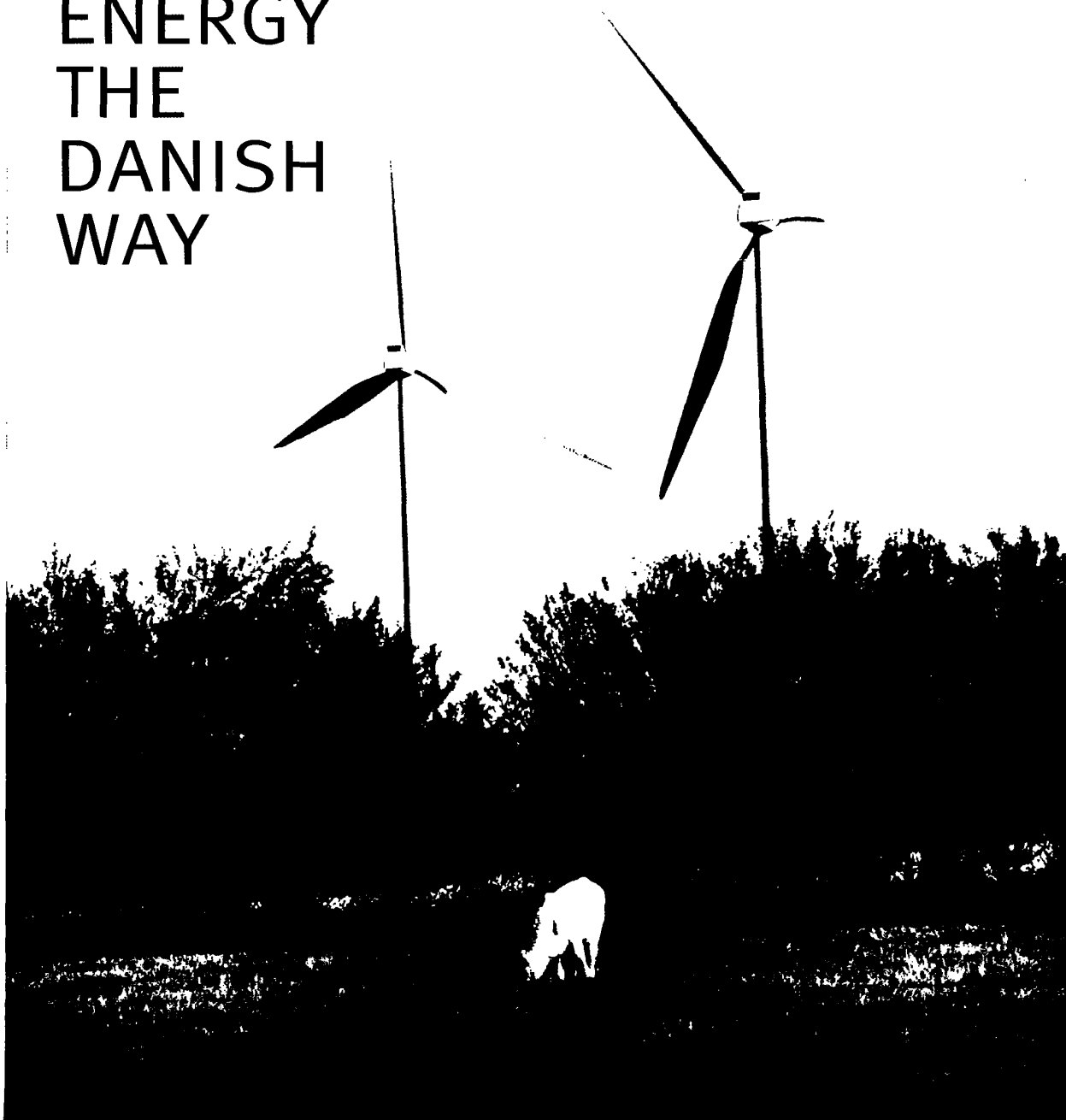


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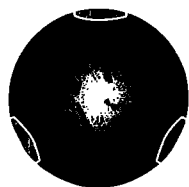
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is published quarterly by the  
Trade Council, Ministry of Foreign  
Affairs of Denmark,  
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DK-1448 Copenhagen K  
Telephone +45 33 92 00 00  
Telefax +45 33 92 19 18  
www.eksportraadet.dk

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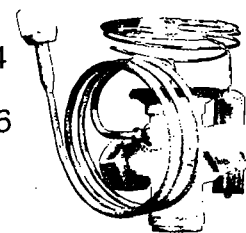
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March 2007  
ISSN 1601-9776

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Cover: Renewable energy covers 14% of the Danish energy consumption



## FOR A BETTER GLOBAL ENVIRONMENT

*By Per Stig Møller,  
Minister for Foreign Affairs*

For more than 30 years, successive Danish governments have prioritised more efficient energy exploitation, while at the same time bringing tough legislation on environmental protection. This has benefited both the environment and the energy balance, and strengthened the Danish corporate sector. It has forced Danish companies to think innovatively and dynamically. Danish companies are world leaders in consultancy and manufacturing in the energy and environmental efficiency industry.

The Danish government is focusing on the strength of Danish energy and environmental technology, which is in demand throughout the world. Danish companies and the Danish government have a shared responsibility to show that there are better and cleaner technologies than those many countries use today. This not only boosts Danish exports, but also brings benefits associated with Danish energy and environmental competences, such as increased supply security and an unshackling of economic growth from its impact on the environment.

Energy efficiency and a better environment are interrelated. The biggest environmental concern today is the massive consumption of energy by growth economies. With a combination of Danish solutions and technologies we can help ensure that the global environment improves. We owe that to the world.



## SOLUTIONS FOR ENERGY EFFICIENCY

*By Flemming Hansen,  
Minister for Transport and Energy*

Important global challenges are lying ahead to secure stable energy supply – a necessary foundation for continued economic growth – while at the same time protecting the environment and mitigating climate change. The Danish experience shows that it is indeed possible to pursue economic growth while reducing consumption of energy and safeguarding the environment. Our energy consumption today is at the 1980 level – despite economic growth of more than 50%. This has been achieved while maintaining Denmark's economic performance and maintaining Denmark as one of the most competitive countries globally.

The key to this success is efficiency in production as well as in consumption of energy. In order to improve efficiency, it is very important that the energy production is based on state-of-the-art technology.

Strong efforts have also been put into developing renewables such as wind energy. In Denmark, 15% of the total energy produced comes from renewable sources, in particular wind and biomass. The Government has recently announced to double this proportion by 2025 as to reduce the use of fossil fuels. Denmark maintains its position as a world leader in wind turbines.

Research and development of new and more efficient energy technologies are crucial if the use of fossil fuels are to be reduced. Intensive research and development is being carried out into new technologies such as second generation biofuels for transport, fuel cells and more cost effective wind turbines. As global energy consumption is expected to increase more than 50% over the next 25 years, Danish energy technology is in a strong position to reduce environmental adverse effects.



## GROWTH IN HARMONY WITH THE ENVIRONMENT

*By Connie Hedegaard,  
Minister for the Environment*

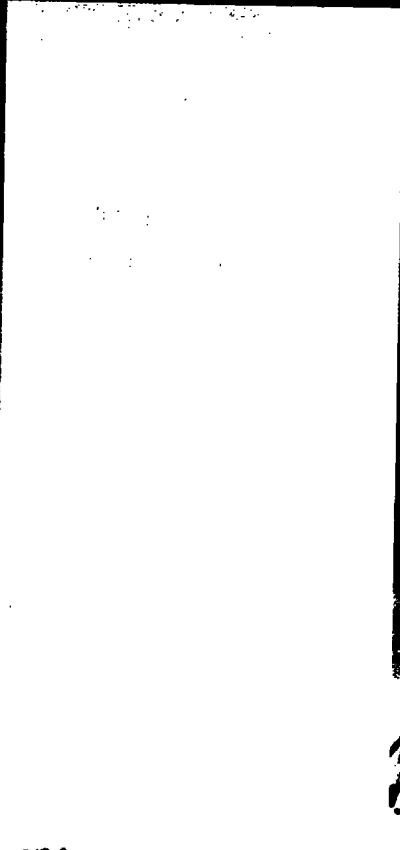
Man-made climate change threatens to destabilise the Earth's ecosystem and the livelihood of millions of people. It is a global demonstration of the need for economic development to take the environment and human health into account.

Denmark has strived for decades to make our society more environmentally friendly. The solutions developed by Danish companies in order to meet our ambitious environmental standards have made them world leaders within a number of environmental fields: As a result, we command cutting edge technologies for waste water purification and potable water supplies; for smoke cleansing and the removal of hazardous substances from fumes; for the handling and processing of solid waste – including incineration as a CO<sub>2</sub>-neutral contribution to our supply of energy. And many other technologies, products and services developed to minimise pollution and the use of natural resources.

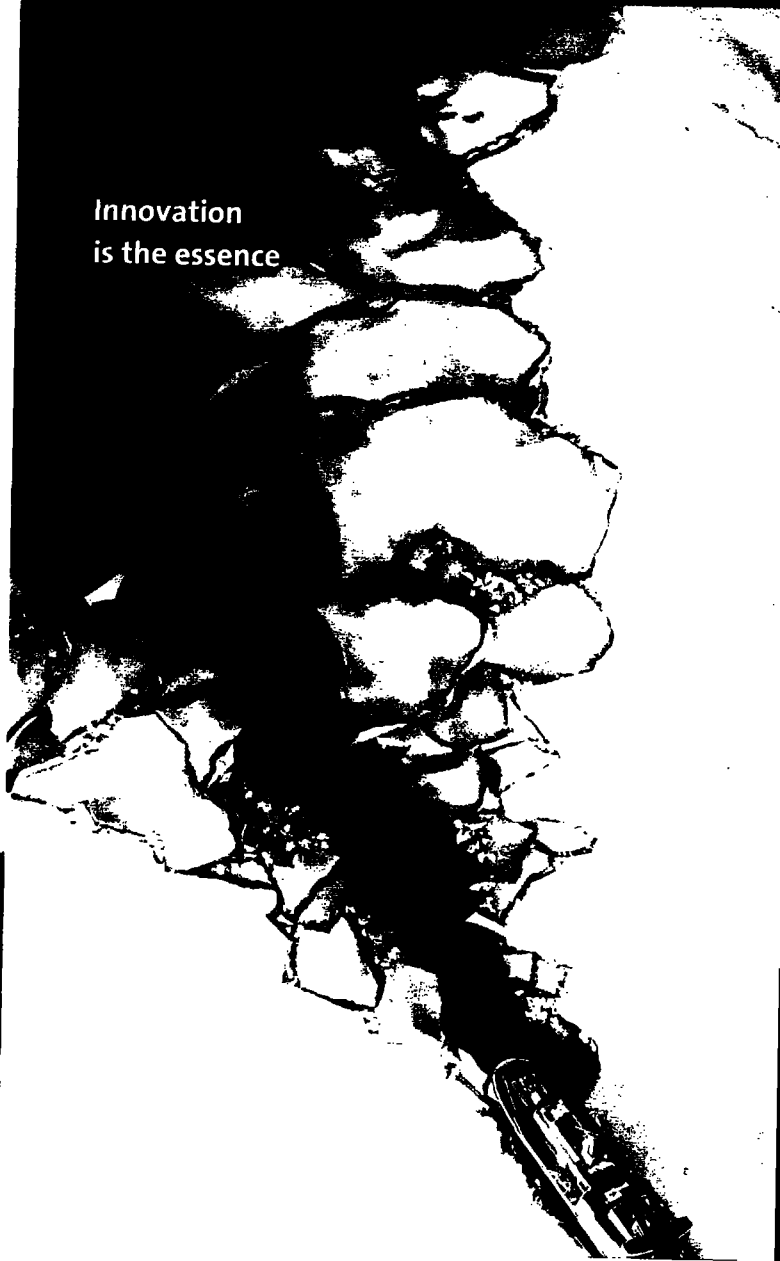
Some have argued that it is too expensive to take the environment into account, and that economic growth should have first priority. But the Danish experience shows, that we can have economic growth and environmental improvement at the same time; they can actually be managed to reinforce each other mutually. We shall be happy to share our experiences with the rest of the world and do our part to leave our planet in good shape for future generations to enjoy.

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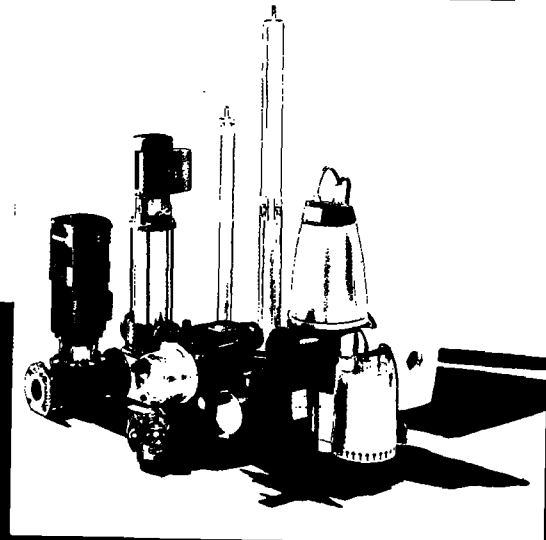


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GRUNDFOS 

# DENMARK PLANS A FUTURE

## WITHOUT FOSSIL FUELS

**ENERGY STRATEGY:** The Danish government has long-term plans to free the country from dependency on coal, oil and natural gas

In 2025 renewables will account for at least 30% of total Danish energy consumption. Today renewable energy in total covers 14% of gross energy consumption and over 28% of the electricity generated. Renewables in Denmark include wind, waste, biomass, heat pumps, solar and geothermal energy. Long term, the plan is to free Denmark from dependency on fossil fuels such as coal, oil and natural gas.

