Second volume
Sixth issue
February 2005

FiB
Bioenergy research

New strategy for liqued biofuels 2

The infection risk of manure separation 4

Tar-free gasification – the road to success 6

BiogasForum Öresund – a platform for cooperation on biogas 8

Decreased funds for biomass

In 2005, biomass will be granted considerably fewer subsidies under the PSO scheme than in 2004. This is true for the pool of DKK 59 million administered by Eltra as well as the DKK 35 million distributed by Elkraft.

Eltra and Elkraft have now determined how the PSO funds for 2005 will be distributed. The total amount is DKK 94 million, which, pursuant to the electricity act, the system operators collect via the electricity bill.

For a number of years, biomass has been granted most subsidies, but from 2005 that will change. In 2004, Eltra allocated a good DKK 24 million to biomass, but this year only DKK 5 million will be spent in this area. In turn, the subsidies for waste will increase from DKK 2 million to nearly DKK 19 million, and fuel cells will also be granted more funds in 2005 than in 2004.

The tendency is the same at Elkraft. Here biomass and waste belong to the same pool, so the figures are not quite comparable with the amounts granted by Eltra. In the past three years, Elkraft has spent approx. DKK 18 million on biomass and waste, but this year only little less than DKK 8 million has been allocated to this area.

According to Klaus Rosenfeldt Jakobsen from Eltra, the change is partly due to the fact that the subsidies to the large power plants have been cut. The tendency is towards making these plants pay for a larger part of their research and development activities.

- We still spend quite a lot of money on gasification, where we have a demonstration programme, but we also try to focus on fewer areas, says Klaus Rosenfeldt Jakobsen.

One of the gasification projects that will be granted subsidies in 2005 is the Viking gasifier, which is covered on page 6. Furthermore, TK-Energi will be granted subsidies to develop a gasifier that will be mounted at a CHP plant in Gjøl in North Jutland, and BioSynergi Proces will be granted subsidies to develop their open core gasifier. Finally, Danish Fluid Bed Technology will receive funds to develop a plant for straw gasification.

Lower raw material prices are crucial if liquid biofuels are to become competitive. Therefore considerable research activities are being carried out with a view to producing ethanol on the basis of cellulosic products such as straw, wood and grasses - i.e. raw materials that are far cheaper than sugar beets and grains.

photo: torben skøtt/biopress

New strategy for liquid biofuels

The Danish Energy Authority has prepared a strategy to strengthen Danish research and development efforts within liquid biofuels. The objective is to commercialise the new technologies for biofuel production within the next 10-15 years.

By Jan Bünger

The new strategy aims at prioritising and co-ordinating public and private research to obtain the necessary critical mass.

At an earlier stage, a strategy for research and development within technologies using biomass for CHP purposes was developed. The new strategy anticipates future challenges in the transport sector, which, in contrast to the electricity and heating sector, is almost 100 per cent dependent on oil supplies.

In many large industrial countries, engine fuels made from biomass are expected to play an increasing part due to security of supplies and environmental considerations. The most important barrier to a wider dissemination is the price of biofuels compared to that of fossil fuels. With continued employment of the familiar technologies and high value sugar and starch raw materials, the production price is expected to remain relatively high for Europe.

Furthermore, a reduction of the additional costs of biofuels is expected to be necessary for an increased use of biofuels in the Danish market to be economically sound.

The new technologies

Raw material prices are decisive for the price of the produced fuel. Internationally, development efforts are concentrated on new technologies that employ cheap residual products as raw materials and generate by-products that also have commercial value. What is important is that the consumption of energy and ancillary materials as e.g. enzymes is as low as possible or that the processes create excess energy, which can be used.

The strategy suggests a strengthening of Danish research and development within ethanol production, which is probably the most attractive biofuel in the medium term. The development of a process which can employ cheap raw materials such as straw and other lignocellulosis-containing residual products will be carried on in pilot and demonstration plants, and new capital has to be attracted for the expensive commercialisation phase.

