Green Growth in the Regions

regions

Clean technology on time

There is enormous growth potential in ecofriendly, clean technologies. A new partnership aims to place Denmark at the cutting edge of cleantech development.

Large-scale solar heating

The citizens demanded CO_2 -free district heating – and they got it. From 2011 on, Dronninglund District Heating will supply half the town with heating based solely on the rays of the sun. The world's biggest solar thermal plant is on the way

Diesel with a clear conscience

Daka Biodiesel manufactures biodiesel from slaughterhouse waste. In East Jutland, the term road hog' has taken on a whole new meaning.



Bent Hansen Chairman, Danish Regions

Carl Holst Chairman of the Danish Regions Committee for Regional Development

The regions invest in climate and energy

hen Denmark hosts the UN Climate Change Conference in December, the main target will be to achieve an international climate agreement to reduce worldwide emissions of CO₂. This means that in future, we must utilise more renewable energy, and use energy more efficiently.

The regions in Denmark put high priority

to helping to reorganise energy consumption and develop new, climate-friendly technologies. Central to these efforts are Denmark's six regional growth fora, which bring together companies, knowledge institutions, municipalities and regions. The growth fora have been vital in launching a wide range of initiatives in the area of energy use and climate adaption, which will also help to safeguard future growth and secure new workplaces.

In this magazine, we focus on some of the innovative and promising initiatives launched and co-financed by the growth fora and the regions. such as the ambitious projects for the development of new cleantech solutions, the work of reducing and streamlining energy consumption, and initiatives to support the development of sustainable energy.

Denmark occupies a strong international position when it comes to developing ecofriendly technologies. The regional growth fora will help to benefit from these possibilities within one of the future's most important growth industries – also when the climate conference has ended. We hope that the examples in this magazine may help to promote interest in creating eco-friendly solutions for the benefit of the climate, citizens, regional growth and employment.

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2









There is enormous growth potential in ecofriendly, clean technologies. A new partnership aspires to place Denmark at the cutting edge of cleantech development.

Read more on page 4

A GREENHOUSE HARVESTING ENERGY

A pilot project at a giant nursery in Funen aims to drastically reduce the energy consumption of the nurseries – and add energy to the list of crops that can be harvested in Danish greenhouses. **Read more on page 8**

LARGE-SCALE SOLAR HEATING

The citizens demanded CO₂-free district heating – and they got it. From 2011 on, Dronninglund District Heating will supply half the town with heating based solely on the rays of the sun. **Read more on page 12**

DIESEL WITH A CLEAR CONSCIENCE

Daka Biodiesel manufactures biodiesel from slaughterhouse waste. In East Jutland, the term 'road hog' has taken on a whole new meaning.

Read more on page 16

BIOFUEL WITH NO AFTER-TASTE

Diese

with a clear conscience Read more on page 16

Fuel made from biomass has been blamed for rising food prices, because crops are grown for fuel instead of food. A new project analyses the potential of producing biofuel from resources that cannot be used for food cultivation. **Read more on page 20**

RUN YOUR OWN MICRO-HEATING PLANT

Some big companies in Denmark intend to make biofuel-powered micro-heating plants the home heaters of the future. **Read more on page 22**

BUILDING WITHOUT BARRIERS

Green construction projects can easily grow out of existing buildings. Through renovation, the capital's 'Plan C' aims to reduce energy consumption to just under one-third. **Read more on page 24**

GREEN VISIONS ON SUSTAINABLE WINGS

Lolland is striving to become one of Europe's leading test environments in algae production – for jet fuel, amongst other things. Power from wind turbines will make the difference. **Read more on page 26**

CLIMATE STRATEGISTS TAKE UP THE FIGHT

With their new climate strategy, Region Zealand and 17 municipalities in Zealand have created the common ground that is essential to efficiently adapt to climate change. **Read more on page 29**

WE CREATE WORKPLACES – AND A BETTER ENVIRONMENT!

Hydrogen technology is one of the most promising avenues in the search for climatefriendly energy sources. One corner of the hydrogen technology world is based in Hobro – but here the climate is not their main concern. **Read more on page 30**

WASTE IS THE CAPITAL OF THE GREEN CYCLE

Bornholm's waste is becoming valuable. A new bioethanol plant has been launched to generate CO₂-neutral energy and extract ethanol from ordinary everyday rubbish – with citizens playing an important role.

Read more on page 32

RISING GROUNDWATER IS AN OVERLOOKED THREAT

Central Denmark Region is the lead partner in a multinational project which aims to learn more about the effects of climate change on groundwater. **Read more on page 35**

3

Clean technologies

Cleantech is an umbrella term for energy and environmental technologies which help to promote sustainable production, enhance energy efficiency, replace fossil fuels with renewables and reduce pollution. 1 20

An analysis published in April 2008 by VækstFonden – an investment fund backed by the Danish government – estimates that the global market for clean technologies – cleantech – is worth more than EUR 175 billion, with an annual anticipated growth rate of between five and 15 percent until 2016.

Copenhagen Cleantech Cluster

There is an enormous growth potential in clean, climate-friendly technologies. A new partnership aims to place Denmark at the cutting edge of cleantech development. he rhythm is set by the gentle idling of the washing machine. "What a day for a daydream ..." crackles the radio. The machine joins in as it removes even the worst stains. The Novozymes laboratory exceeds the wildest dreams of a housewife, and is an important example of the potential for what could become one of Denmark's major future industries: cleantech.

CLUSTERS EARN THE PROFIT

Cleantech is the designation of the so-called 'clean technologies' which help to promote sustainable production, replace fossil fuels with renewable sources, and reduce CO_2 -emissions. Denmark is currently regarded as one of the world's leading countries in cleantech technology. With the need to reduce CO_2 -emissions in the future, a bright commercial future is predicted for the area:

"The dot-com wave set the agenda back in the nineties. In 2000 it was biotechnology that set the agenda. Today, it's cleantech," says Steen Donner, managing director of Copenhagen Capacity, the inward investment agency of the Capital Region of Denmark.

Copenhagen Capacity is one of the primary partners behind a new Danish cluster of cleantech companies that have combined forces to strengthen the development of clean technologies. The Capital Region Growth Forum and Growth Forum Zealand have also played important roles in establishing and funding the collaborative venture, which has been given the name Copenhagen Cleantech Cluster.

The Copenhagen Cleantech Cluster was formally launched in September 2009. Among the initial tasks is the establishment of a knowledge centre which will provide a common portal to all aspects relating to cleantech, investment possibilities, international market potentials, research networks, R&D activities and testing facilities.

Additionally, international co-operation with similar clusters abroad will be enhanced. Improved acces to test and demonstration facilities will be initiated for companies who wish to test their most recent technologies. Finally, co-operation between scientific researchers, private companies, municipalities and other public authorities will be intensifyed.

NO MORE IVORY TOWERS

Clusters have long been recognized as a central prerequisite in creating good growth conditions. Both Silicon Valley and Medicon Valley, with their high-tech investments, represent powerful examples of clusters which, by intensified co-operation between relevant partners, have achieved strong positions in the IT and biotech markets.

This is precisely why cluster co-operation between Denmark's roughly 700 cleantech companies is essential, if Denmark is to retain and expand its current international market position.

The goal is to get as many partners and stakeholders as possible to intensify their cooperation, before another cluster takes the lead. However, the competition is tough, and the vision is for Denmark to retain its position as one of the world's five leading cleantech nations. In order to meet this target Copenhagen Cleantech Cluster has raised a budget of no less than EUR 21 million, which should be viewed in the context of similar international investments currently being made. "If we manage to keep Denmark in the top five, we should be happy. Also, it is possible to succeed if we perform smarter than the others and pool our resources," says Steen Donner.

Both USA, China and most recently South Korea have secured comprehensive funding for developing their cleantech-industries. Likewise, while the Gulf state of Abu Dhabi is currently building the world's first CO₂-neutral city.

"We need to concentrate our common resources. It's no use each of us working in our own ivory towers. All companies across the country must stand and work together, because that way we can make substantial progress," says Anders Stouge, managing director of the Danish Energy Industries Federation, one of the partners behind Copenhagen Cleantech Cluster.

A GLOBAL RACE

The Copenhagen Cleantech Cluster-project currently has a duration of five years.

Apart from the founding organizations, the participants encompass a wide range of public and private sector co-investors, including a number of leading companies such as Haldor Topsøe, DONG Energy, Novozymes, Vestas and Siemens. Together, the partners have already raised funding amounting to EUR 5.4 million.

The project also involves three climate-municipalities in Zealand – Kalundborg, Roskilde and Lolland – and two capital region municipalities, which aim to ensure that Denmark retains its reputation for clean technologies – a reputation that scientists and companies have built up over the past 30 years. This is also the reason why Denmark already today is world-renowned for sustainable energy, new materials, biodegradable raw materials and the decontamination of water, air and soil. The future task will be to invest relevant ressources in areas in which we already have strong positions.

"Denmark is a very small country, leaving us with a limited scope for action. We cannot do everything. Therefore, we need to focus intensively on those areas where we really stand out, such as wind power and water technology. On the other hand we have to accept, that we will never become world champions in the area of solar energy. It is a global race, and we must choose our pitch," says Steen Donner.