Those are the headlines of an ambitious energy strategy presented by the Danish government at the beginning of this year. The government has also formulated a climate plan, which will ensure that Denmark meets probably the most ambitious greenhouse gas targets worldwide. By 2012 Denmark will reduce

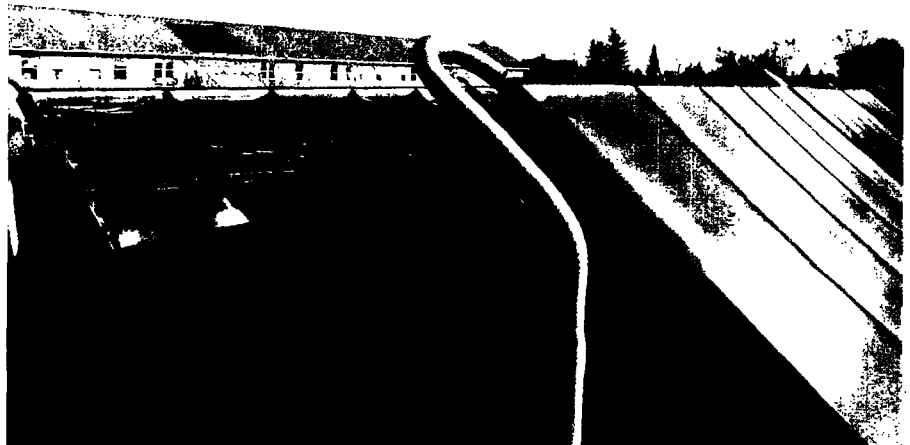
emissions by 21% and 30% by 2020.

At the presentation of the energy strategy, Minister for the Environment Connie Hedegaard said that new technology will be developed to reach the new targets. To maintain Denmark's technological lead, the government has allocated EUR 150 million for further research and development, including a programme to test new energy and environmental technologies in practice.

The programme is geared towards commercialisation of Denmark's key competences in second generation biofuels for transportation, high-power and high-efficiency wind turbines, materials and methods for energy sparing buildings, and research and development in hydrogen and fuel cell technology.

## THE DRIVE TO INNOVATE

**ECO-EFFICIENCY:** Denmark has a cool climate, a large transport sector, highly efficient industry and intensive agriculture. That puts demands on both energy use and the environment. It has also forced Danish companies to think innovatively to utilise energy wisely in order to protect the environment.



Up to the 1970s Denmark depended exclusively on imported fossil fuels. But the energy crisis in that decade thrust the use of energy into sharp focus, with soaring oil prices spawning a broad

range of energy saving campaigns. In the construction sector, attention turned to the low energy house concept, with its improved insulation, and double or triple glazing. Solar and geothermal heating



became topics that neighbours discussed over the hedge.

Energy prices became the driving force for innovative thinking in many industries: in the district heating sector, Danish pipe manufacturers created the world's first pre-insulated pipes; furnace manufacturers greatly improved their combustion technologies; and Danish companies developed electronic control systems to prevent energy waste.

Energy saving became a mantra for industry. Every product and process, from the miniature to the massive, was re-thought – "How can this be made more energy efficient?". It was the cost of energy which drove the innovation.

A special chapter in the story concerns the Danish wind turbine industry, which to date has supplied around 40%

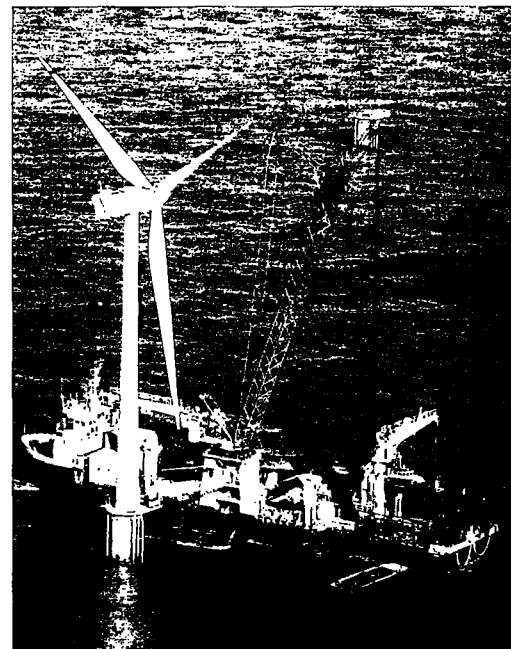
## High taxes

Denmark probably has higher environment and energy taxes than any other country in the world. The aim is to provide incentives to both private consumers and companies to reduce energy consumption or change to more environmentally friendly alternatives.

There are taxes on drinking water and the disposal of waste water. Every company pays waste disposal charges and private households pay for garbage collection. There are high taxes on petrol, diesel, oil and electricity. There are taxes on packaging and there are taxes on substances that promote increased CO<sub>2</sub> emissions.

In 2006, the Danish state received a total income in taxes and duties of EUR 103 billion of which energy and environment taxes accounted for approximately EUR 5.5 billion.

In addition to various taxes and duties, Danes pay 25% VAT on all goods and services.



of the world's wind energy installations. State support enabled the wind energy industry to develop its experience and know-how, assisted by intensive research in aerodynamics, mechanics and electronics. It has given the industry an international lead which it continues to maintain.

- More than 40% of wind turbines installed worldwide come from Denmark
- Denmark has kept energy consumption at 1970 levels, while enjoying economic growth of more than 70%
- Non-fossil sources account for 15% of Denmark's total energy consumption

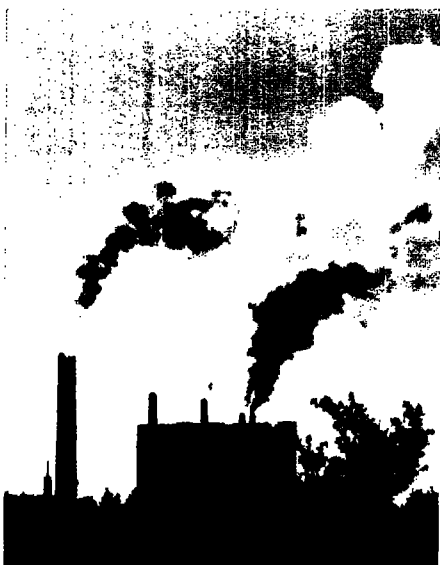
- The Danish concept for district heating from Combined Heat and Power plants is gaining ground worldwide
- Denmark has the world's strictest environmental requirements for land, water and air
- 93% of Denmark's waste water is treated both mechanically and chemically at 1,500 purification plants

- Denmark produces 15 million tons of waste annually. 65% is recycled and 30% is burnt, 95% of which is used for energy production. The rest is disposed of.
- Danish exports of eco-efficient technologies are worth EUR 7 billion annually
- The Danish energy and environment sector employs 60,000 people in 420 companies

# DANISH TECHNOLOGIES IN HOLISTIC ENERGY SOLUTIONS

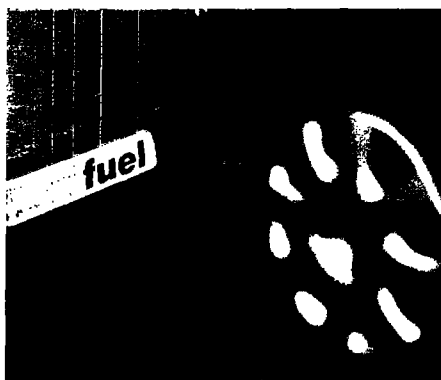
**ENERGY PROJECTS:** Denmark is well qualified to combine economic growth with sustainability and energy efficiency, reducing energy waste and cutting emissions of harmful nitrogen oxides (NO<sub>x</sub>) and CO<sub>2</sub>.

For the third year in succession, the Danish energy sector brought 48 of its best people together for an intensive "Energy Camp" innovation session in November 2006. Away from all distractions for 48 hours, they discussed and developed proposals on how Denmark can continue to build on its key competencies in energy efficiency, renewables and advanced technologies, with the objective of making Denmark a world leader in efficient energy exploitation. In addition a number of scenarios were formulated on how Danish core competencies in the energy sector can be translated into specific projects. Proposals were presented for projects in Brazil, Russia, India, China and the USA. Each project applies technologies developed in Denmark.



- Russian industry wastes around 70% of its energy because low domestic gas prices remove the incentive to modernise energy-wasting, antiquated equipment. The aim of the project is to improve efficiency and modernise domestically, and exploit the economic advantage on international markets.

- Brazil has well-established bioethanol production using source materials from agriculture and the food industry. The Danish project features a combination of second generation bioethanol plants, biogas plants, decentralised power and heat, district cooling and enhancing the energy efficiency of industrial processes. Danish second generation bioethanol research and other advanced technologies form a combined concept unique to the project.



- India has a rapidly growing middle class which is willing to pay to ensure reliability of electricity supplies. The "Indian Dream City" project involves producing an electrical back-up unit which guarantees constant electricity supplies to e.g. small companies, hotels, apartment blocks and institutions. The back-up unit uses environmentally friendly energy forms such as wind-diesel and solar panels.

- In the US, a Danish energy saving concept will be applied to communities of at least 200 households through an agreement with an Energy Service Company, which will supply heat, cooling and electricity on a leasing basis. Danish energy know-how in district heating, biomass, thermal solar heating and combined power and heat stations guarantees significant energy savings. The aim of the project is to shift production of energy from fossil fuels to renewables. Fossil fuels provide most of the energy used for cooling and heating residences in New York State.

- In China, the project features construction of a new town, where super-effective Danish technology supplies all its energy needs using a combination of biogas, combined power and heat stations, thermal and wind energy. The project also focuses on improving construction efficiency and energy distribution. Many of the energy efficiency and environmental benefits derive from the holistic thinking which is central to the project.

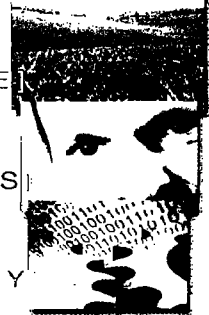
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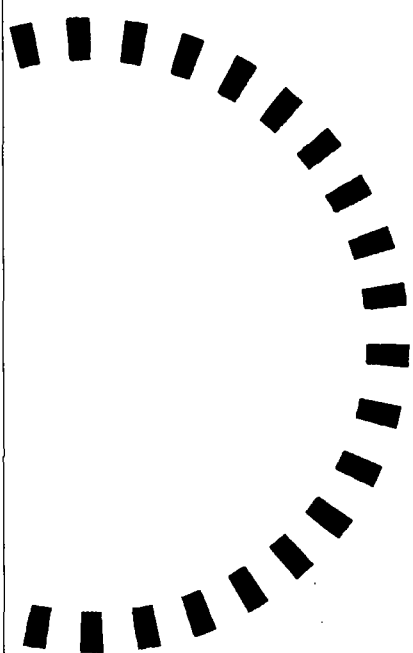
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# WIND POWER – MADE IN DENMARK

In just 20 years Denmark has made wind power into Big Business. In 1983, electricity production from wind power was still a dream. Today nearly 60,000 MW is installed globally, and the figure

is rising rapidly. Wind turbines from Danish manufacturers account for about half of the installed capacity.

The Danish wind turbine industry employs approximately 20,000 people. It

comprises more than 200 companies making everything from turbine towers, nacelles and blades to generators, gear boxes and control systems. Sub-suppliers to the wind power industry export worldwide.

## TURNING THE WIND INTO ENERGY

In the past 20 years, wind turbines have just grown and grown in size. From power ratings of just a few hundred kilowatts to several megawatts. And the growing size of turbines and wind power plants together with the increasingly stringent demands of energy utilities and grid operators, require more powerful and more complex control and IT systems. In the future, optimising wind turbine performance while reducing the size and, if possible, the physical size of the turbines will be an important goal for Vestas.

“The design of a most efficient and reliable wind turbine with little downtime is a challenge in general, including the North American market, demands more reliable turbines”, says Jens Søby, President of Vestas Americas A/S, Vestas’ North American sales business unit.

At an overall level, the Vestas Group focuses on multi-megawatt wind turbines. Large wind turbines are the fastest growing segment, and in 2005 the Vestas Group had a global market share in this segment of more than 40%. Vestas has been a long-term player on the US market, starting in California in the early 1980s. Today, the company has

a North American market share of around 30% (31 December 2005) and a workforce of 650 employees. 2005 was a challenging year for Vestas in North America after having signed up for a number of large projects at short notice. But the company succeeded in turning the tide and has managed the market growth well in the past year.

“We are seeing positive results from our focus on turbine reliability, our increased efforts in the service business and through increased focus on open and constructive dialogue with our customers,” says Jens Søby.

The days of the US market being very much a market purely driven by the short-term extensions of the Production Tax

Credit (PTC) is past. The PTC has been extended to the end of 2008, but the market is now to a greater extent driven by state renewable portfolio standards, the competitiveness of wind energy due to increased prices of fossil fuels, broad political support, and the need for reducing dependence on imports of fossil fuels.

After a 27% market growth in total installed capacity in 2006, the US market is expected to continue growth at this level. The US market had the highest number of installed MW in 2006, and will in many ways continue to be a key market for Vestas.

“In 2006 we introduced the V90-3.0 MW turbine, the most powerful wind turbine on the market, and this turbine will

# A BONUS FOR SIEMENS

In 2004 Germany's Siemens group acquired Danish wind turbine manufacturer Bonus Energi. Due to Denmark's leading position in wind power technology, the group concentrated its entire wind power activities in Denmark. Prior to its acquisition Bonus Energi employed about 850 people. Today there is a workforce of almost 2,000 at the former Bonus headquarters in Brande. A major growth driver is the North American market where since the acquisition, Siemens has gained orders of over 1,400 MW, comprising more than 600 wind turbines for four locations in Texas.

In addition to production facilities in Brande and Aalborg, Siemens has started its own blade production in Denmark and plans blade production in Fort Madison, Iowa, USA.

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be an important part of our future product portfolio. We see endless potential and have consequently decided to build a blade manufacturing plant in the US to support our development in this growing market," Jens Søby continues.

Jens Søby states that the customer base has changed markedly over the last two years, reflecting the growth in the industry and the positioning of wind energy. With past customers predominantly being developers, a typical customer today would be an independent power producer or a utility who can see the advantages of integrating wind energy as part of the energy portfolio, as a means to comply with the requirements of renewable energy portfolio standards.