Furthermore, the strategy suggests studies of the production of DME fuel (dimethyl ether) from gasified biomass

photo: torben skøtt/biopress

Denmark has numerous strong, international research communities in liquid biofuels - e.g. at Risø.

Strategy for biofuels

The report called "Strategi for forskning og udvikling vedr. fremstilling af flydende biobrændstoffer" (Strategy for research and development relating to the production of liquid biofuels) has been drawn up by the Danish Energy Authority. The report can be found on the energy research portal www.energiforskning.dk and on the Danish Energy Authority's website, www.ens.dk.

based on the Danish research efforts within thermal gasification of wood and straw.

Danish position of strength

Apart from the energy supply issue, an assessment of the business opportunities in the global market has also played a decisive role in determining the strategy.

Today, Denmark has strong, international research and business players, which engage in developing new technologies. During the past ten years, BioCentrum at the Technical University of Denmark, Risø and Novozymes have carried out groundbreaking research in the production of bioethanol from straw and other raw materials with a high fibre contents. Elsam has launched extensive development activities where the production of bioethanol on the basis of straw is integrated at a power plant - the so-called Ibus project. In the DME area, the Technical University of Denmark and Haldor Topsøe are up front.

photo: torben skøtt/biopress

Every year, Emmelev Mølle on Funen produces around 60,000 tons of biodiesel on the basis of rapeseed. The technology is well-known, and therefore is not included as an area to be promoted in the new strategy plan.

Therefore, Denmark has a good chance to influence the technological development as well as to take advantage of a technological breakthrough in an international market with considerable potential.

A draft of the strategy was presented to the Danish biofuel sector at an open seminar on 24 November 2004. The completed strategy will among other things be used to implement Denmark's Energy Research Programme for 2005.

Jan Bünger is biomass research coordinator at the Danish Energy Authority. E-mail: jbu@ens.dk.

Ethanol

- Bioethanol can replace petrol and diesel. It may be mixed with petrol, and it can increase the octane number of petrol and thus replace MTBE, which is widely used abroad.
- Petrol driven cars can run on petrol with up to 10 per cent bioethanol without modifications, but engines that can run on pure ethanol also exist. Furthermore, bioethanol can be mixed with diesel oil by means of emulsifiers.
- Today, bioethanol is made from sugary and starchy raw materials such as sugar beets, sugar canes and grain crops.
- Currently, considerable research activities are being carried out with a view to producing ethanol on the basis of cellulosic products such as straw, wood and grasses - i.e. raw materials that are far cheaper than sugar beets and grains. The problem is that the method is relatively expensive, i.a. because the process requires a number of enzymes.

Biodiesel

- Biodiesel is a popular name for rapeseed oil methyl ester (RME). The production of biodiesel is based on well-known technology where glycerine is removed from the rapeseed oil, so that the oil can be used as a fuel in ordinary diesel engines. Rapeseed oil and other types of plant oil can also be used as fuels without refining, but that requires a rebuilding of the engine. Normally, you will be able to rebuild a four-cylinder engine for around DKK 15,000.
- Biodiesel is sold at a number of petrol stations in Europe, especially in Germany and France.
- Every year, Emmelev Mølle on Funen produces around 60,000 tons of biodiesel on the basis of rapeseed. The main part is exported to countries where the oil is exempt from taxes, while a small part is used at large boiler plants in Denmark.
- The need for research is limited as we are talking about well-known technology. The need for development is narrowed down to establishing a standardised product.