CLEANTECH AT 30°

Novozymes has chosen a future-proof solution, because time is ripe for it, both with respect to the world market and the domestic consumers. Co-operation is also about getting individual citizens to take a stand and choose cleantech in their daily lives.

"All the talk about quota systems and how we can save different quantities, easily gets very abstract. There are many ways in which we can support the technologies that already exist, and in a way which is beneficial to the environment," says Mette Johnsen, sustainability manager at Novozymes.

In its washing laboratories, Novozymes works to develop washing powder which will work at low temperatures. If all households in Europe reduced their washing temperatures from 60° or 40° to 30°, the world would save 12 million tons of CO₂emissions per year. This equivalates the annual emissions from three million cars. "The only thing this requires is that Mrs Smith makes do with turning the knob once when she does the washing. In return, she can save 40 percent of her washing bill. It is a very easy choice to make as a consumer," says Mette Johnsen.

Having played an important role in establishing Copenhagen Cleantech Cluster, The Capital Region Growth Forum Copenhagen and Growth Forum Zealand have shown that both regions are capable of setting the agenda for industrial development and for one of Denmark's future sources of income.

"The COP15 Climate Conference will show the world who we are, and what we can do here in Denmark. The Copenhagen Cleantech Cluster is about making sure that we stay focused on the goals even after the lights have been switched off, at the Bella Center," says Steen Donner.



The new cleantech cluster

The Copenhagen Cleantech Cluster is a collaborative venture established by private companies, knowledge institutions and public players, aimed at strengthening Denmark's international cleantech-profile.

The goal is to develop a cleantech cluster which will stimulate increased growth for the region's existing cleantech companies, encourage the establishment of more cleantech enterprises, and attract companies from abroad with talent and knowledge.

The results will include 1,000 new workplaces, 10 public and private partnerships, growth for a wide range of entrepreneurs, increased exports, co-operation with 15 international cleantech clusters, 200 events, and the involvement of more than 200 players.

The principal organisers of the Copenhagen Cleantech Cluster include Copenhagen Capacity, Risø National Laboratory, the Technical University of Denmark (DTU), the University of Copenhagen, the Confederation of Danish Industries and Scion DTU Science Park.

The participants currently include more than 25 public and private sector organisations, including Haldor Topsøe, DONG Energy, Novozymes, Vestas, Seas-NVE, Siemens, Better Place Denmark, Business Link Greater Copenhagen, Business Link Zealand, the municipalities of Roskilde, Kalundborg, Lolland and the City of Copenhagen.

The budget amounts to a total of EUR 21.8 million over a five-year period. During the initial stages, the partners contributed a total self-financing portion of EUR 5.4 million. A corresponding amount has been assigned via The Capital Region Growth Forum, Growth Forum Zealand, and the European Regional Development Fund.

"If we manage to keep Denmark in the top five, we should be happy. Also, it is possible to succeed if we perform smarter than the others and pool our resources,"

Steen Donner, managing director, Copenhagen Capacity

A greenhouse harvesting energy

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

With a share of around one percent of Denmark's total energy consumption, the Danish greenhouses occupy a sensitive position in the climate debate. A pilot project at a giant greenhouse in Funen aims to both drastically reduce the energy consumption of the nurseries, and to add energy to the list of crops that can usefully be harvested in Danish greenhouses.

Hjortebjerg Greenhouse just outside the town of Bogense in north-west Funen, is very large covering six hectares – more than 55,000 square metres – under glass, it is one of the five largest in Denmark. It is so large that the crane which transports the trays of plants around in the greenhouses is fitted with a laser sight so that the operators can find out where they are. The building is so enormous that it expands in the heat.

Another thing which takes enormous

proportions at Hjortebjerg is the energy bill. As at all other greenhouses in Denmark, it takes a great deal of both light and heat if you want to earn profits all year round cultivating fruit, vegetables and potted plants indoors.

At Hjortebjerg, they constructed their owm CHP (central heating plant) in 1996 as the heating demand was so heavy.

"At the time there was a policy to decentralise energy production, and we could see the sense in that," says Steen Juul Thomsen, managing director of the family-owned greenhouse. But with the increasing level of environmental awareness in the nineties, the energy consumption of the greenhouses was to become an ever-hotter political potato.

energy consumption of the greenhouses was to become an ever-hotter political potato. Consequently, in 2000, the Danish greenhouses entered into an agreement with the Ministry of Energy to monitor their energy consumption and ensure that they could both maintain their production levels and save energy. This meant increasing awareness:



Hjortebjerg Greenhouse

The Hjortebjerg Gartneri nursery was founded by Aage Thomsen in 1933. I 1982 it was taken over by his son Jørgen, and the third generational change partly took place in 1993. Today, the greenhouse is run by the second and third generations in equal partnership: Jørgen Thomsen and his three sons Alex, Gert and Steen Juul Thomsen. The greenhouse has around 40 employees, and exports ornamental plants to most of Europe.





"We learned to use computer programs that could control our indoor climate in a much more dynamic manner. Over the years, we have acquired a lot of knowledge in this area," says Steen Jul Thomsen.

In his opinion, all of the energy use which could not be justified on the basis of production needs has now been eliminated. Everything has been analysed, and anything which was not strictly necessary in terms of production has been removed.

"Today, we use 300 kWh of heating per square metre per year, and 50 kWh of electricity per square metre per year. That represents a reduction of more than 30 percent since we seriously introduced energy-conscious production ten years ago," he says.

HARVESTING ENERGY

But even such large savings have unfortunately not turned the nurseries into green enterprises in an environmental sense. More is required for that, so since January 2008, Hjortebjerg has co-operated with the approved technological service institute AgroTech and the Region of Southern Denmark to reduce its energy consumption even more. So far, the results of the partnership indicate that it is possible to completely alter the conditions under which the greenhouses operate today.

"Calculations have indicated that we could produce more heat than we can use. We could actually become an energy company as much as a greenhouse," says Steen Jul Thomsen.

The basic idea is to harvest solar energy and store it under the ground.

"Today, if we need to let the heat out, we just open a window. But it would be more logical to store this heat instead. So that is what we are now attempting to do by pumping surplus heat down into the ground, where we can draw it up again later when we need it," says Steen Jul Thomsen.

For this reason, a brand new greenhouse has been constructed, measuring 5,000 square metres, in which the crop cultivated will first and foremost be the heat of the sun.

"We will harvest energy here, pump it down

into the ground, and then out to the consumers. We will also have plants in here, of course, but it was mainly for the energy harvest that we built it."

In the roof of the new building are two layers of curtains; one that lets the light in, but stops the heat from withering the plants, while the other keeps the heat in when the sun has gone down. In an annexe building is a newly-constructed heat pump installation which sends any surplus heat down to the groundwater level 40 metres underground. From here, the heat can be drawn up again when the weather is cooler.

"The aim is to be able to produce in an energy-neutral way in a heated greenhouse. It's that simple. And I consider it to be realistic that we could achieve this within a two to three-year period; at any rate with regard to the heat," says Steen Jul Thomsen.

"Whether we can make that much progress with electricity, I don't know. I have been following with interest the technological developments concerning diffuse solar panels, which permit the rays of the sun to enter the greenhouse, but not much progress has been made in that area yet. Though obviously, we could make a great many improvements on the electricity side as well."

FROM HOT POTATO TO GREEN ENERGY

Precisely how much more energy could still be saved in the Danish greenhouses is still an open question. All the signs are that progress in areas such as heat pump technology will make it possible to use the greenhouses as energy resources in the future.

The Southern Denmark Growth Forum has helped Hjortebjerg to launch the project "Intelligent Energy Management in Greenhouses". The aim of the project is to find areas in which energy savings and improvements can be made. Subsequently the results will be passed on to other companies within the horticultural sector.

In this way, the reputation of the greenhouses as the Billy Bunters of energy consumption could be transformed into the rather unfamiliar role of the top boys in the class, generating their own heat consumption and thereby passing on CO₂-neutral energy in the system.

"At Hjortebjerg, we expect that with increased energy consciousness, our net energy consumption can approach zero. We will be able to obtain 60 percent of our energy consumption via the stored heat from the greenhouses, and the rest from solar thermal collectors. We will in other words harvest energy in the greenhouse, and produce energy ourselves via solar thermal collectors. I think that in five to six years' time, we could offer to be the energy utility company for the town of Bogense. We have calculated that if we install one or two hectares of solar thermal collectors, together with whatever groundwater heat storage facilities we have room for, we could supply as much energy as the local district heating company supplies today," says Steen Jul Thomsen.

And this potential is not limited to Hjortebjerg. In many parts of Denmark, greenhouses have a direct piped link enabling them to receive heat from the local district heating company. This heat could usefully be sent the opposite direction during periods when the nurseries themselves have surplus heat.

Many partners

The project "Intelligent Energy Management in Greenhouses" at Hjortebjerg is supported by funding from the Southern Denmark Growth Forum and the European Regional Development Fund to a total of EUR 2.7 million. Besides Hjortebjerg, participants in the project include AgroTech, the University of Aarhus (Faculty of Agricultural Sciences), the University of Southern Denmark, Senmatic and Development Forum Odense.

"There is so much heat available that we could send quite a lot back. Judging by what we can save here at Hjortebjerg, many other greenhouses could put at least as much heat back into the system, and reduce the district heating load by 50 percent. The pipes are there already, so why not use them?" Steen Jul Thomsen asks.