"You learn very fast that the US is not necessarily characterised by uniform regulations, codes and laws, and many things are purely regulated through the state. You need to apply for state specific business and construction license, driving permits and so on. When you include Canada, which is part of our market responsibility, the picture works out even more colourful. It is interesting to see that a wind turbine tower is either considered a building or part of a machine, depending on where you are in the market. We have realised that and put our procedures in place to cope with state regulated market requirements," Jens Søby adds.

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# WIND TURBINE BLADES

AT FULL SPEED

**WIND ENERGY:** These days renewable energy is competitive not just in northern Europe, but also in the US where large growth rates are seen, says sales and marketing director Søren F. Knudsen of LM Glasfiber, a major manufacturer of blades for wind turbines for the global market.



LM Glasfiber started as a traditional Danish owned production and sales company of wooden furniture. Later the company added boats and fish ponds to its portfolio, and in 1978 the company commenced production of glass fibre blades for wind turbines. Since then LM Glasfiber has developed into the world's largest manufacturer of blades for the global wind turbine industry.

## Research in India

LM Glasfiber has factories in Europe, Asia and North America. During the 1990s, an increasing proportion of the Danish production was sold to India and now a second factory is being built there.

"Based on major exports to India and national legislation requiring that 10% of the country's energy supply should come

from renewable sources, we placed an independent production of blades in India," explains Søren F. Knudsen. "This enabled us to plan long term and results have greatly exceeded expectations. Our second factory, located near Bangalore, is slated for completion by June 2007 and we expect to employ 700 people."

Søren F. Knudsen says that LM Glasfiber is so pleased with the progress in India, that the company is also establishing a Research and Development Center. The first 20 people are already employed and 20 more staff will join in January 2007. The new centre will develop and construct blades for wind turbines. Søren F. Knudsen emphasises that the centre will only employ local people. "All staff are Indian engineers who will receive relevant training from us," he

says. The principle of employing local people has also been implemented at the two factories where the management comprises Indian engineers. "We have brought the technology into the companies and initially also a Danish management, but otherwise it is our policy that our companies in all countries must have local management."

## Boom in China

LM Glasfiber established its business in China in 2000. "It was perhaps a little too early and we entered the market before it was ready," says Søren F. Knudsen. "But we were fully in place when the boom came two years later. Expectations in China remain high, with constantly increasing demand," he says. LM Glasfiber has an optimal location in a free trade zone with excellent infrastructure. The Chinese company

is 100% owned by LM Glasfiber, but has a Chinese management.

LM Glasfiber is also seeing increasing demand in the USA. The existing production unit in North Dakota was recently expanded, and the company now has an annual production capacity in North America of more than 1,200 MW.

Worldwide LM Glasfiber employs around 4,000 people, and Søren F. Knudsen hopes that the company can create even more jobs internationally. Wind energy is growing strongly, and Knudsen estimates the industry will see an annual increase globally of at least 10%, with Asia and North America being particular growth areas.

[www.lmglasfiber.com](http://www.lmglasfiber.com)



A wind turbine blade is not a commodity product. At LM Glasfiber the blades are built specially to suit each turbine type, in close collaboration with customers. LM Glasfiber is also the world's only blade manufacturer with its own wind tunnel. To optimise its products, the company uses this recently built facility to simulate wind conditions on a 24/7 basis in the location where the wind turbine will be installed.

"A small increase in blade efficiency can make a big difference," says R&D director Frank Nielsen. "If our blade design results in just 2% more power during a turbine's 20 year operational life, the additional revenue can repay the investment in the turbine itself. Our new wind tunnel can help us to achieve that."



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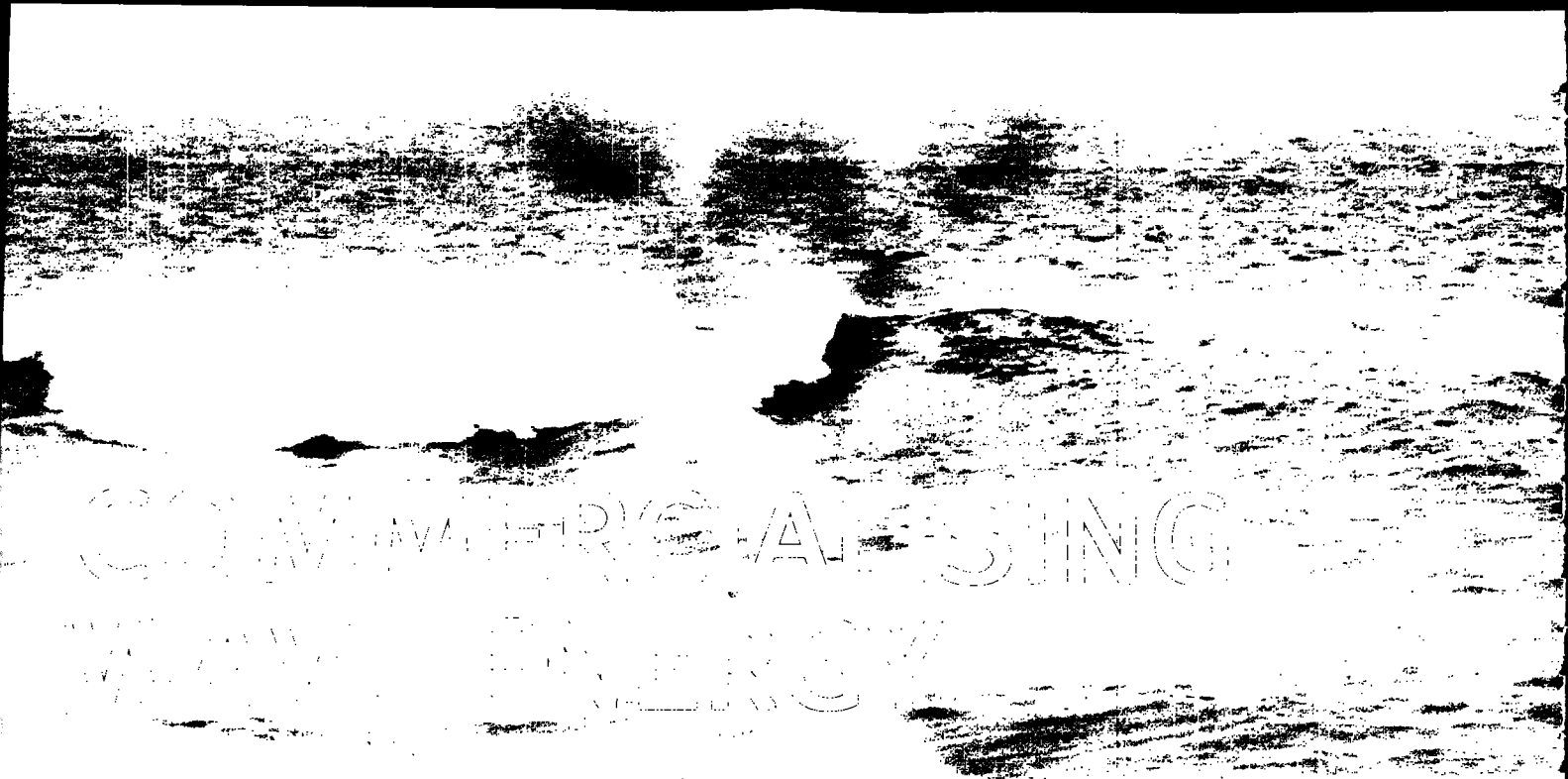
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# COMING WAVE POWER

## WAVE POWER

**WAVE POWER:** Water has long been used as a source of power. But using waves for the production of electricity is new. It has been discussed for the last hundred years, but only now is it starting to be commercialised. One of the players involved is the Danish company Wave Star Energy.

Managing director Per Resen Steenstrup has a strong determination to exploit wave power. His company is called Wave Star Energy, and over the next three years he expects to employ 12 engineers to develop a full-scale wave machine for electricity production.

Wave Star Energy was founded in 2003 with the aim of commercialising wave power. Per Resen Steenstrup has been interested in exploiting the energy in the sea for a long time, and now he has a serious opportunity to realise his ambition.

"It is very difficult to get started because even the simplest prototype must be extremely well constructed. When I began, I found a total lack of comparisons between different wave power systems. It seemed as if everyone before me had started up without building on existing knowledge. I learned from the experi-

ence of others and discovered the following essentials: the wave machine must be storm-proof, the technology simple and the price per kilowatt competitive with offshore wind power."

### Uninterrupted operation

Wave tank tests were carried out in a collaboration with Aalborg University. "That was in 2004," says Per Resen Steenstrup, "and in 2005 we built a 1:10 scale prototype. It was made from standard components, so the construction time was unusually short for this industry where everyone prefers to start from scratch. The prototype was towed out to Nissum Bank on the west coast of Denmark, where it stands in two metres of water. The wave machine is 24 metres long with 20 floats on each side, which generate electricity from the upward pressure of the waves.

The floats are 1 metre in diameter, and can generate electricity from waves of just 10 cm in height. To function best the machine should be oriented so that the waves pass along its length. In a way you can compare it with a giant 40 cylinder engine. The prototype has been built in exactly the same way as the full scale 240 metre long Wave Star machine will be in the future."

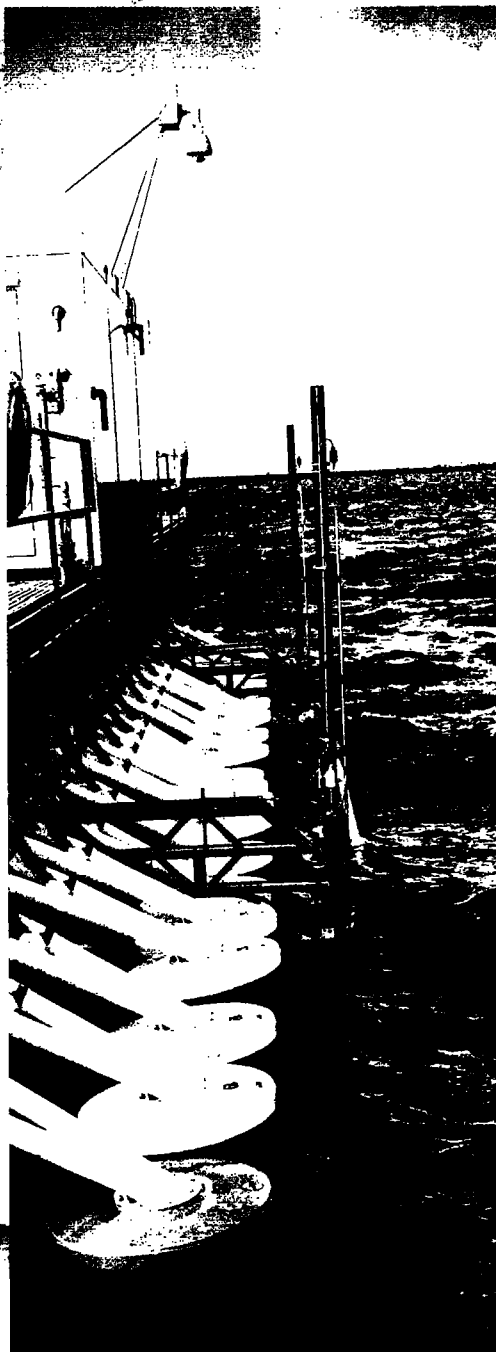
The prototype has an output of 5.5 kW, sufficient to supply the electricity needs of two family homes.

"The wave machine has functioned without interruption since July 2006, and has operated for about 4,000 hours up to December 2006," says Per Resen Steenstrup. "It is a major milestone that the machine has functioned for a period equivalent to the lifetime of a car. It has given us operational experience and lots of enthusiasm to continue. We are al-

ready building a 1:2 scale model of a 6 MW machine, which is the final objective. But initially we will test and document the production figures of the 1:2 scale model, which generates 500 kW. This will take place 2009/2010 in the North Sea 15 km offshore from Esbjerg on the west coast of Denmark. The wave machine will stand on piles which are driven about 10 metres into the seabed. If the waves become too high, an automatic security system will put the machine into "security mode". We expect to market this 500 kW Wave Star model immediately thereafter," says Per Resen Steenstrup.

**Environmental benefit**

Wave machines do no harm to the



marine environment. In fact it has been found that the machine at Nissum Bank has actually attracted marine life. Norwegian lobsters have started to congregate around the piles on the seabed. On the underside of the wave machine, seaweed and other forms of marine vegetation have started to grow, thereby attracting many other forms of marine life. Wave Star has now employed an engineer to specifically document the environmentally friendly effects of wave machines.

Wave machines are being constructed for an operational lifetime of 50 years," explains Per Resen Steenstrup. "We expect the machines will need a major overhaul every 10 years. This will be done on land to avoid the expense of offshore activities. The depreciation period is estimated to be under 20 years."

[www.wavestarenergy.com](http://www.wavestarenergy.com)

# THE MODERN APPROACH TO PIPE RENOVATION

## DIG OR NO-DIG

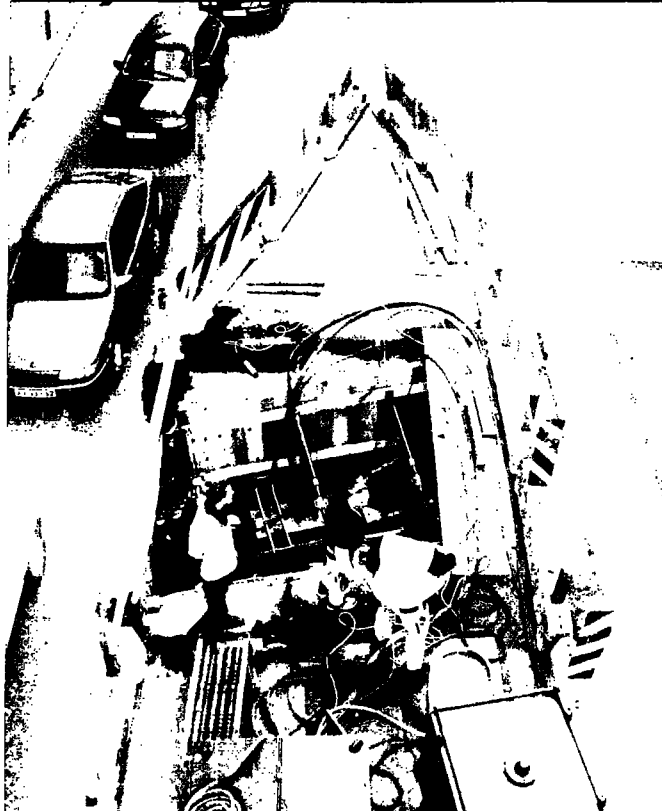
Excavation is the most commonly used method involved when water or sewage pipes need renovation. It is also the most expensive, and the one which creates most disruption.

