the other is higher energy efficiency. District energy can solve both these issues in urban areas.*

Lars Tveen  
Divisional President  
Danfoss District Energy at Danfoss

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 reduction of energy consumption.

**Two kinds 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. The second type is referred to as "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 being recycled and in 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, 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 optimized use of waste products has proven to be an efficient way of reducing the total energy and resource consumption across 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.

**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 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. 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.



**Danish district heating in Anshan - a milestone for energy efficiency, China.**

Located in the north-eastern part of China, Anshan has approximately 3.5 million citizens of which 1.8 million will benefit from district heating. The new district heating system will use non-utilised waste heat from the local Angang Steel plant (China's 3rd largest steel producer) as a primary heating source and will enable Anshan to cut energy consumption and reduce its CO<sub>2</sub> emissions by up to 240,000 tons annually. This makes Anshan the first city in China that utilises district heating for utility water on a large scale. The plan for Anshan, over the next four years, is to utilize surplus heat from Angang Steel as main heating source for the entire city. This will reduce coal usage and CO<sub>2</sub> emissions by 60-90%, as total investment is expected to amount to approximately EUR 200 million. This project requires specific solutions, whereas Danfoss and COWI have joined forces in a strategic partnership delivering both the tailored services as well as the newest technology. The new factory will be covering a total of 60,000 square meters and it will provide a more stable heat supply, noticeably cleaner air, and an improved indoor climate, as well as an abundance of new green jobs. (Courtesy: Danfoss and COWI)



# 10. DENMARK KNOWS ENERGY EFFICIENCY

If your goal is energy efficiency, Denmark is ready as your partner

*The cheapest and most environment-friendly form of energy is the one not used. It is a fact that the demand for energy will increase across all sectors and industries, and using energy more efficiently is an obvious step towards becoming independent of fossil fuels*



Rasmus Helveg Petersen  
Minister for Climate, Energy and Building  
DENMARK

Denmark ranks as one of the most energy efficient countries in the EU and OECD, not least because many Danish companies have optimised their industrial processes, facilities and equipment and obtained substantial reductions in their consumption of energy, water and packaging. Danish products and solutions in energy efficiency can make a considerable positive difference on the bottom lines of companies and individuals alike looking for ways to save energy.

#### Denmark knows how to optimise industrial processes

Denmark is not physically powerful, but we believe that knowledge is power. We know about energy efficiency, because successive governments have addressed our country's limited natural resources, concentrating on using them wisely. As a nation we are known for our ability to collaborate and our expertise is in helping customers and stakeholders reach highly efficient solutions, while developing their ability to profit from that knowledge in turn. We see great opportunity

for mutual benefits in the transfer of knowledge and the growth in both partners' businesses - and we do our work while maintaining a healthy respect for different perspectives and agendas, as well as for the environment.

#### Explore, learn and connect online

State of Green gathers all the leading players within energy efficiency in Denmark. Stateofgreen.com is the official platform for Denmark's green solutions and know-how and offers an online entry point for all relevant information about Danish companies and institutions and their expertise within energy efficiency and Denmark's nine other green strongholds.

#### Come visit us in House of Green

House of Green is an interactive visitors' and exhibition center located in the heart of Copenhagen. House of Green uses a combination of guided storytelling and self-exploration to showcase green Danish integrated solutions and scenarios, as well as an overview of the combined Dan-

ish story within energy, climate, water and resources. Danish representatives act as hosts that both inspire and inform delegations before they move on to on-site visits. For more information about House of Green, please visit [Houseofgreen.dk](http://Houseofgreen.dk).

#### Experience implemented green solutions - live!

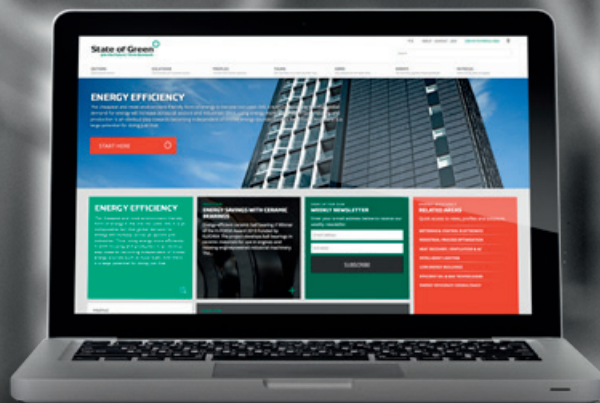
A cornerstone of the Danish vision is to inspire others and demonstrate how a green society is both possible and profitable - and we invite people to come see for themselves. Through State of Green Tours we offer commercial and political decision makers and journalists from around the world a chance to take advantage of the lessons learned by leading Danish companies and institutions within the fields of energy, water, climate adaptation and environment, and to experience Danish green solutions - live. For more information about State of Green Tours, please visit [Stateofgreen.com/tours](http://Stateofgreen.com/tours).



#### About State of Green

State of Green is a public-private partnership founded by the Danish Government, the Confederation of Danish Industry, the Danish Energy Association, the Danish Agriculture & Food Council and the Danish Wind Industry Association. H.R.H. Crown Prince Frederik of Denmark is patron of State of Green.

As the official green brand for Denmark, State of Green gathers all leading players in the fields of energy, climate, water and environment and fosters relations with international stakeholders interested in learning from the Danish experience. Connect through: [www.stateofgreen.com](http://www.stateofgreen.com)



Learn more about Danish solutions in energy efficiency,  
find more cases from around the world and connect  
with Danish expertise at:

[stateofgreen.com/energy-efficiency](https://stateofgreen.com/energy-efficiency)

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Confederation of Danish Industry

 DANISH ENERGY ASSOCIATION



Danish Agriculture & Food Council

 DANISH WIND INDUSTRY ASSOCIATION

  
MINISTRY OF BUSINESS AND GROWTH  
DENMARK

  
DANISH MINISTRY OF CLIMATE, ENERGY AND BUILDING

  
Danish Ministry of the Environment

MINISTRY OF FOREIGN AFFAIRS OF DENMARK