AN EXPENSIVE SAVING - YET AGAIN!

Today, Hjortebjerg's savings have come at a high price. The ready-made solutions are not yet complete, but are being developed at the nursery on an ongoing basis as challenges are solved. Accordingly, the Region of Southern Denmark, via its Growth Forum, is also taking part in efforts to reduce energy consumption at the nursery.

"Right now we are buying expensive solutions, which are not fully developed. That costs money. We have actually put EUR 1.3 million into the project, and have received about half of that in funding. In the end, we will have invested EUR 2 million. So it's not a profitable initiative just yet, but we believe it will be one day. Furthermore, we have gained an enormous amount, in terms of network, from working with eco-friendly production. As such, the dialogue and the cooperation have benefited us a lot," says Steen Jul Thomsen.

He is however happy to emphasise the business aspects:

"The way we see the political wind blowing, we have to do something about our energy consumption now if we are to safeguard the company's future. So showing that we are a modern and responsible company is more for the benefit of the owners and employees than for the benefit of the environment and climate alone. For us, this is purely a business matter. But it doesn't hurt that it's for a good cause."



D anish horticultural greenhouses have already reduced their energy consumption by a considerable amount; from 1996 to 2008 the energy consumed per cultivated square metre fell by 25 percent,far exceeding the goal that the industry laid down in conjunction with the Danish Energy Agency. However, even greater savings can still be made, in the opinion of Leif Marienlund, a consultant with the market gardeners' trade association, Danish Horticulture.

"80-85 percent of the industry's energy consumption is for heating, so given the amount of energy used in Danish nurseries, even small improvements will have a large effect," says Leif Marienlund.

"The horticultural sector uses a lot of energy, and with the amount of focus by society on energy consumption and climate today, we have to do something. If we want the industry to have a future in Denmark, we must continue to optimise our energy use."

He has been monitoring the results from Hjortebjerg with optimism, where it appears possible to save so much energy that the nursery could end up being a net energy producer.

"The potential of this project is very interesting, and in the long run it is easy to imagine that the greenhouses could become heating companies. The most obvious solution would be for the big nurseries in, for example, the Odense area, where they are directly linked to the district heating companies, to deliver heat in the opposite direction. Right now the investments required to make better use of the energy are far too expensive for many nurseries, and this is a challenge. But it represents good economics for society and good operating economics, and it benefits the environment, too."



Nurseries in Denmark

The annual production of Danish greenhouses is worth just under EUR 405 million. Around 75 percent of this comprises flowers and plants, while fruit and vegetables make up the remainder.

Approximately 85 percent of the flower production is exported, while more or less all of the fruit and vegetable production is sold on the Danish market.

Horticulture accounts for around 15,000 primary and secondary workplaces in Denmark. Around 0.9 percent of total Danish energy consumption is used in greenhouses.

Large-scale SOLAR HEATING

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

The citizens demanded CO₂-free district heating – and they will get it. From 2011, the district heating of half the town of Dronninglund will be based exclusively on the rays of the sun. The world's biggest solar thermal collector plant is on the way.

The people of Dronninglund will have to get get used to increased traffic, because from now on, the Dronninglund District Heating Plant will be a popular attraction which other district heating plants interested in development, CO_2 savings and modern production methods can hardly afford to ignore. For right here, at the northern tip of Jutland, there are plans to dig a hole equivalating the size of two football pitches and 15 meter deep at its deepest point.

Subsequently, this pit will be filled with hot water.

The water will be heated by a solar thermal plant, the construction of which is expected to be approved soon by the general assembly of the district heating plant. The solar thermal plant will be by far the biggest of its kind in the world, and will supply half the town of Dronninglund with district heating which will be completely CO₂-neutral, and cost no more than conventional district heating.

If this is such a brilliant idea, you might ask, why has it not been done before?

This is precisely what Carsten Møller Nielsen, chairman of Dronninglund District Heating, is doing. He poses the same question to a team of experts, consultants and partners in the crowded meeting room of Dronninglund District Heating. The group needs to have the final details in place well in advance before the general assembly. They might as well deal with the question of "If this is so brilliant ..." straight away, because someone at the meeting is bound to ask it.

Solar thermal collectors have become cheaper, the price of natural gas has gone up, production reliability has increased, and there are more heat pumps available, those are some of the answers given around the table.

Dronninglund District Heating Plant

"Many challenges still lie ahead to be tackled before the final project can take shape. I am quite sure of that, because nobody else has ever tried to do what we are doing, on this scale."

Carsten Møller Nielsen, chairman, Dronninglund District Heating



Solar heating is efficient

We are familiar with the effects of stored solar heat from our greenhouses and our cars during the summer. Solar heating can produce very high temperatures, and is an extremely efficient source of energy. The roof of the average single-family house alone is exposed to ten times as much heating energy from the sun as the household uses itself.

The planned installation in Dronninglund will have an area of 35,000 square metres of solar thermal collectors. The world's currently largest solar thermal plant is located in Marstal on the Danish island of Ærø, and measures 18,300 square metres. All in all, these factors have turned solar thermal collectors into a realistic alternative to conventional district heating, both in Dronninglund and probably everywhere else.

THE CITIZENS DEMAND IT

Dronninglund's CHP (central heating plant) station was completed in 1990, but the heating plant's first boiler station was built in 1959. The plant supplies heating to the 1,350 households of the town of Dronninglund. The heat is currently based on natural gas, of which around three million cubic metres are used every year:

"When the district heating plant was finished in 1990 it looked new and smart, but the technology, on which it built, was a hundred years old. The heat was produced by burning fossile fuel, in our case natural gas. This was modern at the time, but even back then we already knew that natural gas is a scarce resource which we only have for a limited time, until it is all used up. Therefore, as board-members we had to look to the future and search out the next source of heat," says Carsten Møller Nielsen.

Solar thermal collection emerged as the technology the board was most interested in. Over the following years the members sought expertise and experience with this technology. They visited the Saltum district heating plant in North Jutland, which was working on a model for a solar thermal plant. Furthermroe, the board also visited similar plants in Austria, the Netherlands and Germany, but without finding the optimal model:

"The plants we were introduced to turned out to be either too small, too unprofitable, or too unreliable to work with. We had continually kept the general assembly informed, that we were looking at solar thermal collectors. Then suddenly, after a few years the request came back the other way: "Now it's time you did something about finding an alternative source of energy." The general assembly literally obliged us to identify a valid alternative. And from then on there was no going back. We knew we had to find an alternative. We also knew that the solution must not cost the citizens more than they currently paid for heating. Also, we knew that we had their full support. The last factor, in particular, is what has enabled us to get this far," says Carsten Møller Nielsen.

"Many challenges still lie ahead to be tackled before the final project can take shape. I am quite sure of that, because nobody else has ever tried to do what we are doing, on this scale. As such, it is essential that the consumers support us, and are fully informed about the project and what it involves. This in turn requires a very high level of information, so that people actually do understand the project and gain confidence in it."

SAVES MORE THAN 6,000 TONS OF \mbox{CO}_2 ANNUALLY

Dronninglund is not the only place demonstrating increased climate awareness; consumers in general tend to demand cleaner energy. Hence, other similar companies are also considering solar thermal collectors. As a result, solar thermal collection technology has reached the stage at which its stability, sophistication and price are now at a level which permits the building of a solar thermal plant on the scale planned by Dronninglund District Heating.

And we are talking big installations and

comprehensive figures. Dronninglund District Heating will cut the first sod for the project in spring 2010. This should be taken quite literally: fifteen metres down, and covering an area of 10,000 square metres, roughly equivalating the size of two football pitches. Subsequently, the hole will be filled with between 60,000 and 70,000 cubic metres of water.

It will in fact be the biggest lake in the area – and the world's largest solar thermal plant. The cost of the entire installation will be around EUR 11.7 million.

"We could actually supply the entire town with heating in the very same way. The technology is already there and available to us. But this would imply a doubling of the investment and a interest level which I would not like to commit us to pay. The planned size of the installation is still very big, and serves to demonstrate that this can be done on a large scale," says Carsten Møller Nielsen.

The installation will be operational in 2010-2011, and 2011-2012 will be the first season in which the sun exclusively will be ensuring hot water in Dronninglund.

Chemical engineer Ole-Kenneth Nielsen of Denmark's National Environmental Research Institute has calculated how much CO₂ the current Dronninglund district heating plant would emit if it were to produce those 20,000 MW hours of energy that the solar thermal collector plant is expected to supply every year. Currently, Dronninglund District Heating uses three million cubic metres of natural gas a year; on the basis of standard values for heating value and emission factors, this would produce 6,744 tons of CO₂-emissions. In future, the environment will be spared this.

The regional growth forum sets the ball rolling

hen, a few years ago, the general assembly of Dronninglund District Heating first demanded that CO_2 -friendly ideas be translated into action, the company initially applied to the North Jutland Growth Forum for funding for a preliminary survey and calculations.

Per Alex Sørensen, who has been a close partner of the solar thermal collection project via the engineering company PlanEnergi, states that the funding obtained from the North Jutland Growth Forum was what initially made it possible to examine the potential of the project and its future prospects:

"We didn't know much about the market potential of solar thermal collectors, and we

were in doubt about whether the plant could be made to function without public subsidies. We needed to investigate this thoroughly, and the grant we received made this possible," he says.