According to Jesper Nielsen, international sales and marketing director of Scandinavian No-Dig Centre, between 20 and 30% can be saved on a renovation task if its system is used instead of excavation. Scandinavian No-Dig Centre specialises in machines which burst the existing pipes as the new ones are inserted.

Scandinavian No-Dig Centre reckons that only 5-10% of an old installation needs to be dug up. These excavated spaces are used to deploy machines which hydraulically insert the new pipes, at the same time bursting the old ones. The machines can lay 70-100 meters of pipes per day, ready for use.

### Understandable design

"We have our own customers, but we also act as sub-suppliers to major contractors," says Jesper Nielsen. "We have been in business since the early 1970s, and have developed a product whose characteristics are widely recognised as essentially Scandinavian: simply designed and highly efficient. Our machines are easy for any contractor to understand how they work, and we ensure this through direct customer contact. Communication and knowledge exchange are essential to have satisfied customers."



**PIPE BURSTING:** Scandinavian No-Dig Centre specialises in machines which can renovate old underground pipes without digging up more than 5-10% of the old installation



### Growth in Russia

Scandinavian No-Dig Centre has a 25-30% share of the global market. Non-excavation methods are popular in northern Europe, but in the last four years Russia has also increasingly adopted it. Scandinavian No-Dig Centre has recently supplied a machine to the water authority of Syvtivkar Vodokanak, a major city in north-east Russia. The company also supplied training, as well as extensive consultancy services.

The Asian market has many potential customers, but Jesper Nielsen thinks it will take time for them to accept this new method of pipe renovation. "It will need plenty of discussions, but I have no doubts that the Asian markets, especially China, will overtake the European market in a few years."

### US collaboration

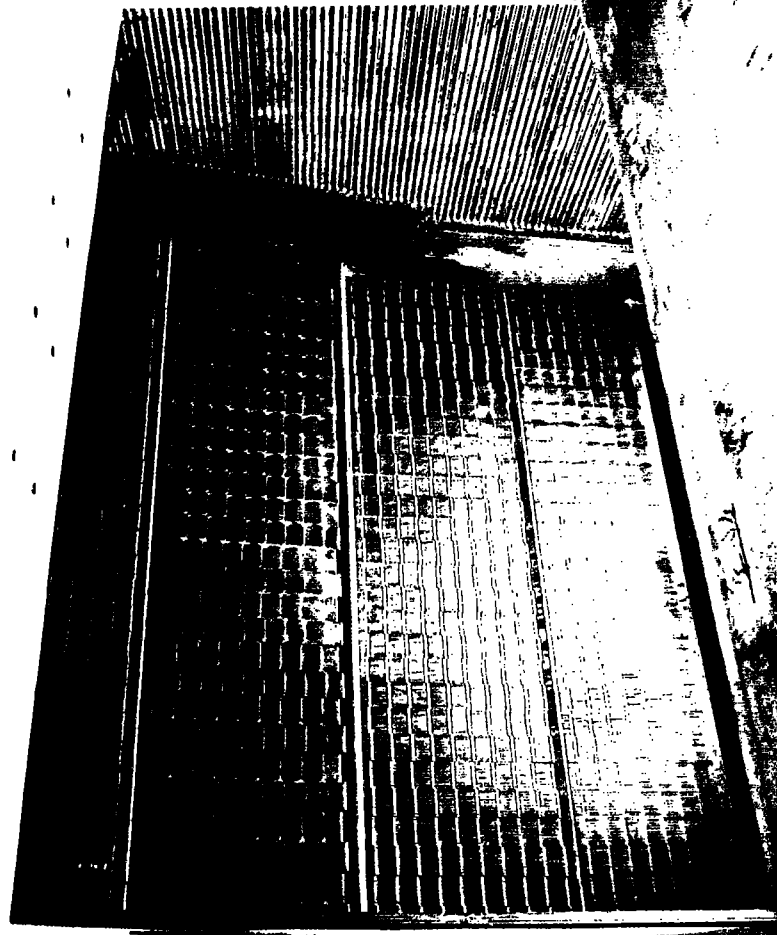
In the USA, Scandinavian No-Dig Centre has entered an agreement to deliver pipe bursting equipment to Ditch Witch, a supplier of construction machinery for renovating water, sewage and gas pipes.

"We are very satisfied with this agreement," says Jesper Nielsen. "Now we can fully concentrate on supporting Ditch Witch. We have also gained access to 350 dealers worldwide. It has taken us around a year to adjust our company to the new collaboration, but I have no doubt that we now have a six lane highway ahead of us."

[www.no-dig.dk](http://www.no-dig.dk)



# SUSTAINABLE AND RELIABLE SOLUTIONS WITHIN WASTE-TO-ENERGY AND BIOMASS ENERGY



Combustion grate at Gärrstad, waste-to-energy plant, Sweden

Babcock & Wilcox Vølund is one of the world's leading suppliers of equipment and technologies designed to convert household waste and bio-fuels into thermal energy – under maximum consideration of sustainability and environmental impact.

We have delivered more than 500 waste-to-energy, biomass, and fossil fuels solutions in more than 30 countries worldwide.

We are continuously developing our range of boiler, grate and firing systems to fulfill our clients' needs and expectations in order to deliver plants with optimum energy utilization and reliability.

Our services includes a comprehensive spare-parts programme and 24-hour hotline.

Read more on our website: [www.volund.dk](http://www.volund.dk)



**Babcock & Wilcox Vølund**




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DK 6705 ESBJERG Ø

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[WWW.VOLUND.DK](http://WWW.VOLUND.DK)

# RESEARCH SOLVES WATER PROBLEMS



**WATER AND ENVIRONMENT:** Watertech's core competences comprise mapping and limiting water and soil pollution, especially using IT tools.

Watertech is one of Denmark's many consulting engineering companies which has specialized in the environment. The company has so far focused its expertise on south east Asia, where both water and environmental problems are major issues.

"We identify water resources, and how to control and exploit water from the Mekong River," says Jens Baadsgaard Pedersen. "It can also be water supply and distribution. In many places in the world, half of the water is lost before it



*Managing director  
Jens Baadsgaard Pedersen*

reaches the customer. In Denmark it's less than 7%," he says. Watertech is currently conducting a project for Bangkok municipality, which has the world's largest water supply unit. Watertech has a similar project in Kuala Lumpur.

#### **Partnership**

"Watertech has no externally supported tasks and all our projects are fully paid by the customer," says Jens Baadsgaard Pedersen. "We can do that because our concept gives the customer added value which can pay for our work when we collaborate with local companies. We start by forming an overview of a given country. Then we choose the partner, and establish a 50/50 company. From Denmark we supply training, technology transfer and interim management. The partner supplies local knowledge and networks. The company typically passes break-even point in 1-2 years, after which the division of input is usually 20% from Denmark and 80% from the local company. Our first company in Vietnam, which now employs 35 people, has reached a posi-

tion where it is exporting knowledge and know-how to the entire region.

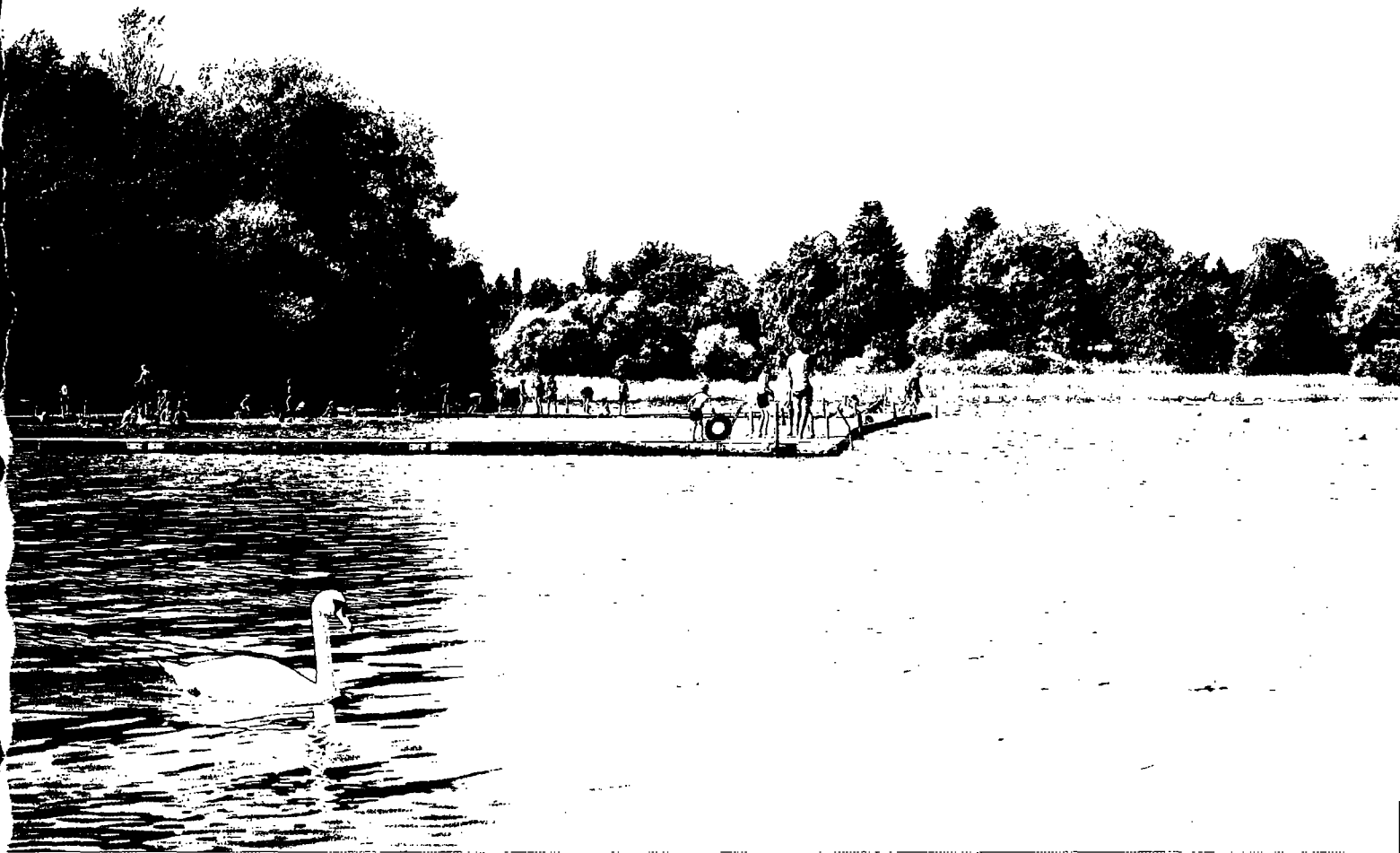
#### **Sustainable concept**

"We are currently focusing on China and specifically on the area around Hong Kong, where we soon hope to find a suitable partner. We also have great expectations of the Chinese market because we have a very sustainable concept: to start foreign companies and export our knowledge. The need for solutions is global, and our strength is a combination of the best possible technology from Denmark and local people," concludes Jens Baadsgaard Pedersen.

Watertech develops its knowledge through research and development projects. In collaboration with major Danish players such as the Technical University of Denmark and the Royal Veterinary and Agricultural University, the company conducts research in its specific competence areas to maintain its position at the cutting edge.

[www.watertech.dk](http://www.watertech.dk)

# Sustainability



In the field of energy, Grontmij | Carl Bro develops and streamlines production, distribution and consumption with the aim of creating a sustainable environment for people, business and authorities. We plan and execute new energy generation projects based on the latest technology and offer all types of consultancy services from special initiatives to turnkey solutions. Read more about our expertise at [www.grontmij-carlbro.com](http://www.grontmij-carlbro.com)



planning connecting  
respecting  
the future

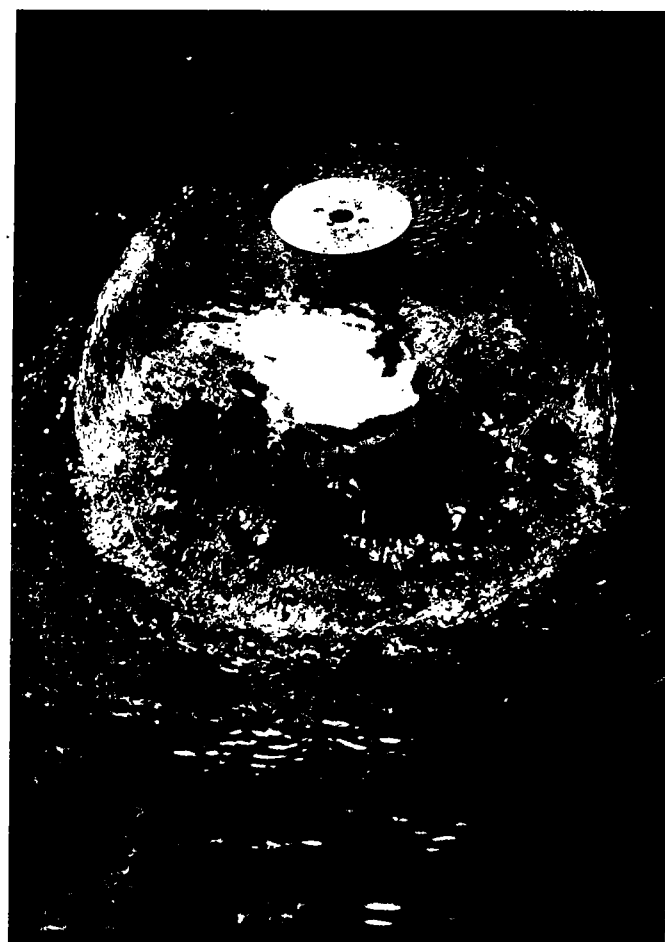
# PUMPS FOR ALL PURPOSES

"Every new product from Grundfos must be more energy efficient than its predecessor, so all Grundfos products are unique," says CEO Søren Sørensen, who heads sales and marketing for the group. "Product uniqueness is something in which Denmark, as an industrial nation, generally leads the way," he says, "We constantly aim to be innovative, so that our pumps have minimal environmental impact. It's a win-win-win situation, because we can sell more, consumers have lower power costs, and the environment becomes less burdened."