GtL og DME

- GtL (Gas to Liquid) covers a number of technologies where gasified biomass is converted to liquid biofuels.
- A working group appointed by the European Commission has concluded that the expected market share for biofuels in the EU of six per cent can be increased to 15 per cent if GtL products are counted.
- In Denmark, Haldor Topsøe has developed processes for the production of petrol, methanol and DME (dimethyl ether) from natural gas. In principle, it should also be possible to produce these fuels on the basis of biogas or gas produced from thermal gasification of straw and wood.
- DME resembles diesel in many ways. From an energy-economic point of view, it is just as efficient as diesel, but no particles are formed, and the product can thus help limit air pollution.
- DME requires specially developed engines. In theory, a diesel engine can be rebuilt for DME, but in practice this is too expensive.

The infection risk of manure separation

photo: techras miljø aps

A new study from the Danish Institute for Food and Veterinary Research concludes that the infection risk connected with the sale of products after manure separation is no larger than the risk connected with the sale and delivery of raw manure. In the light of that, the Danish Veterinary and Food Administration has given the Regional Veterinary and Food Control Authorities an opportunity to grant exemptions from the hygiening requirement of the bioproduct regulation.

By Dorte Lau Baggesen

A continued growth of Danish pig production presupposes that a solution be found to handle the large amounts of manure. In that connection, there has been a lot of focus on biogas plants with manure separation, which is a method that can reduce the environmental impact and the area requirements to farmers.

The simplest form of manure separation is a centrifugation with for instance a decanter centrifuge. In this way, the manure is separated into a liquid fraction, which contains most of the nitrogen, and a solid fraction, which contains a considerable amount of phosphor.

A simple separation of the manure reduces the area requirement for the property with 25 per cent. Employing high-technology solutions where the liquid fraction is postprocessed makes it possible to reduce the area requirement with up to 50 per cent.

It has, however, proved difficult to sell the solid fraction, which, according to new demands from the EU, has to be hygiened before it is sold. Therefore, it is relevant to throw light on the infection risks that may be connected with the separation of manure from farming.

Infection risks of a new technology

In cooperation with the Danish Institute of Agricultural Sciences, TechRas Miljø ApS and Kemira Miljø A/S, the Danish Institute for Food and Veterinary Research has carried out a project that focused on the infection risks that are connected with the use of a new technology for manure separation.

The mobile decanter mounted in front of one of the farms. The decanter, which was made available by TechRas Miljø ApS, was installed and controlled by Næstild Maskinstation.

The project compared the microbiological status of the separation products with the corresponding status for raw manure. The comparison covered the contents of specific groups of bacteria, resistant bacteria, parasites and vira in the raw material and the products. Furthermore, the amounts of microorganisms that would be spread on farming land were compared.

A total of seven herds of pigs were included in the study, which was carried out in 2003. On each farm, a mobile decanter was mounted. Manure from the pretank was led into the decanter, where it was separated by centrifugation at 2,800 revolutions/minute.

On all farms, the researchers made sure the separation process was functioning correctly and was stable before sampling. Most often, this meant that the decanter had to be installed 1-2 days before the tests were carried out, and that it had to run stably for around an hour before sampling.

Previous studies at DJF-Bygholm and the Danish Institute for Food and Veterinary Research showed that the materials were very homogenous and that it was therefore possible to carry out the project by analysing part samples.

Three part samples were taken from raw manure, the solid fraction and the liquid fraction respectively. The samples were all analysed for the presence of selected microorganisms that are pathogenic to domestic animals and/or humans. The studies included analyses for bacteria, parasites and vira. Fur-

The researchers behind the project

- Researcher, PhD Henrik B. Møller.
- Microbiologist, PhD Anders Hay Sørensen.
- Senior research associate, PhD Lars E. Larsen.
- Researcher, PhD Charlotte K. Hjulsager.
- Senior research associate, PhD and dr. med. vet. Charlotte Maddox-Hyttel.
- Researcher, PhD Heidi Larsen Enemark.
- Senior research associate, PhD Lars B. Jensen.
- Researcher, PhD Yvonne Agersø.
- Senior research associate, PhD Anders Stockmarr.

thermore, tests were made to determine the content of various indicator bacteria that occur naturally in manure and may throw light on how other groups of bacteria can be expected to be distributed in the fractions after the manure has been separated. Finally, the antibiotic resistance was studied.