In later phases of the solar thermal collector project, Dronninglund District Heating has received a total of EUR 1.75 million from EUDP, the Danish Energy Authority's Energy Technology Development and Demonstration Programme.

Per Alex Sørensen is looking forward to see the project in full size, producing district heating for the town.

"It represents a possible way out of the fix we will otherwise be in when the natural gas runs out," he says. • "It represents a possible way out of the fix we will otherwise be in when the natural gas runs out"

Per Alex Sørensen, consultant with PlanEnergi

"We could actually supply the entire town with heating generated by solar thermal collectors. The technology is already there and available to us. But this would imply a doubling of the investment and an interest level which I would not like to commit us to pay."

Carsten Møller Nielsen, chairman, Dronninglund District Heating



How it works:

A solar heating plant uses the natural and sustainable energy radiated from the sun to heat water. The solar thermal collector contains water mixed with anti-freeze, which is heated up by the sun's rays and pumped into a hot water tank, where the water gives up its heat and is returned to the solar thermal collector.

The challenge with solar heating is to store the heat. In Dronninglund, this will be done by storing the warm water in a giant lake, which will be covered and insulated. The temperature of the water in the lake will be close to boiling point at the top, and around 45° at the bottom. During winter the water temperature will be around 50°, and a heating pump will make sure it has the right forward flow temperature.

with a clear conscience

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

Daka Biodiesel manufactures eco-friendly biodiesel from slaughterhouse waste. In East Jutland, the term 'road hog' has taken on a whole new meaning for cars and buses.

ust a few years ago, it would have been inconceivable that one day, motorists would be able to power their cars with meat waste from a slaughterhouse.

But today this dream has become a reality, and moreover one which is tried and tested. You may already have driven on biodiesel made from slaughterhouse waste, especially if you have filled your car since the start of 2009 with diesel from one of the 75 petrol stations in Aarhus, where biodiesel has been added to the fuel.

Diesel made from waste from slaughterhouses and Danish agricultural production comprises 5 percent of the diesel used in Denmark's second largest city. Simply put, every twentieth kilometre driven by cars in Aarhus is powered by slaughterhouse waste or animal fat. If you fill your tank with fifty litres of diesel, 2.5 litres will come neither from the North Sea nor the Middle East, but from the Daka Biodiesel company located in Hedensted, Denmark.

"We don't call it a pilot project, but rather a demonstration project," says Jacob Mogensen, project manager with the CBMI – the Centre for Bioenergy and Environmental Technology Innovation, which administers the B5Next project, of which Daka's biodiesel is an offshoot.

"The difference is important; a demonstration project works, whereas a pilot project still needs more testing. This solution works, and it works on a large scale and with perfectly ordinary cars. That is what we are demonstrating in Aarhus," he says.

FROM GOLD TO DUST

It was a mad cow that started it all.

In 2001 there were several outbreaks of mad cow disease in Britain; a terrifying illness that could also infect humans and turn out to be lethal

The cause of the disease was the failure to keep animal and vegetable proteins separate in animal feed production. The protein-containing meat and bone meal with which the animals were fed thus contained remnants of their own species. This particular combination resulted in the cows becoming infected. The EU subsequently imposed a total ban on feeding





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animal-derived proteins to the animals we eat. "At one blow, the residue products of the slaughterhouses went from having considerable value as an ingredient in animal feed, to being either a waste disposal problem, or a much less valuable fodder ingredient," says Kjær Andreasen, managing director of Daka Biodiesel.

"Almost 70 million euro's was suddenly knocked off the value of the residue products from the slaughterhouses."

What had previously been a good and valuable residual product, because it could be turned into animal feed, could in future only be used in fodder for animals we do not eat, such as mink, cat food, etc. – and just a small part of it, as only about one-third of the waste could be used for that purpose.

Consequently, the Danish slaughterhouses, which own Daka, were obliged to search out innovative alternatives.

"Seventy million euro's is a lot of money, which just disappeared overnight. As a result, since 2001 we have been on the look-out for something that could make our products valuable again. We think biodiesel may be the right way," says Kjær Andreasen.

JOINT INTEREST

But it's not enough just to have a good idea. Even when Daka had made massive investments in the technology that makes biodiesel production possible, they still faced barriers in terms of accessing relevant markets. And this is where the Central Denmark Growth Forum entered the scene.

"Daka was trying to market a product to the oil industry which was unfamiliar to the industry and a competitor to oil," says Henrik Brask Pedersen, head of Environment, Technology and Infrastructure at Central Denmark Region.

"Moreover, the economic incentives for using the product were not in place, as biofuels are still more expensive than fossil fuels. As a result, they had problems accessing the market and getting their product tested."

The Central Denmark Growth Forum and Daka therefore consulted with the Danish Agriculture & Food Council, after which they entered into dialogue with the trade association of the Danish oil companies, and the Ministry of the Environment. The result of this dialogue was a desire to test out the market, by way of a demonstration project, which would help them to acquire all the experience they needed. For this purpose, Denmark's Road Safety and Transport Agency and Central Denmark Region jointly provided a grant of EUR 2.7 million for investments in infrastructure in the form of the tanks at filling stations, etc., which would enable the project to operate on a large scale in the Aarhus metropolitan area.

"We have a joint interest in this. In a regional perspective, it is important that we help to support companies from the agricultural sector, which is an important business in this area. At the same time, we know that from 2011 on, the EU will demand that 5.75 percent of the fuel used in the transport sector is derived from biological production. So the oil companies were also interested," says Henrik Brask Pedersen.

NUTS AND PORK CRACKLING

Companies like Daka have existed for a very long time; for as long as agriculture has existed, there has been a need to dispose of the carcasses of animals which have either died or were slaughtered at the farm. Similarly, the slaughterhouses have always been left with a residual product, once they had removed the cuts of meat we wish to eat.

One-quarter of Daka's raw materials comes from animals in agricultural production, and the rest from the residual products of the slaughterhouses.

The raw materials are put through a giant mincing machine, after which the water is evaporated and the fat squeezed out. From this a fat-based substance is manufactured, which comprises the basic ingredient in biodiesel. The end product is almost colourless, with an odour that could be described as half-way between rancid nuts and pork crackling.

"It smells a little unusual, but not when it is used. And it has the further advantage of emitting far fewer particles into the air than ordinary diesel," says Jacob Mogensen.

A CHEAPER ALTERNATIVE

And it is not only in Aarhus that you can drive with Daka biodiesel; in Funen some buses which run on it. Based in Aarhus, De Grønne Busser (The Green Buses) drive all across the region with a mixture of diesel and biodiesel in their tanks. The same goes for some of the milk tankers at Arla Foods, Denmarks largest dairy group.

"We feel it's a question of providing the Danish transport industry with a sustainable platform. In the long run, we will all have to run on electricity – there's probably no other alternative. But until the technology is sufficiently developed for us to make practical use of this in our daily operations, we will have to find a different solution in the short run. Biodiesel is a very good alternative here," says Kjær Andreasen.

"We don't have enough pig waste and deepfrying fat in Denmark to completely replace fossil fuels, but it can be part of the solution," he continues. "And a cheaper part of the solution than electricity is right now".

Enormous infrastructure investments will be required before we can drive using electricity – around EUR 13,500 per car. Biodiesel is much easier to use with the existing infrastructure. The cost of the infrastructure investment required is less than EUR 1,350 per car – corresponding to the extra cost of biodiesel during the lifetime of the car."

A GOOD STORY

In terms of image, the switch to biodiesel production has meant a lot to Daka. The company used to be known mainly as a place on the East Jutland motorway where passing motorists would hurriedly wind up their windows and turn off the ventilaton. But now the odour from the plant has been greatly reduced, and Daka's new venture is popular.

"It has given our company an image boost. Be fore, when our employees told people where they worked, the response might have been "Daka? That place that smells bad?", whereas now it is "Daka? Oh yes, you make biodiesel!" And that is rather more pleasant," says Kiær Andreasen.

"Another good aspect of this product in relation to, for example, vegetable biomass, is that this is biomass we already have. You don't need to use a field that might otherwise have been used to grow food. That has helped to lend legitimacy to our product," he continues.

So all that's left now is the prejudices, which are a bit wearying for the Daka employees.

There has hardly been a single IV item about biodiesel in buses which hasn't been accompanied by the sound of pigs grunting. It's a bit irritating. Driving with biodiesel is no more about stuffing dead pigs in your tank than shoes are about wearing dead cows on your feet. We feel it's rather more sophisticated than that."

A MIDWIFE ROLE

However, the project is not all the way home yet. The economic implications of producing biodiesel are still a long way from replacing the EUR 70 million that the slaughterhouses lost with the ban on animal proteins in animal feed production. In fact, a very long way:

"We have invested EUR 24.5 million in this plant, so it's been an expensive project. And even though we're making a profit, it's still nothing like the kind of money we were making on these products before the ban. We still lack the best part of EUR 70 million to close the gap," says Kjær Andreasen with a smile.

The story is also a good one for Central Denmark Region:

"We have been good midwives and have helped things to happen – getting Daka together with the oil industry. Now we know that the project can function on a large scale, so Daka and the oil industry can take it from here. Our role is now at an end," says Henrik Brask Pedersen.