## Turbo-growth

One of Grundfos' most important collaboration countries is Russia, which the company considers a turbo-growth area. The entire Eastern European region grew by 30% in 2006 compared to the year before. Grundfos generated revenues in the region of EUR 300 million in 2006, and forecasts revenues for 2007 at EUR 350 million, with Russia alone accounting for EUR 100

**Great American potential**  
North America has great potential for pump manufacturer Grundfos, which has a presence in Mexico, USA and Canada. The group is building a new factory in Mexico, which is



**ENERGY EFFICIENCY:** Grundfos makes pumps for heating and cooling plants, oil burners and gas boilers, pumps for wastewater disposal and industrial pumps. In fact, half of all circulation pumps in Europe are from Grundfos.

slated for completion mid-2007. It has also established a large sales company in Kansas and a factory in California. In 2006 Grundfos acquired the American pump factory Paco. "We have moved elements of

our development activities to the USA and are investing in the extension of our sales and marketing competences," says Søren Sørensen of Grundfos. "Today we have only 8-10% of the US market, so for us the growth potential

million, corresponding to 50% growth. By 2010 revenues in the region are forecast to exceed EUR 500 million, and more than EUR 200 million in Russia alone. Today Grundfos employs approximately 2,000 people in eastern Europe of whom 300 are in Russia. The largest production unit outside Denmark is in Hungary, where production for the entire Grundfos group is carried out.

Grundfos has made two major investments in Russia: establishing its own sales company, and in 2005 opening a new factory, which both produces and distributes to the Russian market.

In China, which is also a large growth market, Grundfos has established both a factory and a sales company, employing a total of 800 people. Annual growth is 25% and 2006 revenues were approximately USD 100 million. Grundfos primarily sells pumps to the industrial sector, particularly the construction and waste water management industries. As in Russia, Grundfos employs directors with local language and cultural understanding.

[www.grundfos.com](http://www.grundfos.com)

is considerable. If we hold to our strategy, I am convinced we can double our market share and increase our sales from the current USD 250 million to a level above USD 500 million by 2010."

CEO Søren Sørensen



#### Pumps of the future

In 2005, world leading pump manufacturer Grundfos introduced a new range of energy saving pumps rated "A" according to the EU energy labelling system. In 2006 alone the new pumps saved European consumers approximately 400 million kW.

"It is an upgrading of our circulation pump programme," says head of sales and marketing Jan Warrer. "We have scrutinised every single component of our pumps in order to improve their energy efficiency. Our new pumps can save up to 80% more energy."

# EDUCATION WORLDWIDE

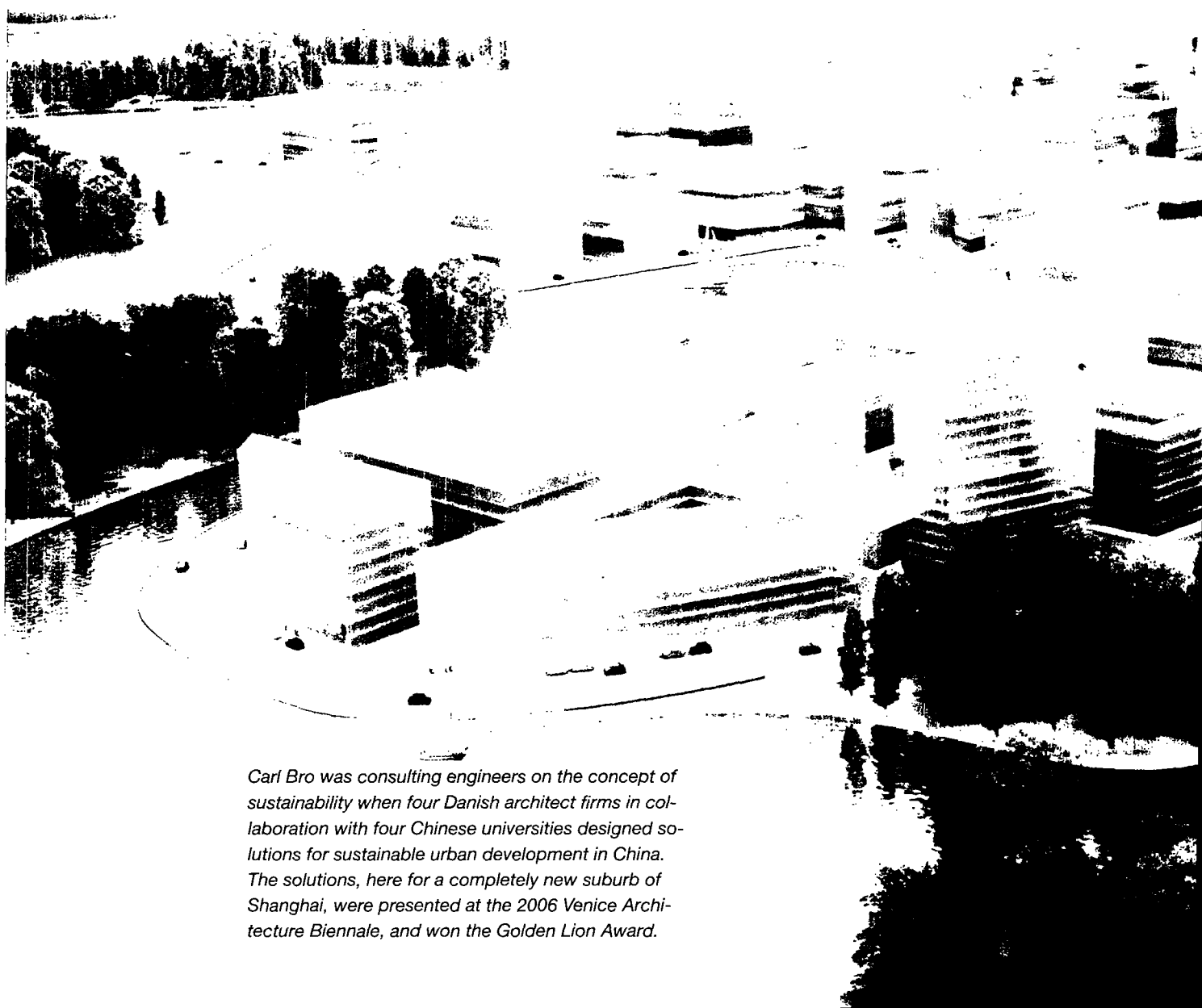
Training in Denmark and abroad - Teacher training - System export

[www.brock.dk](http://www.brock.dk)



# SUSTAINABLE HOUSING SOLUTION

**SUSTAINABILITY:** Involvement in a winning Danish project for Venice Architecture Biennale has raised the profile of Carl Bro as a firm which successfully incorporates sustainability into its solutions.



*Carl Bro was consulting engineers on the concept of sustainability when four Danish architect firms in collaboration with four Chinese universities designed solutions for sustainable urban development in China. The solutions, here for a completely new suburb of Shanghai, were presented at the 2006 Venice Architecture Biennale, and won the Golden Lion Award.*



*Hans-Martin Friis Møller*

“The ability of Danish companies to think sustainability into solutions has substantial export potential. Despite the rise in GNP, Denmark has continued to keep its energy consumption down, which no other country in the world has done,” says Hans-Martin Friis Møller, divisional director for Environment, Water & Energy, at Grontmij – Carl Bro, the consulting engineering company.

“Denmark has achieved it through the development of wind energy, constant focus on energy efficiency and energy savings. In this context the “Zero Energy House” (a super-insulated dwelling developed in Denmark at the start of the 1970s oil crisis) is a milestone achievement worth putting extra efforts into. In the coming years we should be aiming at having far more Zero Energy Houses in Denmark than the 4% of the housing stock which they represent today,” says the divisional director.

#### **Sustainability**

“Many developing countries could also benefit from Denmark’s holistic thinking in the environmental area,” says Friis Møller. “For example the needs of the rapidly growing middle class in India cannot be met by the country’s existing power grid.”

Hans-Martin Friis Møller points to four large-scale housing projects in China, in which Carl Bro has collaborated with Danish architects and Chinese universities, as outstanding examples of how Danish architects have thought in sustainability as a fundamental element. The projects recently won the prestigious Golden Lion Award at the Venice Architecture Biennale. They present sustainable solutions for a number of Chinese cities where economic growth and rising populations are putting heavy pressure on natural resources.

#### **Merger**

The consulting engineers Carl Bro has just merged with the Dutch consulting firm Grontmij. The new company Grontmij – Carl Bro is now the fifth largest consulting engineering company in Europe with a total workforce of 7,000 and offices throughout the world.

[www.carlbro.com](http://www.carlbro.com)

# WASTE AND BIOMASS ENERGY

**COMBUSTION:** Extracting energy from waste and biomass means killing two birds with one stone and being environmentally friendly too. It solves a disposal problem and produces energy which is largely CO<sub>2</sub> neutral.

At the same time as intensive research in second generation bioethanol technology is being conducted in Denmark, production of first generation bioethanol is in full swing in other places around the world, some of which are using combustion technology from the Danish company Babcock Wilcox Vølund. The company's latest order is a boiler for the German concern Südsucker, which is building a bioethanol plant in Belgium which will produce 800,000 litres of bioethanol daily.

"Babcock Wilcox Vølund is specializing in combustion technology for large scale plants," says director John Veje Olesen of Babcock Wilcox Vølund. "Our expertise in straw combustion was influential in landing this EUR 30 million order in Belgium, where the bioethanol will be produced from wheat. After grinding the kernels, the husk and chaff can be burnt to produce steam and electricity,

which will supply about 80% of the entire plant's energy needs.

#### **CO<sub>2</sub> neutral**

"Combustion of wheat husk and chaff is CO<sub>2</sub> neutral and does not add to global warming," says John Veje Olesen. "It makes the plant extremely environmentally friendly as well as economically sound. Combusting waste kills two birds with one stone. It solves a disposal problem, which many places in the world struggle with, and at the same time produces energy which is largely CO<sub>2</sub> neutral. Combined with the right flue gas cleaning, it is a very neat environmentally friendly solution."

#### **Great savings**

"Denmark is extracting most energy from waste and biomass, which is used as fuel in combined heat and power [CHP] stations, in the world" says John Veje

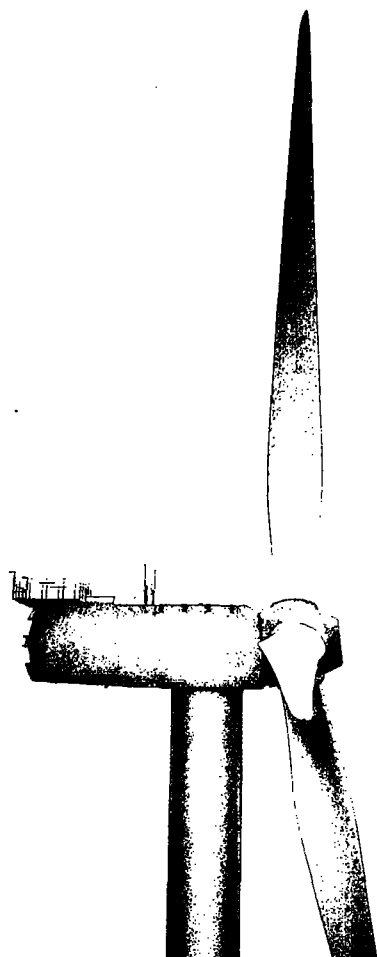


*Director John Veje Olesen of Babcock Wilcox Vølund*

Olesen. "Danish waste-fired CHP stations make good use of our technologies, which are increasingly in demand abroad where there is growing interest in using indigenous resources to produce energy. In the EU there is the potential to burn 50 million tons of waste annually, the energy equivalent of 8.2 million tons of coal. In Denmark, energy from waste is used to supply electricity and heat to more than 400,000 households.

[www.volund.dk](http://www.volund.dk)





[www.lmglasfiber.com](http://www.lmglasfiber.com)

## Striving to reduce the cost of energy

Intensive R&D work focusing on aerodynamics and blade profiles has enabled LM Glasfiber to improve the efficiency of wind turbine blades, and thus extract even more energy from the wind.

LM Glasfiber has boosted the ability of composite materials to meet demands for lower weight and greater strength, without compromising on blade reliability. We operate the most comprehensive testing programme in the industry,

right from laboratory materials testing on individual fibres to full-scale testing of blades. This ensures maximum reliability with minimal blade maintenance costs over the service life of the wind turbine.

Experience gained from manufacturing more than 80,000 wind turbine blades, along with a global manufacturing, sales and service organisation, ensures highly efficient, reliable blades for your next wind energy project.



LM Glasfiber

# ONLY PAYING FOR THE HEAT YOU USE



**METERED CONSUMPTION:** Saving energy requires two things: the right product to encourage savings, and the prospect of money saved returning to consumers' pockets

That is Brunata's concept for energy metering. The Danish company manufactures radiator mounted meters which measure heat supplied from district heating, gas or oil. The meters register heat consumption in buildings where multiple residents share the costs. Brunata's meters show with 100% accuracy how much heat each resident uses, so that bills can be fairly apportioned.

#### **Saving energy**

"Accurate measurement is essential for fair apportioning of bills," says technical director Klavs Fischer Hansen, Brunata. "Metering of consumption has also been shown to provide energy savings of 20-35%. When heating costs are incorporated in for example fixed rents, users don't pay attention to their energy consumption. But when they can see how

much heat they are using, it focuses their minds and puts them in the mood for saving. And that is a good thing both for the environment and the consumer's pocket."