Indicator bacteria

The study showed that the amount of indicator bacteria was large, and that there were large variations among the herds. The liquid as well as the solid fraction contained bacteria. The separation process entailed a small concentration of indicator organisms in the solid fraction. However, with regard to infection the levels were still comparable with the level in raw manure. The same was true for antibiotics resistance.

The tests for specific pathogenic microorganisms resulted in proof of salmonella in one herd and virus in two herds. Parasites such as roundworm and cryptosporidium were common in the studied herds, but after simple separation roundworm eggs could only be found in the solid fraction (figure 1). This can be explained mainly by the size of the microorganisms and their inclination to attach themselves to certain particles.

photo: techras miljø aps

The solid fraction is separated from the rest in the decanter centrifuge, which was made available by TechRas Miljø ApS, Pieralisi Agent Denmark.

The infection risk that is connected with the handling of manure and separation products has to do with the concentration of infectious matters in the material, but furthermore the amount that is spread on the land plays a part. The use of separation products instead of raw manure is expected to entail changes in the amounts spread and possibly also in the intervals for spreading. Considering these expected changes in handling patterns together with the registered concentrations of infectious matters in the products, the conclusion is that in the long run the total deposit of infectious matters will only differ slightly between the different handling methods (figure 2).

With regard to fertilization with the solid fraction, specific handling problems may mean that the product will be spread fewer times but in larger amounts (for instance 9 tons/hectare every third year). This will mean a considerably larger infection risk at the time of the spread, which has to be taken into consideration.

Exemptions from the hygienisation requirement

According to the bioproduct regulation, products have to be hygiened at 70 °C for 60 minutes after manure separation, and they must meet specific hygiene requirements if they are to be sold from the farms where they have been produced. The results of the project show that the contents of pathogenic and antibiotics resistant organisms do not vary greatly in raw manure and fractions from manure separation. ▶

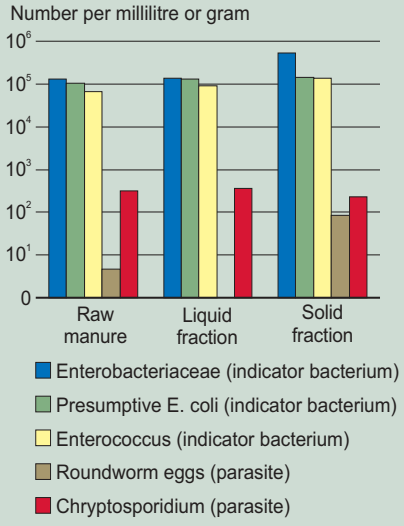


Figure 1. Average find of specific microorganisms in raw manure and fractions after simple manure separation.

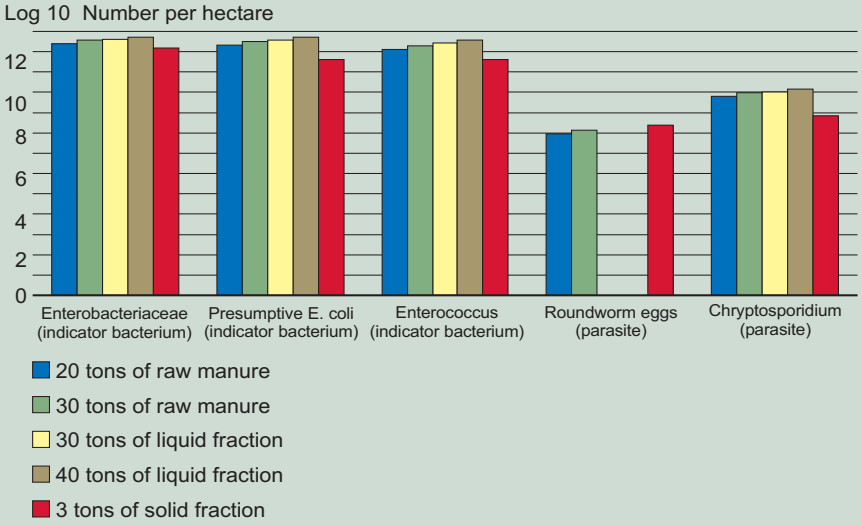


Figure 2. Amount of specific microorganisms spread on farming land using different strategies for the spreading of raw manure and products from simple manure separation (decanter centrifuge). The amounts are shown as average numbers for results from seven herds.