Facts:

Biodiesel costs slightly more than traditional diesel; during the demonstration period it has cost between 9 and 20 euro cents more per litre, depending on the price of oil. However, as the amount of biodiesel in the tanks in Aarhus is just five percent of the whole, the actual difference for the motorist is just 1 euro cent per litre.

What's more, the use of biodiesel helps to keep the price of fossil diesel down, so in the final analysis it will probably be cheaper for the consumer.

The B5Next project, which is the name of the collaborative venture on biodiesel, is supported by Denmark's Road Safety and Transport Agency and the Central Denmark Region. Apart from Daka Biodiesel, the other partners in the project are Shell Denmark, the Danish Petroleum Association, Kuwait Petroleum Danmark, OK, Statoil Denmark, Statoil Automat Danmark, and YX Energy. The project's administration is undertaken by CBMI (the Centre for Bioenergy and Innovation in Environmental Technology).

B5Next has asked 100 persons in Aarhus whether they would be willing to pay more for their fuel in return for a greater proportion of biodiesel in the tank. The vast majority replied that they would.

Daka sells ten percent of its production on the Danish market, while the rest is sold on the international market in Rotterdam. If Daka sold all its production in Denmark, it would account for two percent of the total Danish diesel consumption. Together with the rape seed oil refinery in Emmerlev in Funen, Daka can provide enough diesel for around six percent of the Danish consumption. EU goals require that ten percent of diesel consumption is based on biomass by 2020.

"We don't have enough pig waste and deep-frying fat in Denmark to completely replace fossil fuels, but it can be part of the solution. A cheaper part of the solution than electricity is right now."

Kjær Andreasen, managing director, Daka Biodiesel

Bioficient Bioficient WITH NO BAD AFTER-TASTE

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

Fuel manufactured from biomass has been accused of causing soaring food prices because crops are grown to produce fuel instead of food. A new project aims to analyse the potential of producing biofuel from resources that cannot be used for food cultivation.

"By their nature, meadows are located in lowlying areas, where the soil often contains a very large amount of nutrients. By planting crops which can make use of these nutrients, we ensure that less is flushed out into the waterways. That is a good environmental argument. Then there is the energy-related perspective, in that we can harvest a crop to obtain biomass, which can then be used for biofuel."

Kathrine Hauge Madsen, centre director, AgroTech

hen we use energy in the future, it will not be pumped up from the ground or stored in barrels; it will be borrowed from the wind, created by the sun – and harvested in the form of biomass which can be turned into biofuel.

The work of harvesting energy is naturally of great interest to AgroTech, an approved technological service institute, which provides impartial, research-based guidance and technological services within such fields as agriculture and foodstuffs.

But harvesting biomass for energy is not the only aim; improving the environment by cultivating biomass is another, parallel goal.

Kathrine Hauge Madsen, centre director of AgroTech, is responsible for a joint Nordic project which will experiment with harvesting biomass in environmentally sensitive areas, focusing on grass and willow, respectively. The willow will be specially planted, while the challenge with grass, which we already have, is to find the best way to harvest it.

Central Denmark is beginning to see the potential of exploiting environmentally sensitive or unused areas for biomass production. One part of the project deals with planting around 1,500 hectares of willow in the uplands of Ringkøbing Fjord and Nissum Fjord, while the other part of the project will experiment with harvesting up to 1,000 hectares of grass along the banks of the Nørreå River between the cities of Viborg and Randers.

"If we achieve the results we are hoping for – that is, if the economic and ecological aims support each other – the meadow grass project in Nørreå could be scaled up to encompass very large parts of the 150,000 hectares of land of this type that we have in Denmark," says Kathrine Hauge Madsen.

NO LOSS OF FOOD

And before there is an outcry, let us say straight away that this is not biomass production based on edible crops which are subsequently turned into biofuel. "By working with grass and willow, we are utilising resources that exist already, and we are getting more out of areas that are not suitable for food production," points out Søren Ugilt Larsen, head of the willow project with AgroTech.

Both projects, however, must combine energy production with protection of the environment.

"It's a question of thinking holistically, rather than in individual elements," says Anders Buhl-Christensen, deputy mayor of Randers and a member of the Central Denmark Growth Forum.

"The Danish Parliament has been approving comprehensive water environment plans for many years. These two projects represent an alternative way of viewing environmental improvements. Here, we are trying to create a form of industrial development, one of the byproducts of which is environmental improvement," he continues.

The goal is also to develop tools which the municipalities and others can use in connection with the implementation of the EU water framework directive.

"It extends the range of possibilities from merely being a matter of bans and regulations," says Anders Buhl-Christensen.

WIDE POTENTIAL

There is thus a great deal of potential in making use of meadow areas for this purpose, which conveys several benefits.

"You could for example look at it from an environmental perspective; by their nature, meadows are located in low-lying areas, where the soil often contains a very large amount of nutrients. By planting crops which can make use of these nutrients, we ensure that less is flushed out into the waterways. That is a good environmental argument. Then there is the energy-related perspective, in that we can harvest a crop to obtain biomass, which can then be used for biofuel," says Kathrine Hauge Madsen, to which her colleague Søren Ugilt Larsen adds: "There is also the aspect of tending and caring for our meadow areas, either by harvesting or mowing, in order to secure a high diversity of plant and animal life. If we fail to do this, the areas will eventually be dominated by rushes, which is rather dull. So if we want to have interesting and varied natural surroundings, we have to tend them. A fourth perspective is that by using biomass to manufacture biofuel, we also obtain large amounts of nutritious residual products, which can then be used as fertiliser in ecological production."



Facts:

The 'Biomass from Meadows' project was launched at the start of 2008, and will run until 2012, with both environmental and energy-related aims. The project's budget is approximately EUR 4.8 million, of which just under EUR 3 million is earmarked for the willow project, and just over EUR 1.9 million for the grass project. The partners behind the project include KASK (Interreg IVA - the Kattegat-Skagerak programme), the Central Denmark Growth Forum, the Danish Food Industry Agency and the owners of the meadow areas.

The Central Denmark Growth Forum is supporting the project with the aim of testing the relevant technologies at a full-scale level. In a report published in December 2008, the Ministry of Food, Agriculture and Fisheries recommended that 100 times as many energy willows should be planted in Denmark (150,000 hectares) than was done in the project in Central-Jutland.

RUN YOUR OWN

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

A number of major Danish companies are working to make biofuel-powered micro-heating plants the home heating systems of the future.

n the Danish towns of Vestenskov and Sønderborg, a group of ordinary consumers are testing and demonstrating a product whose marketing potential is quite dizzying.

The question of its potential is one we will return to. What is being tested in Sønderborg is the use of bioenergy for micro-heating plants in private households, while in Vestenskov, a similar system is being tested which draws its energy from wind turbines.

In simple terms, the oil and natural gaspowered central heating systems which today heat 750,000 Danish households will be replaced with micro-heating plants which will supply both electricity and heat to the homes via fuel cells.

It sounds like a challenging task, and it is. What's more, it involves major investments. Right now, a micro-heating plant for private use costs between EUR 95,000-105,000, and a device like this has to be installed in every single test home taking part in the project. Quite a tidy sum is thus involved for anyone interested in exploring the possibilities and potential of this particular market. For this reason, the Region of Southern Denmark has decided to support the project financially via the Southern Denmark Growth Forum.

"Our job is to support local trade and industry, preferably in harmony with some of our own goals," says Anders Bræstrup, regional development consultant.

"This project helps us to advance two aims. Firstly, we are supporting the region's many mechatronics companies, i.e. companies that produce mechanical and electronic components for various kinds of energy solutions. And secondly, we are helping to create more growth through new energy technologies. Therefore, the Southern Denmark Growth Forum supports the project enabling us to find out whether theres is a market," says Anders Bræstrup.

A LARGE MARKET

So far, the region has done this by contributing EUR 725,000 to a development project, which from January 2009 until September 2011 will analyse the potential of using bioenergy in micro-heating plants. "It is definitely very promising. In Denmark we have 750,000 oil or natural gas-powered heating systems which could be replaced, but in Europe the potential is vast. Around five million units of this type are replaced every year."

Per Balslev, managing director, Danfoss Fuel Cell Business

"We cannot contribute in a way which distorts competition," Anders Bræstrup continues, "so we are often involved at an early stage of the development process, when the end product is still some way off. The contribution of the growth forum to this project has been to help to qualify the idea."

Subsequently, a number of major Danish companies related to the energy sector have chosen to participate, including Danfoss, which has high expectations when it comes to the results of the project.

"It will be interesting to see whether we can get this to work on a commercial basis," says Per Balslev, managing director of Danfoss Fuel Cell Business.

"So far, this kind of equipment is still too expensive for people to install without subsidies, but we hope that in the course of the project we will be able to pass rapidly through several stages of development, so that we can obtain a reliable picture of the potential of this type of installation."

Currently, it is expected that micro-heating plants will be installed in around 100 homes in Vestenskov and Sønderborg during the test period. Each of these installations currently costs between EUR 95,000 -105,000, but Danfoss expects the price to fall considerably in the long run.