#### **Providing total solutions**

Brunata supplies total solutions including software, hardware and service, and its metering systems can be monitored via the internet. The company's latest generation of meters, Brunata Futura, blend good looks with advanced technology.

"Brunata Futura measures both the radiator's surface temperature and the room's air temperature. Heat consumption is then calculated from the difference between the two," says Klavs Fischer Hansen. "Brunata's patented technology ensures that external heat

sources such as the sun, stoves and cookers are not included in the reckoning. It is only the central heating which users pay for."

#### **Raising awareness**

There are more than 20 million Brunata meters in operation worldwide. The latest focus area is China, where district heating is the most widespread method of heat supply in both old and new residential buildings.

"In addition to providing metered measurement solutions, we also focus equally on raising awareness of energy use, by convincing the authorities that it pays to do so – both in regard to saving money and reducing CO<sub>2</sub> emissions," says Fischer Hansen.

[www.brunata.com](http://www.brunata.com)

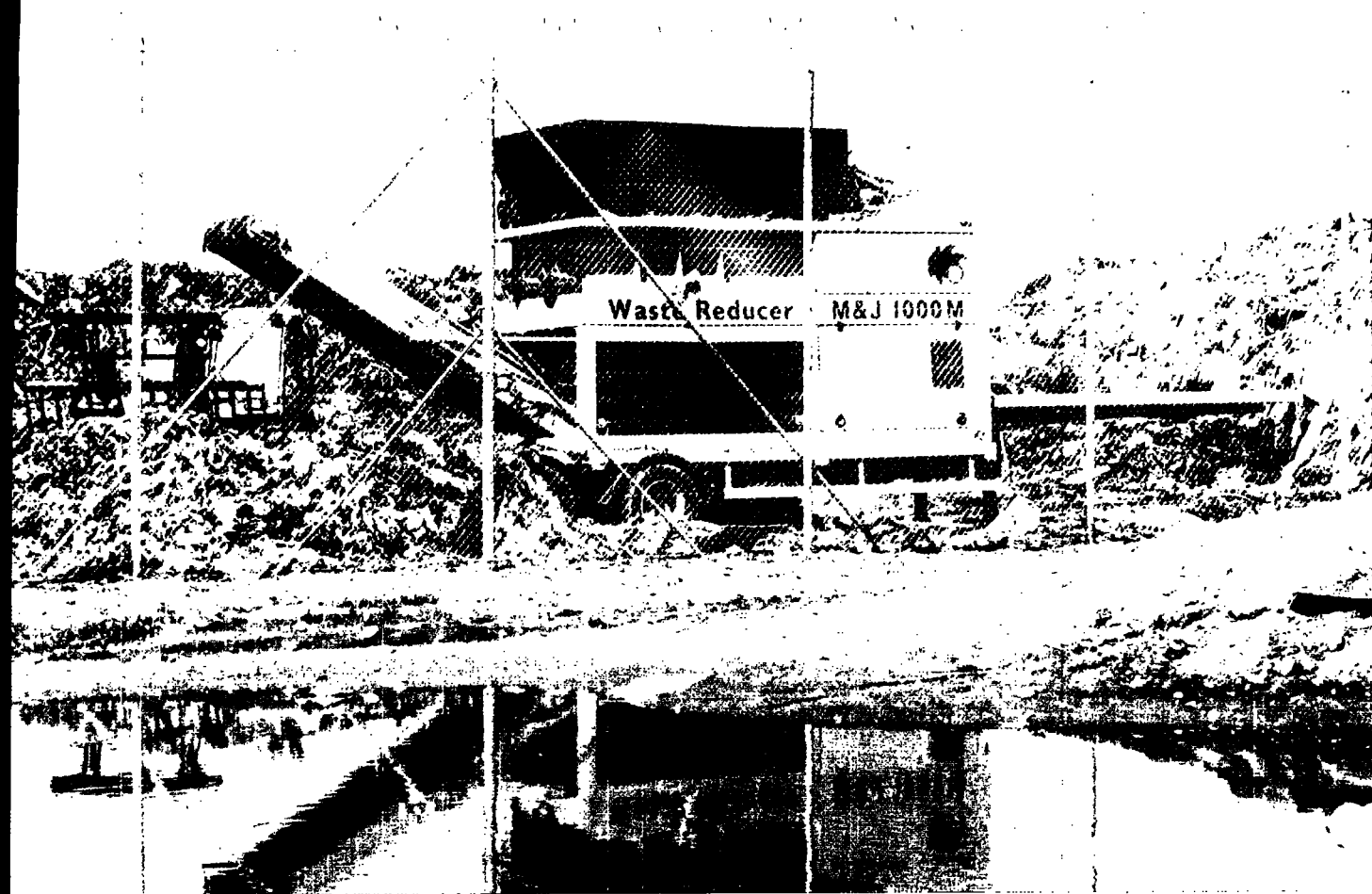
Knowledge taking people further



Your global  
energy consultant---

Ramboll is a leading international consultancy with more than 5000 dedicated specialists. Our expertise within energy consulting covers waste-to-energy, district heating, energy production plants and wind energy. We are market leaders in a global context within the waste-to-energy field and over the years we have been involved in large district heating projects in Northern Europe and Asia. [www.ramboll.dk](http://www.ramboll.dk)

**RAMBOLL**



**WASTE MANAGEMENT:** Orange beasts that devour everything! Cars, railway sleepers, refrigerators or electric cookers. Large, tough carpets or garden waste well mixed with big roots from trees. For snacks they gobble up hundreds of tons of dead cows per day. Feed all this stuff into a shredder from M&J Industries, and out comes a regular stream of small pieces, ideal for either combustion, recycling or disposal.

M&J Industries in Denmark has made shredding into an art. Its machines have found their way to waste processing operators worldwide because of their highly efficient shredding of almost any type of waste. The secret of M&J's awesome efficiency is its patented cutting-table and knife design, which can even reduce enormous engine blocks to tiny tablets.

"Waste disposal is not an exact science, where coefficients and variables can be put into formulas and calculated," says sales director Claus Warming, M&J Industries. "Practical experience is essential for development, production and sales of efficient and reliable shredders."

M&J Industries has gained that experience from 20 years of developing and optimising unique shredder technology, which was patented in 1993 and has since been strengthened with two further patents, the latest in 2006.

"When you have found the right principles to determine how the knives are shaped and how they cut, the rest is a question of quality, quality and quality,"

says Claus Warming. Several competitors have tried to copy the company's patented principles, but M&J Industries has successfully protected them, and M&J's quality remains unrivalled.

"Another reason for our leading position on the world market is our large product programme and extensive service," says Warming. "A shredder is not just 'a shredder'. There is a difference between shredders that handle carcasses and those that convert household waste into combustion-friendly material. We manufacture them all, stationary or mobile, from massive monsters to modest machines used as post-processors to shred down to grain sizes of 50-80 mm."

Even the best machines can fail and like anything with teeth, M&J's shredders need to visit the dentist from time to time. If a shredder is out of action for a protracted period, chaos will result. Therefore M&J Industries offers a same-day service, all year round. Cutting-table renovation with new knives and bearings takes a maximum two days.

[www.mj-as.com](http://www.mj-as.com)

*Danfoss*



## Global Environmental Responsibility

For many years Danfoss' business objectives have focused on sustainable development, social responsibility and financial results that meet today's requirements in such a way that the needs of future generations can also be met.

It is important to us, as a global company, that we are environmentally responsible. Therefore our factories – more than 62 in 24 countries – are to be environmentally certified according to ISO 14001.

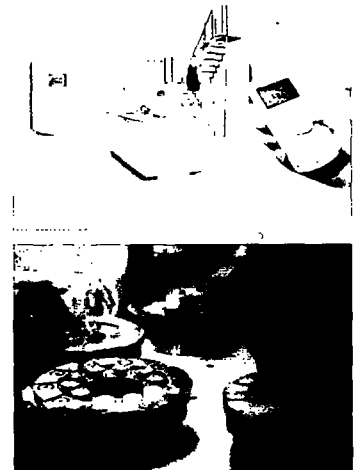
Danfoss has also joined the ICC Business Charter for Sustainable Development and the United Nation's Global Compact for social and environmental responsibility.

**Read all about this and more, in our Environmental Accounts, which can be found at [www.danfoss.com](http://www.danfoss.com)**

### **Energy saving products and production**

Many of our products can be used for the optimum control of technical systems, leading to environmental improvements and a reduction in energy consumption.

Each individual product can have a different environmental impact. The impact might be seen in the production phase for example, or in the operational phase, or when the product is disposed of after being used. So Danfoss uses life-cycle observations when we develop new products. This way, we know where the environmental impact needs to be reduced.



### **Danfoss A/S**

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E-mail: [danfoss@danfoss.com](mailto:danfoss@danfoss.com)

Velux started developing roof windows in 1941, and is still the world market leader. But today its product portfolio contains much more, including skylights, decoration and sunscreening, and solar panels.

Velux's renewable energy solutions can be integrated into the roof just like roof windows. To show the potential of its products, the company has constructed two buildings in Denmark and Spain respectively to demonstrate that low energy houses can have large window areas, and at the same time a good indoor climate.

#### Thermal solar heating

Kurt Emil Eriksen, head of building legislation at Velux, believes that thermal solar heating has a great potential worldwide – it supplies more energy today than wind turbines and is extensively used in China. Eriksen expects that thermal solar heating will provide a significant future proportion of the energy used for hot water and central heating in



## ROOF WINDOWS

**ENERGY EFFICIENCY:** Velux is one of the strongest global brands in the building materials industry. Popular worldwide, Velux roof windows signal daylight and fresh air

## LIGHT, AIR, AND ENERGY

Europe and the USA. In Denmark it is estimated that thermal solar heating can cover 15% of energy consumption in buildings.

#### Attic apartments

In 1999 Velux entered an apartment block renovation project in St. Petersburg, Russia, which involved installation of a new attic storey on the building. The idea was that both renovation of the old building as well as construction of the new attic, would be financed via sales of the new attic apartments. In 2004 Velux extended the idea in collabo-





In 1999 Velux entered an apartment block renovation project in St. Petersburg, Russia, which involved installation of a new attic storey on the building

ration with a number of partners, and developed a prototype attic dwelling for installation on top of existing buildings. This was part of a larger European building renovation project in eight countries. The attic dwelling provides low energy consumption, optimal daylight and a pleasant indoor climate. Energy is produced by a combination of thermal solar energy and solar panels, making the dwelling CO<sub>2</sub> neutral and independent of other energy networks.

"The project is interesting from a renovation perspective, but so is the dwelling in itself," says Kurt Emil Eriksen. "Many places in the world would be interested in a residential building that makes its own electricity. The CO<sub>2</sub> neutral demonstration building is on display in front of the Velux headquarters and is frequently visited by people with an interest in energy efficiency. The low energy consumption is provided by a combination of solar cells,

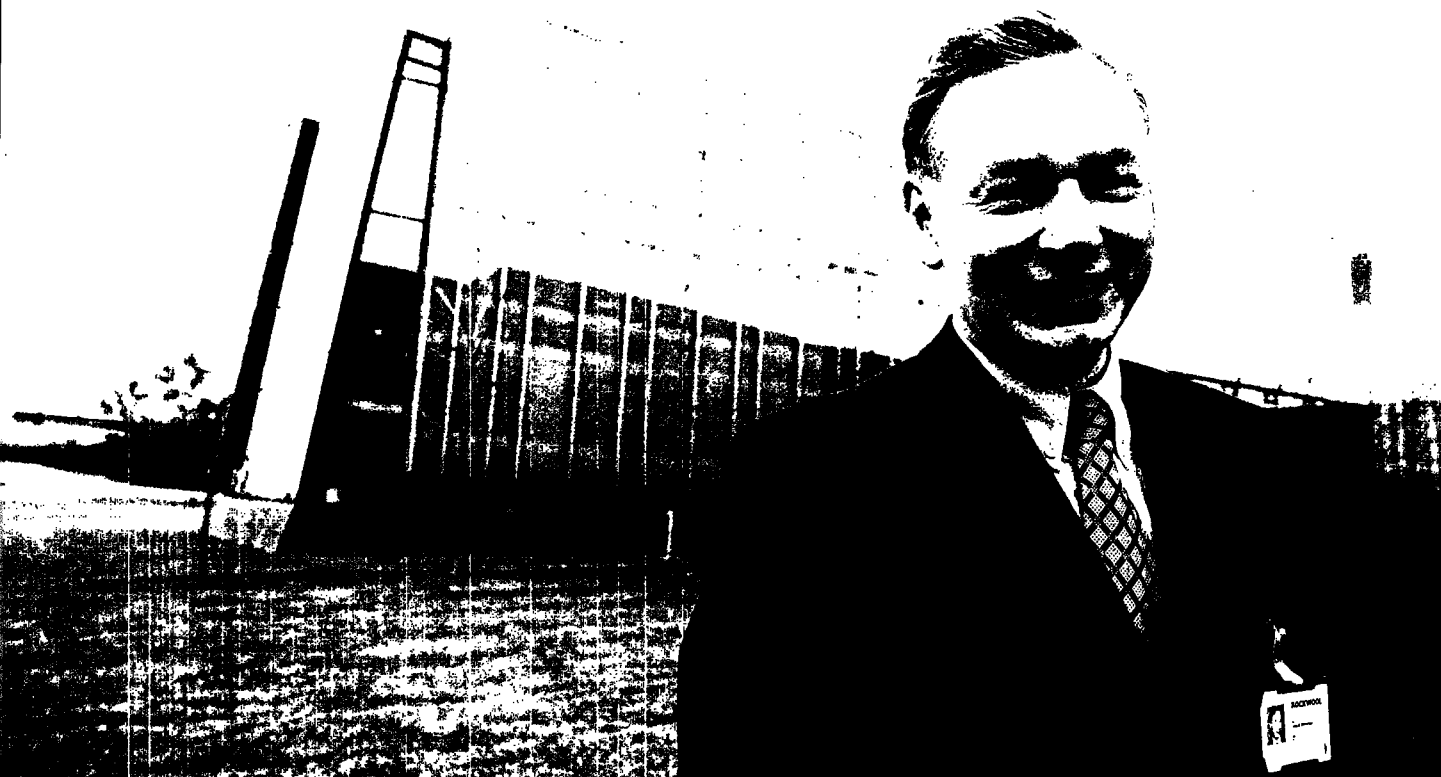
solar panels, suncreening, low energy window panes and heat recovery."