Thus separation products that are handled with the precautions taken when handling and spreading raw manure will not pose an increased infection risk.

In keeping with the results of the project, the Danish Veterinary and Food Administration, which administers the bioproduct regulation, has assessed that the sale of separation products will not directly pose a larger infection risk than the sale and delivery of raw manure. The Danish Veterinary and Food Administration has therefore given the Regional Veterinary and Food Control Authorities the opportunity to grant individual exemptions from the requirement, provided certain conditions are met.

The infection risk that is connected with the handling of separation products, however, must be reassessed if a market is found for these products outside the agricultural sector. The establishment of a market for the sale of fertilizers to e.g. market gardens, recreative areas, forestry or for export to areas short of nutrients would have a positive effect on the development of the of separation technology. Such a development, however, presupposes that the hygienisation required under the bioproduct regulation is performed, or that the products are subjected to a similar and approved treatment to reduce their content of infectious matter. In particular, this will be important if separation products are sold over large distances, thus increasing the risk of regional and/or international spreading of the organisms in the products.

Dorte Lau Baggesen is a senior research associate, PhD and project manager at the Danish Institute for Food and Veterinary Research. E-mail: dlb@dfvf.dk

Notes:
1. Order no. 604 of 15/7 2002.
2. Regulation no. 1774/2002 of the European Parliament and the Council of the European Union (EC) of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption (the bioproduct regulation).

Tar-free gasification - the road to success

photo: torben skøtt/biopress

For many years, Denmark has drawn attention to itself internationally in the field of biomass gasification. One of the success stories is from the Technical University of Denmark, where researchers have developed a gasification plant which can produce a tar-free gas and which has set the world record for electricity efficiency. But the road has been long and bumpy, and if the employees had not found alternative ways to fund their research they would not have succeeded.

By Torben Skøtt

- Danish research policy is totally unimaginative. The politicians believe we should all research the three things that we have learnt to say parrot-fashion: nanotechnology, biotechnology and IT. It is good to be upfront in these areas, but thinking that we can live by the same as anyone else is foolish.

These words are spoken by senior lecturer Ulrik Henriksen, who is a project manager at the Technical University of Denmark. For decades, he has participated in the development of some of the world's best gasification plants, and along the way he has thought quite a bit about what it is going to take to turn the many theories at the universities into practice.

Ulrik Henriksen in front of the Viking gasifier at the Straw Fort.

- Denmark has had success focusing on different areas than other countries, for instance in the energy sector, and it is important that we hold on to these positions of strength. We have spent quite a few years trying to become leaders in thermal gasification, so it would be smart to apply our knowledge, says Ulrik Henriksen, who is deeply concerned that with the latest energy compromise politicians have made it much more difficult to build gasification plants in Denmark.

The Straw Fort

Converting straw and wood to gas is not difficult - and is not a new invention either. What is difficult is to produce a gas that is clean enough to be used in an motor.

With regard to that, the researchers of the Institute of Mechanics, Energy and Construction at the Technical University of Denmark have come far. Or to be accurate: The researchers of "the Straw Fort" - a special department of the institute, which to outsiders does not exactly look like a university. The Straw Fort consists of a jumble of on-site huts, laboratories, workshops, coffee makers and several Gyro Gearloose inventions that help create the environment needed for ideas to flourish and not least to create results in practice.