"Naturally, the price of the installation is a factor which is decisive for whether its great potential can be realised. When we reach a stage, at which we are able to mass-produce the product at a price around EUR 7,000 each, it will become commercially interesting," says Per Balslev, "It is definitely very promising. In Denmark we have 750,000 oil or natural gas-powered heating systems which could be replaced, but in Europe the potential is vast. Around five million units of this type are replaced every year, so if we could sell just a small proportion of these at EUR 7,000 each, it would be an interesting market," says Per Balslev. •



Facts about the micro-heating plant project:

The project "Use of Bioenergy in Micro-heating Plants" is part of the national project "Danish Micro-heating", which is targeted at developing and testing micro-heating plants based on fuel cell technology. The national project has been awarded a EUR 6.7 million grant by the Danish Energy Agency, and includes companies in the energy sector such as DONG Energy, COWI, Topsøe Fuel Cell, IRD, SEAS-NVE and DGC.

Besides Danfoss, Aalborg University Esbjerg, Sønderborg Municipality, Syd Energi and Dantherm Power are also taking part in the regional bioenergy part of the project, and via its growth forum, the Region of Southern Denmark has helped to ensure financing for the project.



ENERGY RENOVATION

"Plan C has the potential to turn the Capital Region of Denmark into a leading centre for energy-conserving renovation, and at the same time contribute to enhancing the competitiveness and growth of Danish construction on the global market."

Jørgen Christensen, chairman, Capital Region Growth Forum

Gate 21

PLAN A PLAN B PLAN

without barriers

BY: SIGNE MARKVARD / PHOTO: LARS H. LAURSEN

Green construction projects can easily be based on existing buildings. In the Capital Region of Denmark 'PLAN C' aims to reduce energy consumption to just under one-third by renovating existing buildings. "We need to take a good look at the buildings we already have, instead of just using eco-friendly plasters. Renovation is a holistic project," says architect Signe Kongebro, who has been helping to compile the Capital Region's new project on energy-conserving renovation, 'Plan C'.

The idea is to create a renovation plan which goes beyond the plans we have seen up until now. Plan C will create a powerhouse in energy-conserving renovation, and by experimenting with large-scale urban renewal, it will develop concepts, processes, materials and technology which can be disseminated and applied by a broader group of players.

"We need to look at the big picture, and include all the details. That will help us to repeat the same exercises very efficiently and quickly later on," says Signe Kongebro. Gate 21, the former Environmental

Gate 21, the former Environmental Knowledge Park, will be responsible for the implementation of Plan C until 2013, and together with 36 partners, will develop, test and demonstrate new solutions within energy-conserving renovation in the seven municipalities of the Vestegnen-area (i.e. seven suburbs west of Copenhagen) taking part in the project.

of Copenhagen) taking part in the project. "Plan C includes a number of demonstration projects, in which various solutions will be presented within the areas of ventilation and cooling, heating systems, lighting and sustainable energy, as well as climate shields, facades and roofing. The idea is to provide inspiration and demonstrate ways in which we could plan construction in the future," says Jørgen Christensen, chairman of the Capital Region Growth Forum, one of the major investors behind Plan C.

"As a project, Plan C has the potential to turn the Capital Region of Denmark into a leading centre for energy-conserving renovation, and at the same time contribute to enhancing the competitiveness and growth of Danish construction on the global market," he continues.

SOLAR CELLS ON THE ROOF

Around 40 percent of Denmark's current energy consumption takes place in buildings. Through energy-conserving renovation, however, energy consumption could be reduced to just under a third of its present level.

In the municipality of Albertslund the first home renovations have already been completed, and provide proof that energy-conserving renovation can be both simple and inexpensive. In the coming years, the municipality faces a comprehensive renovation of its existing housing stock from the 1960s, 1970s and 1980s, for which reason nine test homes have been selected to function as experience-generating projects before the large-scale renovations are initiated.

"We can thereby contribute tried and tested solutions, and create a revitalisation of the town. In two of the test homes, we have actually succeeded in cutting energy consumption by 73 percent," says Anne Marie Holt Christensen of Albertslund Municipality's Technical and Environmental Administration. "It is also important that we begin to measure other dimensions besides energy savings. We have seen before how enhancing the indoor climate and lighting in schools can improve children's learning abilities. In other words, we should also consider the 'non-energy benefits' and secondary effects that extend beyond the actual hole in the wall that lets in more daylight"

Signe Kongebro, architect, Henning Larsen Architects

With their re-insulated facades, roofs and crawl spaces, the two Albertslund homes stand out from among the council homes on the Bjørnens Kvarter estate. Low-temperature district heating and solar cells have also been installed in the houses.

GAINS RIGHT ACROSS THE BOARD

As Plan C continues to gather knowledge, this will be tested on 10 to 15 selected projects, mainly in the Vestegnen-area, which during the coming years will see billions invested in renovation. At the same time, the renovations will also serve as large-scale demonstration projects, in which new forms of ventilation, lighting, district heating, facades and roofs will be realised and presented to the public. The project is also intended to create a seed bed for new export products within the fields of solar heating, solar power generation and district heating.

"It is a question of looking at how much we can get out of the existing buildings. From our point of view, there is no major difference between renovation and constructing new buildings. The buildings have to be used in the best possible manner, without becoming too expensive to live in," says Signe Kongebro.

Via the project, all of the involved parties will beat a path through the legal, cultural and technical barriers which today can make it difficult to carry out energy-conserving renovation tasks.

"It is also important that we begin to measure other dimensions besides energy savings," Signe continues. "We have seen before how enhancing the indoor climate and lighting in schools can improve children's learning abilities. In other words, we should also consider the 'non-energy benefits' and secondary effects that extend beyond the actual hole in the wall that lets in more daylight."

By the summer of 2010, Plan C expects to have gathered a sufficient foundation of experience to begin specific construction projects. "Our goal is for the knowledge we gain to be so well-honed, competent and up-to-date that Gate 21 will pop up as the first hit in the search engines when people around the world search on the term 'energy-conserving renovation'," says Peter Terman Petersen, regional director at COWI, a leading Danish engineering consultancy company and one of the partners behind Plan C. •



Facts:

- Around 40 percent of Denmark's current energy consumption takes place in buildings. It is estimated that energy-conserving renovation could reduce energy consumption to just under a third of its present level.
- 'Energy-conserving Renovation Plan C' is intended to turn the Capital Region of Denmark into a leading centre for energyconserving renovation, make the Danish construction industry more competitive, and generate growth on global markets.
- The project aims to create a network of around 1,200 companies, knowledge environments and companies which can establish contacts and a basis for new products and services within the area of energy-conserving renovation.
- The project has a budget of approximately EUR 5.2 million, spread over 3½ years. Approximately EUR 3.9 million has been procured via the Capital Region Growth Forum, including EUR 2.5 million from the European Regional Development Fund.
- Lead-partner behind PLAN C is Gate 21. In addition, 36 companies, municipalities, organisations and institutions are also participating, including the City of Copenhagen, the municipalities of the Vestegnen-area, the Danish Construction Association, Henning Larsen Architects, COWI, Vestegnens Kraftvarmeselskab I/S, DTU Byg, the Copenhagen Business School, the Alexandra Institute, the Danish Technological Institute and Copenhagen Capacity.

Green visions fly on

BY: SIGNE MARKVARD / PHOTO: LARS H. LAURSEN

Lolland aims to become one of Europe's leading test environments for algae production – for example for aircraft fuel. Power from wind turbines will make the difference.





The sea's own fuel

Algae develop via a process of photosynthesis, in which nutrients, water and CO₂ are turned into sugar compounds or biofuel molecules with the help of light. During their growth, the algae absorb CO₂ which is later released through combustion. Algaebased biofuels are thereby much more climate-friendly than traditional fossil fuels.

> Test environment Lolland

an Stand and

co-friendly aircraft that take off with a tankful of algae fuel: this futuristic scenario, which just a few decades ago was merely an idealistic thought experiment, is now well on its way to becoming a reality. Airlines such as Continental, Virgin Air-

lines and Japan Airlines have already made successful test flights using biofuel, while SAS, together with fifteen other airlines and the aircraft manufacturer Boeing, work to promote algae-based aviation fuel on the market.

Meanwhile, right down to earth, and buried up to their elbows in the latest initiatives, is the energy community of Lolland, which is where we find one of Europe's test environments for the cultivation of algae for energy.

FLYING SINNERS

Aircrafts require cleaner fuel than cars, trains and ships, so aircraft fuel must meet much higher standards. Biofuels based on algae have already been tested in small jet-powered passenger aircraft, using a 50 percent blend of normal fuel and biofuel. The results have been promising, and comprise an important step on the road towards the goal of the large airlines to greatly reduce the CO_2 emissions from aircrafts, and eliminate them completely in 50 years' time – even despite the fact that international air-traffic is expected to increase substantially over the next decades.

Today, aviation is one of the big sinners in the global CO₂ balance book. According to the United Nations' Intergovernmental Panel on Climate Change, IPCC, civil aviation accounts for around 2 percent of the world's emissions of man-made greenhouse gases, and the figure is expected to reach 3 percent by 2050. It was with this in mind that an international research workshop held on Lolland in 2009 opened up the floor to debate and visions. Scientists from the USA, Japan, China, Germany, Spain, Israel and Denmark gathered here to discuss the possibilities and perspectives of cultivating algae as a new renewable source of energy.

THE WHOLE WORLD'S PROJECT

The workshop, which was realised with the help of funding from Growth Forum Zealand, really put Lolland on the world map. The aim of the algae project is to develop techniques for cultivating, harvesting and drying biomass.