Velux sees increasing interest in energy efficiency and renewables. "It is clear that on the large and very interesting US market that the focus is now on energy efficiency and supply reliability of fossil fuels," concludes Kurt Emil Eriksen.

[www.velux.dk](http://www.velux.dk)

# KING OF HOT AND COLD

**ENERGY EFFICIENCY:** 40% of all the energy consumed worldwide is used in buildings principally for heating and cooling. Rockwool, which manufactures stone wool insulation, says that if insulation and energy efficiency were optimised, the 40% figure could be halved.



Rockwool is a Danish company with global operations in insulation and building products based on stone wool. With energy efficiency high on the agenda worldwide, optimism is similarly high at Rockwool because “the product is amazing, and will be sought-after for years to come”.

“Two of our most important markets, North America and Russia, have also discovered the importance of insulation. In Russia there is even greater awareness than dictated by legislation,” says group chief executive Jakob Sørensen of Rockwool International. “But we work



hard to get the message across about how profitable insulation is, and how to save on CO<sub>2</sub>. At the same time standards of building insulation are being raised everywhere in order to prevent costly energy waste."

The Russian authorities have invited Rockwool to help set standards for insulation. In Rockwool's publication "Environment 2006" it is estimated that by using efficient insulation, the energy consumption of buildings can be halved.

#### New markets in Europe and the USA

Rockwool has two stone wool factories in Poland and two in Russia. Jakob Sørensen remembers Rockwool's first years in Russia, immediately after the collapse of the Soviet Union, as a considerable challenge.

"There were significant differences in working practices," says Sørensen. "As a Danish company we are used to operating with demanding environmental and safety requirements. After a concentrated initial period, the two factories are now running well. In fact our Moscow facility has recently won a prestigious safety prize."

On the North American market,

Rockwool has two factories in Canada, close to the US border. The market for stone wool is relatively small, accounting for just 5% compared to glass wool and foam insulation, and according to Jakob Sørensen the reason is the construction industry's conventional habits.

"Our products have great market potential, not least because they are more fire-proof. This is one of the messages we communicate to trade associations, architects, consulting companies, contractors and politicians. So far, North America accounts for only 5% of Rockwool's total annual revenues, but it will grow," says Jakob Sørensen.

#### Major new investments

Rockwool's strategy is to expand its activities abroad. The company has initiated a major investment programme including construction of a new factory, and is also focusing on growing its thermal insulation business, having acquired a factory in Malaysia.

Because insulation material mainly consists of air and is expensive to transport, Rockwool focuses on establishing business operations in densely populated areas with high concentration of

companies. "In Europe we have a fine-meshed network of factories," says Jakob Sørensen. "And in the long term we aim to do the same everywhere else, since there is a limit to the distances one can transport the products."

Rockwool is determined to get the message across that insulation is sound economic sense. "It cannot pay not to insulate," says Jakob Sørensen. "Energy efficiency must be thought into the building right from the start in order to optimise the end results."

[www.rockwool.com](http://www.rockwool.com)

Rockwool has manufactured stone wool since 1937, when it started modest production at a factory in Hedehusene, west of Copenhagen. In 2005, the company generated annual revenues of EUR 1.35 billion. Today Rockwool is the world's largest manufacturer of stone wool, and is listed on Copenhagen Stock Exchange.



#### Erupting volcano

*The most energy intensive part of the production process of Rockwool is the melting of the stone which takes place at 1,500°C – comparable to an erupting volcano. The stone is converted into lava, and spun into fibres while the material is fluid. Nonetheless, during its service life Rockwool insulation typically helps to save 128 times the amount of energy used to produce it.*



#### Sound insulation

*Rockwool not only insulates against heat and cold, but also functions as sound insulation. The Rockfon subsidiary is among Europe's largest companies producing acoustic ceiling plates, which are made of painted stone wool and cut to size. The ceiling plates are frequently used in open plan offices, institutional buildings, schools and factories.*

# ENVIRONMENTALLY FRIENDLY ELECTRICITY PRODUCTION

**FUEL CELLS:** Environmentally friendly micro and macro power plants are under development for the corporate sector and private homes.

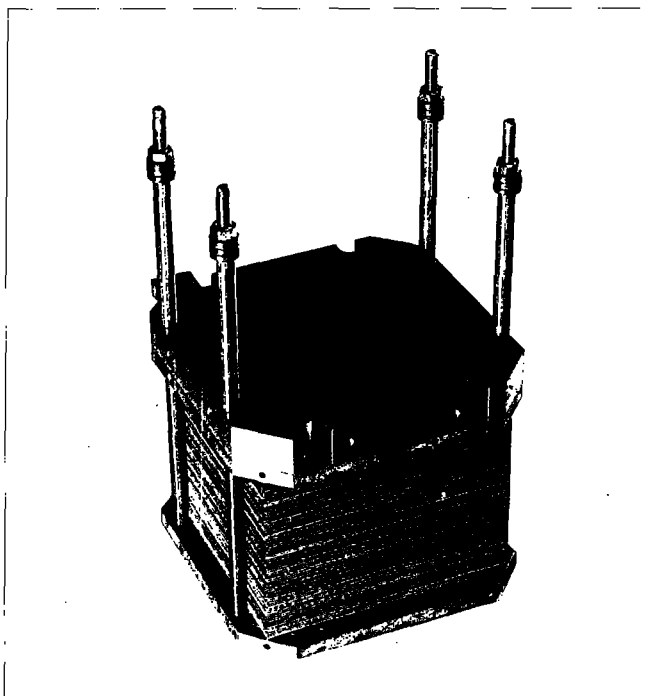
Fuel cell technology is still at a development and testing stage. At Topsoe Fuel Cell, which in collaboration with Risoe National Laboratory is among the European leaders in fuel cell research, the objective per unit is to produce power for 40,000 hours. To date, Topsoe Fuel Cell has achieved 13,000 hours and the signs are that the target will be reached in 3-4 years. The first production is anticipated some time after 2008.

Topsoe Fuel Cell is collaborating with Risoe National Laboratory on fuel cell development, while the company itself will handle production.

"We are naturally expecting a competitive price for our products," says Helge Holm-Larsen, business development director at Topsoe Fuel Cell.

#### **Efficient and environmentally friendly**

"We can see that the cost price is dropping, but the price must naturally be seen in relation to the other advantages that fuel cells offer. The products will have a very high power density as well as the ability to use different fuels," says Holm-Larsen.



#### **Fuel cells**

A fuel cell is a high-efficiency electrochemical device, which converts the chemical energy in a fuel into electricity without prior combustion and without movable parts. A fuel cell basically comprises two electrodes (anode and cathode) and an electrolyte. At the anode the fuel is oxidised, releasing electrons. The electrons pass through an external electronic circuit to the cathode, where they react with oxygen. The process provides an electric current from a continuous supply of fuel.

There are different types of fuel cell. Topsoe Fuel Cell concentrates on Solid Oxide Fuel Cell (SOFC) technology. The chemical reaction in SOFC takes place at extremely high temperatures, resulting in a high level of efficiency.

Solid Oxide Fuel Cells can utilize numerous types of fuel at high efficiency. Combustion of diesel in a conventional diesel engine exploits only 25% of the fuel's energy, while more than 70% exploitation can be achieved by SOFC using diesel as feedstock.

Fuel cells are also tremendously efficient and environmentally friendly compared to conventional motors, generators and turbines. When fuel cells convert chemical energy into electrical energy, the only waste product is water, which makes the process environmentally friendly.

Helge Holm-Larsen divides the potential market for fuel cells into three segments: two for stationary applications and one for transport applications.

"Coaches and trucks will increasingly need electrical power for cabin heating, TV, air conditioning etc. Today's batteries can only power such devices for a short time unless the engine is run to provide continual recharging. This is however an expensive and polluting method with poor electrical efficiency. Our solution, for which we believe there is a giant market worldwide, is to install a small power plant which can use diesel as fuel. There are plenty of advantages: less fuel consumption, less emissions and less noise."

#### **Market segments**

"The market segments for



*Helge Holm-Larsen,  
business development director at Topsoe Fuel Cell.*

stationary applications are micro combined heat and power for residential application, and distributed generation," says Helge Holm-Larsen. "The latter is primarily for local power stations outputting 0.5-1 MW, but there is also a new trend among large companies which are starting to produce their own electricity. Altogether we expect a strong increase in all forms of decentralised electrical power generation in the next 10-20 years. A fuel cell power station makes economic sense, and for families it means less dependency on the grid and lower costs," says Larsen.

Topsoe Fuel Cell has recently received a EU grant of EUR 4.7 million for testing and demonstrating production and use of fuel cells over the next 3-4 years. "We consider this to be a signal from the EU that we are on the right track with our production method," says Helge Holm-Larsen.

[www.topsoefuelcell.com](http://www.topsoefuelcell.com)

# TH!NK HYDROGEN

## Electric car with Danish fuel cells

H2 Logic, a small Danish development company in fuel cell technology, will deliver fuel cell systems for further development of Think, an electric car from Norway's Think Technology. During this year up to 8 demonstration cars will be tested in Scandinavia. The H2 Logic systems will extend the car's range to 300 km per hydrogen fill-up.

The Think electric car was developed in 2002 while Think Technology was owned by Ford Motors. H2 Logic's fuel cell system will now be integrated in the car's battery system.

Fuel cells convert hydrogen into electricity through a chemical process. The only waste product is pure water. Hydrogen is produced via the reverse chemical reaction, namely the electrolysis of water. Production of hydrogen in this way is done using electricity from wind power, usually at night. The hydrogen can be stored and used thereafter in the transport sector.

[www.h2logic.dk](http://www.h2logic.dk)

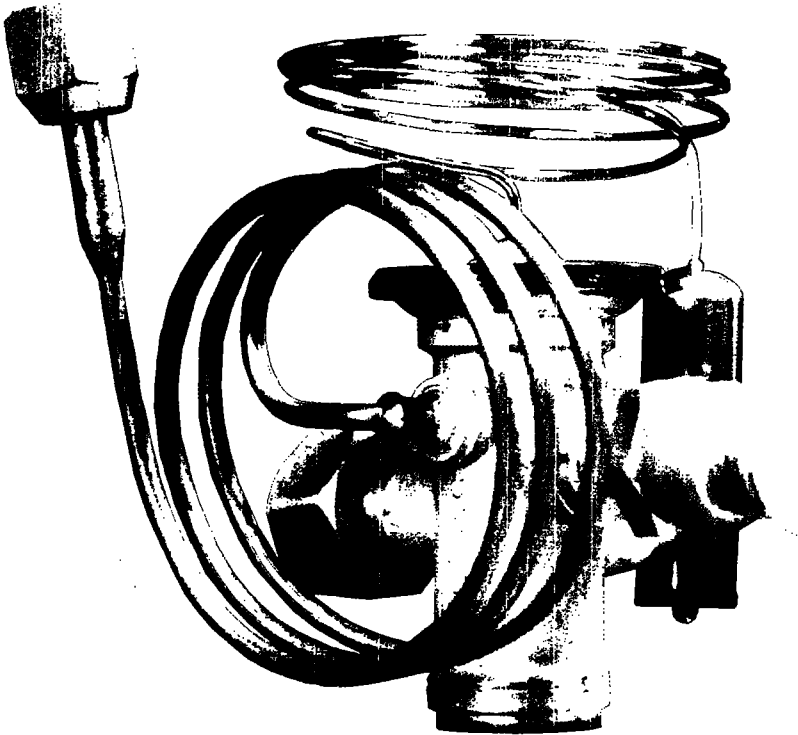
Read more about Danish fuel cell technology on  
[www.ird.dk](http://www.ird.dk)



# ENERGY EFFICIENCY IN HEATING AND COOLING



Niels B. Christiansen,  
Deputy CEO & COO  
of Danfoss



**ENERGY EFFICIENCY:** It is no coincidence that Denmark is a world leader in energy efficiency. The country is not richly endowed in natural energy resources like coal, and the population has long understood the need for thrift in the use of energy. For the last 30 years, a succession of energy taxation policies has kept this attitude front of mind both among private consumers and in industry.

It has also made Danfoss A/S a world leader in mechanical and electronic components for heating and cooling of residential buildings, refrigeration of food and production line control. The company's product portfolio includes valves, compressors and thermostats, which are used in countless systems worldwide.

"Our products and our brand are positioned to communicate that we are a company committed to energy efficiency. Energy and environment issues are high on the agenda in just about every country these days, which make our energy

efficient solutions highly relevant," says Niels B. Christiansen, Deputy CEO & COO of Danfoss. "Our products also have a strong reputation for reliability. We have produced high quality for many years, and we know that our customers expect it of us. We take great care over our production so that our products last for many years. Replacing or repairing a plant is expensive, and so everybody in the supply chain needs to be sure that the products will last."

Danfoss is a strongly research and development oriented company. Product

development is an extremely thorough process which builds on the extensive knowledge Danfoss already possesses. Currently under development is a compressor, whose speed can be varied according to need, so that no more energy is used than required.

Danfoss' export strategy is to enter relevant markets as quickly as possible. "It is easier to gain a share of the market while it is growing", says Niels B. Christiansen, who reveals that Danfoss has just acquired companies in China in order to have a presence when the anticipated market expansion begins. In the USA, Danfoss has acquired a number of companies to expand its market share.

"We are already major players in the cooling and air conditioning market in the USA," says Christiansen, who adds that acquiring a new factory can also complement existing activities on a market.

"Air conditioning is a very important market for us in the USA, and we have recently developed a special valve for this application area. Air conditioning accounts for a third of all the energy used in the USA, so it is a giant market with an enormous potential for energy saving."