The Straw Fort is a pet name, which has led to quite a few funny episodes over the years, says Ulrik Henriksen. For instance when one of the students from the institute had applied for a job in the military, whereupon an officer contacted Ulrik for a description of the fort that he had established in Lyngby.

The people behind the Straw Fort started out by developing straw gasifiers. They are still in this area, but the primary focus is now on developing large systems, where the gas can be used in power plants. They do not require the gas to be tar-free, and that makes it possible to produce simple and cheap plants. The work is carried out in cooperation with a number of companies, including Danish Fluidbed Technology.

Paid themselves

Nearly fifteen years ago, the researchers of the Straw Fort agreed to develop a stable wood gasification plant that could produce tar-free gas for a motor. Their aim was to develop a technology that would make it possible to produce electricity and heat for the many small district heating grids around the country on the basis of biofuels.

- The problem was how to raise enough money for the project, says Ulrik Henriksen.

- I know the subsidy system from A to Z, and I knew we would not be granted subsidies to build a pilot plant at the Straw Fort. We would be met with all sorts of demands to find a plant host, cooperate with researchers in Denmark and abroad, participate in conferences and seminars etc.

- It would turn out as it usually does. We would have lots of discussions with our cooperation partners and spend enormous amounts of time participating in meetings and conferences and writing reports, while the actual purpose of making the gasifier work would become a side-issue.

- Fortunately, over the years we had worked up a profit at the institute, and with that money we started building a plant completely after our own minds.

- It took thrice as long and became thrice as expensive as we had expected. Fortunately, at one point the Danish Energy Agency chose to subsidize the project so we succeeded in finishing it, says Ulrik Henriksen, who does not try to conceal that those were the best years of his long career as a researcher.

> *– Forskningspolitikken i Danmark er fuldstændig fantasiforladt. Politikerne tror, at vi alle skal forske i de tre ting, vi har lært at sige udenad: nanoteknologi, bioteknologi og IT.*

- Going to work every day and seeing that the gasifier has run unmanned all night - that is a fantastic experience. It is very different from preparing project applications and reports.

Commercial state

Today, the Viking gasifier, which is the name of the plant, has run for more than 2,000 hours. The gas is free of tar, the operation is fully automated, and the electricity efficiency has been measured to 25 per cent, which is a world record for plants that size.

This year, the construction of a plant ten times larger than the plant at the Straw Fort will start. This will take place in cooperation with COWI and the Weiss boiler factory in Hadsund. The plant will be built at Weiss, which has the necessary staff of engineers and professionals to manage the construction and commissioning.

Subsequently, Ulrik Henriksen expects the plant to be commercialised. The gasifier will probably cost the same as an ordinary boiler plant, but on top of that there will be costs for the motor installation.

Research and development

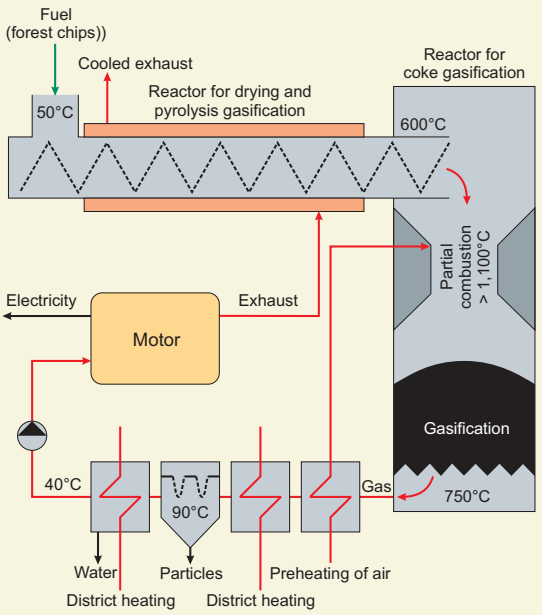
Ulrik Henriksen wonders that while there is a lot of focus on research, there is not much talk about how the results are used in practice.