This biomass can then be used for industrial purposes, such as the production of biogas, liquid fuels, chemicals, food products, animal feed and health and beauty products.

The reason for the great international interest in biofuels based on algae is that the CO_2 it produces is environmentally neutral, compared to traditional fossil fuels. During its growth, the algae stores large amounts of CO_2 through photosynthesis, and this CO_2 is released again when the fuel is combusted.

The new areas set aside for the cultivation of algae are one of the attractions which now draw between 20 and 100 guests a week to Lolland for the so-called 'Energy Tours', on which visitors receive a guided tour of the development initiatives that the little community has launched in the areas of hydrogen and biofuel.

"Next week two foreign ministries, 168 secondary school students, and a housewives' association will pay us a visit," says Leo Christensen, project manager with Lolland Municipality.

Today's guided tour is for members of the Danish Society of Engineers (IDA), who will be visiting the dykes in Onsevig.

"If sea levels continue to rise, one third of the island of Lolland will disappear; it's as simple as that," says Leo Christensen, turning to the tall dykes that guard the coastline against the violent waves. The area behind the dykes is being used for experiments with algae pools, and a number of universities are collaborating to investigate the growth of particular kinds of algae.

ALGAE UNDER THE WIND TURBINES

The Lolland Municipality is working to make use of the areas underneath its off-shore wind turbine parks, as these provide ideal growth conditions for algae. The combination of electric power, sunlight and large amounts of nutrient salts in the sea water creates an optimum environment, and allows the municipality to make use of areas which would not be used for other purposes.

"The electricity from the wind turbines gives us new possibilities to experiment with algae growing, as it makes it easy to combine the cultivation with pumps and lighting. This could produce results we have not seen before," says Leo Christensen.

Another idea is to cultivate algae at district heating and sewage treatment plants, which can provide the algae with favourable growth conditions. Roskilde University, Aalborg University and Flensburg University are joining forces to cultivate algae for biofuel at a district heating plant at Søllested on Lolland. The project combines the heat and CO_2 of the plant's exhaust gases with sewage, which contains all the nutrients that the algae need in order to grow.

"It would be a beautiful world if the sewage of the big cities could become aircraft fuel in the airports of those same cities," says Leo Christensen. "It will be a long time before we get that far, but the technology and methods do already exist."

Besides the fact that biofuel based on algae is CO_2 neutral, its production does not take up

valuable areas of agricultural land. The rising demand for biomass produced in arable crop areas has in some periods caused food prices to rise, with serious consequences for a number of third world countries.

"These results can be disseminated to those parts of the world where they are really needed. There is enormous potential in cultivating algae as biomass, and thereby increasing our energy resources," says Leo Christensen. •



Aviation's green accounts

According to the United Nations' Intergovernmental Panel on Climate Change, IPCC, civil aviation accounts for around 2 percent of the world's emissions of greenhouse gases. If all SAS aircraft were powered by biofuels, it would reduce the company's annual emissions of CO_2 from 5.7 million tons (corresponding to 10 percent of Denmark's total emissions of CO_2) to just over half that figure. The goal of SAS is to reduce its CO_2 emissions by at least 20 percent by 2020, and in the long run to achieve CO_2 neutrality in its flights.



Climate strategists take up the fight

BY: SIGNE MARKVARD / PHOTO: LARS H. LAURSEN

With a new climate strategy, Region Zealand and 17 municipalities in Zealand have created the common ground that is essential to efficiently confront climate change

 he 17 municipalities of the region came together, discussed, and finally found agreement.

Region Zealand thereby became the first region in Denmark to draw up a common regional climate strategy, containing visions, goals and concrete action plans of action for ways in which we can adapt to climate change, and in particular, counteract it.

"We have succeeded in these efforts thanks to some enthusiastic front runners from the whole region, and because the Regional Council and the municipalities really wanted this to happen," says Per Bennetsen, director for regional development at Region Zealand.

This major, decisive task was solved through collaboration between the region and a number of ambitious, climate-active municipalities in Zealand such as Roskilde, Lolland and Kalundborg, who acted as the driving force behind the compilation of the Zealand climate strategy.

SERIOUS CONTRIBUTIONS

"It's been a perfect process," says Claus Steen Madsen, Director of Technology, Development and Culture with Kalundborg Municipality.

"It is incredibly difficult to coordinate the efforts of 17 municipalities, but with the commitment and support of the Municipal Contact Council (KKR), we succeeded. Everybody also contributed to the new strategy, so that it was given a firm foundation in which we all feel a sense of ownership."

The goal of the strategy is to promote the use of renewable sources of energy, and create a co-ordinated response to climate changes which will affect the development of the entire region. One of the initiatives has been to set up a regional climate network for technical staff who work with climate-related issues. Here, too, it is a question of exchanging experience and sparring.

"The individual municipalities and the region as a whole can save part of their energy budgets, but what really makes a difference is when everyone contributes, so that we can present a united front as a region, and show others the best way to tackle climate change," says Per Bennetsen.

The climate strategy

The climate strategy is based in the Regional Development Plan for the Region Zealand, and was adopted in the spring of 2009 by the Regional Council and Municipal Contact Council of Zealand.

The strategy has three overall goals:

- Long-term restructuring of the energy system into a system based on persistent sources of energy
- Co-ordinated response to ongoing climate changes which impact the region's development
- Development of new climate-innovative products, services and system solutions in the region

The focus areas of the climate strategy are:

- Energy Systems
- Agriculture
- Industry
- Transport
- Cities and Buildings
- The Open Landscape
- Health and Contingency
- Internal Activities

The strategy has now been adopted; an organisation has been created, and a steering committee has been appointed for the implementation. The next step will be the realisation of the strategy's contents and targets.

"We have been able to do something for each other and for the environment across the boundaries of the municipalities. The goal is naturally to involve even more parties, so that we can tackle climate change together," says Per Bennetsen.

We create workplaces – and a better environment!

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

Hydrogen technology is one of the most promising avenues of research in the quest for climate-friendly sources of energy. One corner of the hydrogen technology is based in Hobro – but here the climate is not their main concern.

Aalborg University

30 | regions

"Sometimes it sounds like gibberish, when they start talking about hydrogen. Half an hour may pass by at a meeting during which I've understood nothing at all. My job is then to say: "Fine – but what can we use it for?" We have to keep that aspect in mind all the time. The borderline between research and practical application is where things happen."

Lars Udby, director, Cemtec concerning meeting sessions with the two major companies at Cemtec; Dantherm Power and Serenergy



You aren't in the company of Lars Udby very long before you hear his favourite mantra: "We create workplaces. That is what we are here for, first and foremost. The fact that it also produces some useful spin-offs in the form of eco-friendly products and a great store of knowledge is a bonus which makes us pleased and proud. But we are not here to save the world," says Lars Udby, who is the director of Cemtec, the Centre for Energy and Materials Technology located in Hobro in northern part of Denmark.

Lest you haven't heard, he repeats it: "We are very aware of the fact that we cannot live by knowledge alone. You can only live of knowledge when it has been translated into services or products that can be sold."

So far, so good – we have clearly understood the aim of the research and production efforts in high-temperature fuel cell technology taking place in North Jutland under the slightly awkward name of "HeatPhase 2". HEAT stands for Hydrogen Economy and Applied Technology centre.

HOT HYDROGEN

Here, in the middle of a roundabout in a scenic, hilly landscape near Hobro, Cemtec is the centre responsible for focusing on and providing support for targeted efforts to find a technological niche.

"It's a long way to the nearest university, and we have problems attracting graduates. We took a look at Ringkøbing, located in western Denmark, and saw what they were doing in wind turbine technology. They were specialising, so we decided to do that, too. Our choice fell on hydrogen and high-temperature fuel cell technology," says Lars Udby.

It was more or less by chance that Cemtec chose hydrogen – but it is far from accidental that their partner, Aalborg University, is working with the same element. Aalborg University has been conducting intensive research into hydrogen and fuel cells for the past decade – efforts which have so far borne fruit in many different respects, both at the university and at Cemtec. They have for example managed to transform uncleaned biogas into hydrogen, demonstrated fuel cells for aircraft in Germany, and have got an electric car to run on hydrogen and fuel cells. Many of these results have been produced through co-operation between the university world and the companies at Cemtec.

Professor Søren Knudsen Kær is head of the research programme into fuel cell systems at Aalborg University and co-ordinator of the North Jutland Hydrogen and Fuel Cell Centre (H2FC), and he is enthusiastic about collaboration between scientists and the business community:

"The sparring is valuable for both parties. Attempts to solve the problems of companies often produce interesting educational situations. And we can offer new knowledge, which these companies can then apply in a context that we had not foreseen. It all produces excellent dynamics," he says, adding:

"In the absence of Cemtec, we would have had no cluster effect – the concentration of knowledge and companies which makes this area interesting for us. Furthermore, without Cemtec, we probably would have had little reason to drive to Hobro."

60 WORKPLACES

And the aim to create workplaces has also been achieved. Today, Cemtec houses the companies Serenergy and Dantherm Power, which employ 60 people between them, mainly engineers. The two companies originated in Støvring and Skive respectively – both towns are located in the region - but have moved in together to pursue joint efforts. Serenergy makes fuel cells, while Dantherm Power uses these cells in the systems it creates:

"We cooperate a lot, and there is a great mutual exchange of ideas," says Peder Rasmussen, civil engineer and test manager with Serenergy. "When we are here together, we can make use of our common skills in joint projects and knowledge sharing. There are many advantages for us in that."