District heating is a focus area in the eastern European countries, especially in Russia where a lot of new building is taking place. In the early 1980s Danfoss entered the Russian market, which is now one of its top 5 markets along with USA and China, with a growth rate of between 30 and 40%. This market spread helps make Danfoss more global as well as less dependent on a particular region.

[www.danfoss.com](http://www.danfoss.com)

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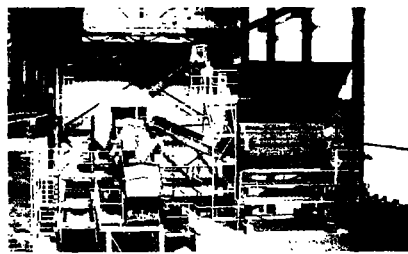
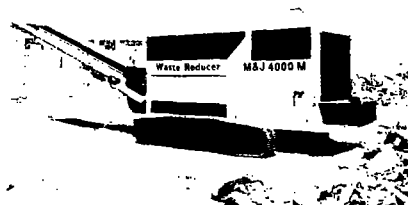
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# FROM STRAW TO HORSEPOWER

Second generation bioethanol, produced from waste products such as straw and wood chips, is not yet economically competitive with first generation bioethanol which is made from carbohydrate-rich crops such as sugar beet. But at Risø National Laboratory, now part of the Technical University of Denmark (DTU), they are working flat out to make second generation bioethanol as cheaply as petrol. Professor Erik Steen Jensen, who heads the programme at Risø, expects that bioethanol will be cheaper to produce in the long term, with excellent opportunities to export biofuel technologies.

## Multiple biomass sources

"We are working on a biorefinery concept at Risø," says Erik Steen Jensen. "In the long term it might be possible to use many different kinds of biomass depending on the global location of the refinery. The world needs both renewables and reliable energy supplies, and in this connection straw and waste could play an important role. Under all circumstances, we have to do something to reduce CO<sub>2</sub> emissions."



**BIOETHANOL:** Risø National Laboratory has incorporated export opportunities and sustainability in a major research programme on the production of second generation bioethanol

Risø has been working on producing bioethanol for car engines since the early 1990s, and is currently developing new technologies for pre-processing biomass for second generation technologies. Together with DTU, Risø has patented a process to convert straw into ethanol.

## More environmentally friendly

"The process involves subjecting straw to a high pressure treatment, using methods that have been continuously refined since the early 1990s," says Erik Steen Jensen. "In collaboration with Dong Energy and Copenhagen University we have recently built a plant in Skærbæk, Jutland, which can process 1 ton of

*Erik Steen Jensen*

straw per hour. Our objective is to rapidly increase this to 25 tons per hour by optimising both the technology and production processes."

"Our biorefinery concept is designed to exploit most of the many different substances in plant tissue," says Erik Steen Jensen. "Besides producing bioethanol, other plant components can be used to manufacture industrial source materials and products such as drugs, bioplastics and biocomposites for the transportation sector and for lubricating oil. Straw makes the entire process a lot more environmentally friendly because it is a waste product, and the unconverted portion can be used as animal feed or for electricity and heat production in a power station."

In Denmark, cars can now use petrol containing 5% ethanol. In January 2007, Risø acquired three specially engineered cars which can run on fuel containing up to 85% ethanol. "It seems right to use them in the light of the work we are doing. It takes the project to its natural end point," says Erik Steen Jensen.

[www.risoe.dk](http://www.risoe.dk)

# BIOETHANOL PLANTS TO MEET FUTURE NEEDS

Denmark's lead in the development of second generation bioethanol is rooted in the fact that straw has been used as fuel for many years in Danish combined power and heat stations, and the technologies for utilizing it have been continuously developed.

The use of straw as a source material for second generation bioethanol production is a considerable challenge. In comparison with first generation bioethanol source material like corn and maize, more complex enzyme-based processing is required. But it can be done and in addition to bioethanol, the residual products can also be utilised e.g. as animal feed or fuel for an associated power station.

## Refining and developing technology

Denmark's leading energy company DONG Energy was among the first to start research in this area.

"We are aiming to refine and develop a technology, which could become the answer to meeting the increasing demand for renewable energy," says research and development director Charles Nielsen, DONG Energy. "We have gained a lot of knowledge at an early stage, which gives us an advantage in product development. If we succeed, it will be a lucrative business. We expect that it will be possible to use a vast number of different materials in this process, and it is far from certain that the crops we use today are best."



**BIOETHANOL:** DONG Energy is aiming to become a major player in the production of bioethanol from straw and biomass, and anticipates full scale production by 2012.

**Providing complete solutions**  
DONG Energy has plans to build a full scale plant, slated for completion by 2012, that will be integrated with an existing power station, enzyme factory and refinery. The company already has a small pilot plant which can process one

ton of straw per hour. A new plant which can process four tons per hour is being built at the same location. The full scale plant is planned to have a nameplate capacity of 20 tons per hour.

DONG Energy aims to invest EUR 18 million in tech-

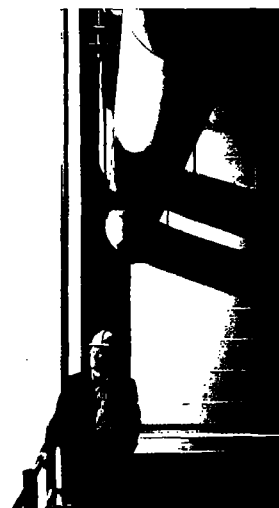
nology development, as a step towards the ultimate aim of selling complete plants on the world market.

## Important enzymes

The USA and China are the main competitors in the development of second generation bioethanol plants. Both countries are putting a lot of cash into it, but from a technological perspective the Danish project is thought to be far ahead. As Charles Nielsen points out, it is not solely a matter of economic investment, but just as much about know-how.

"There are many components involved," says Charles Nielsen. "Enzymes alone account for around half of the cost of the entire process. And in this area, Denmark's Novozymes is among the leaders in this important aspect."

[www.dongenergy.dk](http://www.dongenergy.dk)



# THE ENZYME KING

**BIOETHANOL:** Enzymes are the key to efficient and cost-effective production of bioethanol from second generation plants. Converting straw and other biomass to ethanol needs the right enzymes.

Denmark's Novozymes A/S is the world's leading manufacturer of enzymes. Most of its production goes to washing powder manufacturers worldwide, but these days enzymes for bioethanol production are increasingly filling the order book, and account for 10% of the company's revenue.

Enzymes for bioethanol production were already known when Novozymes first started up its own development programme in the 1970s. But the company was quickly able to produce new enzymes through the development of many new technologies. In first generation plants the enzymes break down carbohydrates e.g. from maize, and in second generation plants it breaks down cellulose from straw, into simpler sugars, which are then fermented by yeast to produce ethanol.

"Today we supply more than half the market, and I am sure that our current position is the result of development, and spend 12-13% of our total revenues each year on research and development," says Poul Ruben Andersen, marketing director of Novozymes.

#### Growing market

"Ethanol added to petrol currently accounts for only a tiny



proportion of world consumption of fuel, but in the western world there is a collective will to make it much greater. The USA aims to increase its ethanol consumption sevenfold by 2017, while in the EU the objective is to increase the percentage of ethanol in petrol from 2% to 10% by 2020," explains Poul Ruben Andersen.

One of the challenges regarding cost-efficient production of bioethanol from second generation plants is that the enzymes currently account for no less than half the production price.

"We aim to make the enzymes four to five times better, while keeping the price on a par with enzymes for production of ethanol in first generation plants," says Poul Ruben Andersen.

Novozymes is collaborating on the development of second generation bioethanol plants in USA, China and Denmark.

"Second generation plants are essential in order to meet political objectives," says Poul Ruben Andersen. "We believe we will get there in 4-5 years, and reckon that in the long term bioethanol will replace at least half of the petrol and diesel the world uses."

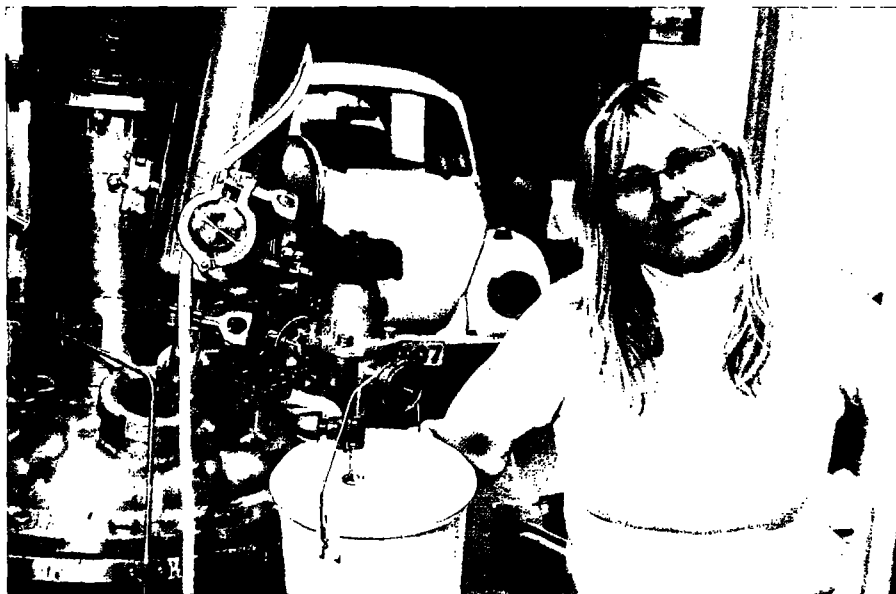
[www.novozymes.com](http://www.novozymes.com)

Novozymes has entered an agreement with China National Cereals, Oils & Foodstuff Corporation, COFCO, to supply enzymes to COFCO's new bioethanol plant in Harbin. By 2011, the Chinese concern aims to become the world's largest manufacturer of bioethanol produced in second generation plants.

In February, US President George W. Bush visited the Novozymes enzyme facility in Franklinton, North Carolina. The President used the visit to flag the administration's goal of reducing gasoline consumption by 20% in the next 10 years, by using alternative fuels such as bioethanol. Novozymes President and CEO Steen Riisgaard forecasts a 20% annual increase in sales to the US in the coming years.



# LEADING IN BIOETHANOL TECHNOLOGIES



*Birgitte K. Ahring*

**BIOETHANOL:** The world's first second generation bioethanol plant is in operation at the Technical University of Denmark. The performance of the MaxiFuels pilot plant has helped to give Denmark a technological lead in the production of bioethanol from cellulose

The Technical University of Denmark (DTU) has conducted ethanol research for 15 years. Professor Birgitte K. Ahring has headed the research and patented several processes. She is also the co-founder of BioGasol, a DTU spin-off company which aims to market and sell technological licences in a few years. BioGasol is involved in the world's first second generation bioethanol plant, which is located at the university.

The pilot plant is the first step towards commercialisation of the technology. It is planned to be replaced in 2008 by a demonstration plant, and in 2010 by a full scale plant which will be located in Denmark. A second demonstration plant, which is also planned, will be located outside Denmark.

#### **Investors sees gold mine**

"The first full scale plant has a planned capacity of 10 million litres of ethanol

annually, but right now it is more important to demonstrate the pilot plant's capabilities than to focus on quantity," says Professor Ahring. "There is a great deal of interest from investors, who see a potential gold mine in this technology."

Investor interest is being heightened by the requirements for increased energy efficiency in the automotive sector, particularly in the US, Brazil and Sweden where the markets for cars with flexifuel engines, which can run on fuel containing up to 85% ethanol, are in strong growth.

Professor Ahring predicts that new types of engines will enable cars to drive 32 km on a litre of pure ethanol. It is estimated that the production price of a litre of bioethanol from the MaxiFuels plant is DKK 2.30. The production price for the full scale plant is expected to be somewhat lower. In comparison it costs approximately DKK 3.22 including CO<sub>2</sub>

tax to produce a litre of petrol at an oil refinery.

#### **Broad spectrum of biomass**

"In the future, bioethanol plants will be able to utilise biomass from many different sources. It is important that this takes place in a competitive and environmentally correct way," says Professor Ahring, who points to other important future initiatives. "We need to think about environmentally friendly bio-refineries which can convert virtually all forms of biomass into energy products, as well as chemicals currently derived from oil. We believe that MaxiFuels points the way not only to tomorrow's biofuels, but also to the bio-refineries of the future."

The production of ethanol from biomass also creates methane, hydrogen and a combustible solid residue that can be converted into fuel pellets. In the MaxiFuels plant one ton of straw produces 310 litres of ethanol, 70 cubic metres of methane, 20 cubic metres of hydrogen and 230 kilos of solid fuel.

[www.biocentrum.dtu.dk](http://www.biocentrum.dtu.dk)



# COMPANY PROFILES

THE FOLLOWING COMPANY PROFILES HAVE BEEN SUBMITTED BY THE ADVERTISERS IN THIS ISSUE

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The Danfoss Group is a global enterprise, created by the efforts of dedicated people, with a reputation for using advanced technology in products and processes and for awareness of environmental and energy saving issues.

Danfoss is among the world leaders within its business areas: Refrigeration and Air-conditioning Controls, Motion Controls, Heating & Water Controls. The Danfoss Group has modern factories on four continents, sales companies and representatives in more than 150 countries and about 17,000 employees worldwide.

Our production facilities around the world are capable of turning out some 250,000 components a day. All are geared for efficient production runs and make use of the most advanced manufacturing techniques.

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ICT Logistics is a transport – and logistic company offering our services and competence to CIS, Russia, Baltic, and Central East Europe.

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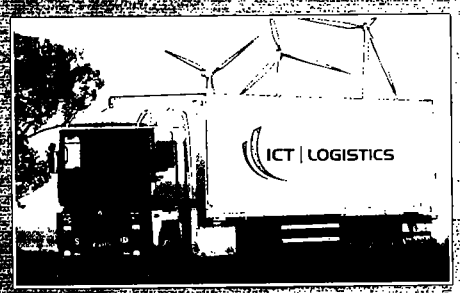
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*Jesper Stolbjerg / Chief Financial Officer*

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