- I do not believe in researchers sitting in their "ivory towers" at the universities producing knowledge for the companies to use in their development departments. Development has to be based much more on equal cooperation. The companies often encounter problems that are difficult for them to solve when they work with development, and that is where we can help.

- That is why it was a great mistake to abolish the Danish Energy Authority's Development Programme for Renewable Energy (the UVE programme). The programme was a possibility for theorists and practicians to work closely together and create results that worked in practice, finishes Ulrik Henriksen

The functioning of the Viking gasifier

The process in the Viking gasifier consists of two steps: pyrolysis and coke gasification. The damp wood chip is fed into the pyrolysis reactor, where strong heat makes the water evaporate and then separates the fuel into a coke fraction and a tarry gas. Between the two reactors, air is added to break down the tarry matter. When the products from here are led through the coke reactor, the coke is converted to gas. Subsequently, the gas is cooled by means of a heat exchanger, and the soot particles are collected in an ordinary bag filer.



FiB – Bioenergy Research is published with support from Denmark's Energy Research Programme, Elsam and Energi E2. The newsletter, which is free of charge, is published six times a year both in a Danish and an English version. Both versions can be downloaded from the Internet at the following homepage: www.biopress.dk

The Danish version of the newsletter is also available in a printed version supplied as an insert in the Danish magazine, Dansk BioEnergi. Further copies of the Danish version can be ordered from BioPress, via the following e-mail address: biopress@biopress.dk, or telephone number +45 86 17 34 07.

Editor responsible: Torben Skøtt

Production:
BioPress
Vestre Skovvej 8
DK-8240 Risskov
Telephone +45 8617 3407
Telefax +45 8617 8507
E-mail: biopress@biopress.dk
Homepage: www.biopress.dk

Photo on the front page:
TechRas Miljø Aps, Technical University of Denmark and BioPress

Copies printed: 4,000

Print: CS Grafisk. The magazine has been printed on environment-friendly offset paper.

Next issue:
to be published in the middle of April 2005. The deadline for articles is 15 March 2005.

BiogasForum Öresund

photo: Miljø & Ressourcer, Danmarks Tekniske Universitet

- a platform for cooperation on biogas

Those who are interested in biogas now have a new place to exchange experiences. BiogasForum Öresund is a network for people who are interested in biogas established as a cooperation project between Sweden and Denmark.

Swedes and Danes now work together side by side to promote and strengthen the development of biogas in the entire region around the Sound.

In the future, BiogasForum Öresund will function as a platform for research and impartation of knowledge of biogas. A website has already been established at www. biogasforum.dk, where among other things you can find information on common biogas facilities, concrete information on biogas and information on biogas research at Lund University and the Technical University of Denmark. Moreover, you can find links to other companies, association and authorities working with biogas.

BiogasForum is also in charge of a series of seminars. Two seminars have already been held - one in Sweden and one in Denmark - with many participants from both countries.

The next seminar which is called "At bygge et biogasanlæg - fra idé til virkelighed" (Building a biogas plant - from idea to reality) will be held at the Technical University of Denmark on 10 March. Here farmers, advisers and others who are interested will have the opportunity to present their views on and experiences with the long, hard process from the idea to the finished biogas plant. In particular, the Swedes are very interested in hearing the Danish contributions, as we have far more experience in this area than the Swedes.

BiogasForum is administered and maintained by Environment & Resources at the Technical University of Denmark and by the department of bio-engineering at Lund University.

A Danish and a Swedish following group with representatives from the Danish Energy Agency, the Danish Biogas Association, BWSC, the Food and Research Economics Institute, Skane Energy Agency, the municipality of Helsingborg and LRF Skåne (a Swedish farmers' association).

Anyone who wants to be part of the network and participate in the arrangements is welcome. It is free and unbinding. See www.biogasforum.dk for further information.