A common process

The two projects, HeatPhase 2 and the North Jutland Hydrogen and Fuel Cell Centre, were founded in 2007 with funding provided by the North Jutland Growth Forum, as a conscious investment in hydrogen and fuel cell technology in North Jutland. The projects also recently received a total of just under EUR 2.5 million in support from the European Regional Development Fund for their activities, which makes them the biggest investments of the North Jutland Growth Forum in the area of energy.

Together, the two initiatives cover the entire field from industrial research and development to demonstration and commercialisation. The project helps to spotlight North Jutland as one of Denmark's leading centres of hydrogen and fuel cell technology.



is the capital of the green cycle

BY: SIGNE MARKVARD / PHOTO: LARS H. LAURSEN

Bornholm's waste is becoming valuable. A new bioethanol plant has been launched to generate CO₂-neutral energy and extract ethanol from waste – with citizens playing an important role.

tractor slowly shovels its way through the mountains of this month's gossip columns in the grey hall of the Vestermarie recycling station. Further along the line, the hands of two Bornholm men take over the work. With practised hands, they remove the glossy magazines before the piles of paper and cardboard disappear into streamlined bins. The result towers up outside, like columns in a giant game of Tetris with nature: sorted waste is Bornholm's new gold.

This new bioethanol demonstration plant in the village of Aakirkeby on the Danish island of Bornholm has been established by the Danish company Biogasol. The plant, BornBiofuel, represents the next step along the road to a full-scale commercial bioethanol plant, which is expected to cost just under EUR 36 million. In the future, people will be able to deliver their waste here, and in return receive eco-friendly petrol, green energy and cold cash.

The BornBiofuel project, which is co-funded by EUDP (the Danish Energy Authority's Energy Technology Development and Demonstration Programme), aims to make 'the bright green island' even greener in future.

THE PETROL OF THE FUTURE

"BornBiofuel will be a new cornerstone in the international branding of Bornholm," says Thor Gunnar Kofoed, managing director of the company.

The vision is to create a sustainable cycle, in which farmers, companies and citizens will deliver grass, garden refuse, paper and wood to the plant. The biomass will then be transformed into energy, primarily in the form of bioethanol, which can be used as fuel for vehicles. But the plant will also create electricity, heat and wooden pellets, which will be returned to the Bornholmers. As BornBiofuel is a so-called second-generation plant, which uses biomass from plants rather than food, the process produces no waste.

Today, wood, paper and cardboard is transported from Bornholm to Grenå (on the Danish mainland) and Sweden to be recycled. But now, all that must end. The new plant will be much more CO₂-friendly, as the involved processing, transport and incineration can now be dropped.

> However, the posters with their colourful arrows illustrating the eco-friendly cycles of the future still only hang on the walls of the empty halls of the BornBiofuel plant. All of the processes must be scientifically tested before the new plant can open – and the results obtained in the laboratory will have to be scaled up 40,000 times. "It is a lot of work, because we want to be 100 percent ►

> > Sorted waste from citizens on Bornholm helps to fuel the island's new bioethanol plant. Bornholm Growth Forum has secured funding for a project to study how best to motivate people to contribute.

Bornholm Bioethanol

"BornBiofuel will be a new cornerstone in the international branding of Bornholm,"

Thor Gunnar Kofoed, managing director, BornBiofuel



sure that everything will work exactly as it is supposed to from the day we open the plant. After that, it's up to the people of Bornholm," says Thor Gunnar Kofoed, who expects construction to begin on the new plant in 2010.

INQUISITIVE AND OPEN-MINDED

BornBiofuel aims to create 50 new workplaces in Bornholm, and in particular, to save so much CO_2 that it will attract international attention. However, the participation of the local community will be the most important factor deciding how the project develops in future.

"The crucial thing is that Bornholmers

"This could create a revolution in the whole concept of the role of waste in society"

Ole Morten Petersen, director of Bornholm's refuse department, BOFA

continue to be open-minded and inquisitive towards the project," says Tobias Lau, managing director with the innovation company Social Action, which is holding a user survey to measure how enthusiastic Bornholmers feel about delivering the raw materials to the new plant and using its end products.

If not enough local waste can be delivered to the new plant, BornBiofuel may need to import waste from the Baltic nations, which again would have a negative impact on the local ecocycle.

Via the Bornholm Growth Forum, Biogasol has therefore received funding from the European Regional Development Fund and the programme User-Driven Innovation (administered by the Danish Enterprise and Construction Authority) for the project "The User-Driven Second-Generation Bioethanol Plant". During the period 2008-2009, the project will investigate the best ways in which to motivate the local community to contribute to the cycle.

The knowledge acquired through the project will subsequently be applied in other peripheral areas of Europe planning to construct similar bioethanol plants.

NEW MANTRA

Although the survey is still under way, all the indications are that a particularly important factor will be getting farmers to deliver straw to the new bioethanol plant. The public authorities are another important partner, as grass cut from the island's roadsides could provide an important source of energy. The logistical jigsaw puzzle accompanying the green initiative will thus be a major challenge.

"The questions include who is going to collect the grass, what machines they can use for this, and how we can motivate everyone to take part. We need to find some solutions which will make it easy for all parties and motivate them to contribute to the project," says Tobias Lau.

Much of the waste will continue to come from the waste collection stations which already exist in Bornholm. These will function as collection points for the users' waste, passing on sorted wood, paper and refuse from gardens and parks to the bioethanol plant. Here, too, they are looking forward to the future partnership.

"This could create a revolution in the whole concept of the role of waste in society," says Ole Morten Petersen, director of Bornholm's refuse department, BOFA.

"The mantra in the waste debate has always been: if paper and cardboard can become paper and cardboard, that's the best we can do. But in Bornholm there are signs that we can do it even better," he concludes. •



From waste to green energy

The Bornholm Growth Forum and the Bornholm Agricultural Association developed the idea of a bio-experimentarium in which waste products from agriculture, industry and households could be transformed into energy.

The Danish company Biogasol has founded BornBiofuel, which will be responsible for constructing a demonstration plant in Aakirkeby in Bornholm, where the ideas will be realised.

The demonstration plant will produce bioethanol, which can be mixed into petrol, as well as wooden pellets which the Bornholmers can use instead of those that are currently imported into the island. The plant will also produce electricity and heating.

BornBiofuel is a so-called second-generation plant, which uses biomass from plant materials such as grass, garden refuse, wood chips, cardboard, paper and waste from the biogas plant. The plant does not use waste food, and thus produces no waste products.

The plant is mainly based on residual products which currently cost money and energy to dispose of. By transforming these residual products into energy instead, the process saves CO₂.

CLIWAT

groundwater - an overlooked threat

BY: SUNE FALTHER / PHOTO: LASSE HYLDAGER

The debate on adapting to climate change has mainly focused on the rise in sea level, but rising levels of ground water also present a challenge. The Central Denmark Region is leadpartner in a cross-national project which aims to gather more knowledge on the effects of climate change on groundwater.

When the the test of the debate on climate change has focused on the need to reduce our CO_2 emissions, so that we can mitigate the worst damage to our climate. It is understandable that this has been the main area of concern, as the effects are so obvious. The serious flooding caused by storm surges in the sea, or the damage caused to waterways and drains by the increasingly heavy rains, are effects of climate change that everyone can see and understand.

Changes in our groundwater, on the other hand, and thereby changes in fundamental factors affecting our supplies of drinking water and the way in which we construct our roads and buildings, have tended to be overlooked.

However, the Central Denmark Region is working to change that. Together with a number of partners in Denmark, Germany, the Netherlands and Belgium, the Central Denmark Region has set itself the task of finding out what will happen to our groundwater in future, and how we can adapt to climate change in this area. The international co-operation is occurring under the auspices of the CLIWAT-project (i.e. CLImate and WATer), which is supported by the European Union.

"The challenges are serious, and they affect us all, so it makes sense to confront them at an international level," says Rolf Johnsen, a geologist with Central Denmark Region, one of the founders of the CLIWAT-project. "There are several aspects of extreme weather conditions which are best tackled through regional cooperation."

ENOUGH CLEAN DRINKING WATER?

So far, the countries taking part in CLIWAT, have invested EUR 5.4 million – half of which has been provided by the the Interreg IVB programme under the European Regional Development Fund – in seven pilot areas, which until the end of 2011 will each investigate separate issues. Along the way, their experiences will be shared via a joint monitoring group. The core aim of the Danish part of CLIWAT is to investigate the effect of climate change on groundwater.

"During summer drought conditions, it may be necessary to draw groundwater from a larger catchment area in order to ensure that there is enough," says Rolf Johnsen. "That means we must make sure that the water is clean, and that it will continue to be so. In addition, we must ensure that the increased rainfall in winter can be adequately drained away; otherwise, many towns in low-lying areas, such as along the east coast of Jutland, will experience major flooding problems."



Facts:

Our groundwater is a hidden resource in the ground beneath us. In contrast to extreme weather events like storm surges in the sea or powerful flooding, changes in groundwater tend to be more gradual. Nonetheless, these changes can be of crucial significance to the way we organise our society in future. **Danish Regions** Dampfaergevej 22 DK-2100 Copenhagen

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