First volume
First issue
April 2004

FiB
Bioenergy research

Bioenergy research

From research to invoice and from research to welfare improvements. Communication is often very essential to make the most of research potential. The Danish research into bioenergy is hardly an exception.

By Jan Bünger

From a social point of view, good research is characterized by the potential of meeting several key criteria both the "hard" and the "soft" ones. Communication can be decisive if promising research results are to find their way to the next links of the food chain for the practical use: Other research institutes, enterprises, power supplying companies and end-users.

And communication is necessary to increase end-users´ general understanding of the importance of research to society. Actually, the Danish government has set up a think tank concerning *"appreciation of research"*. Good research is in touch with reality, and this message must be promoted.

Insert in Dansk BioEnergi

The Danish Energy Agency now contributes to an improvement in the presentation of the Danish efforts within bioenergy research and development. This takes place through Denmark's *Energy Research Programme*, which grants financial support to the publication of a newsletter six times a year; partly as a separate newsletter and partly as an insert in the Danish magazine "Dansk BioEnergi". Furthermore, the newsletter, can be downloaded from the following homepage: www.biopress.dk in a Danish or an English version.

The power producers Energi E2 and Elsam also grant financial support to the newsletter. The fact is that both have an interest in presenting experience in research and development from a series of CPH plants that have been established under the so-called biomass agreement

To be continued

Continued from the front page

during recent years. Effective biomass exploitation for the production of energy must be persisted.

Innovation

Great social values are involved in biomass exploitation within the Danish energy supply sector. Full biomass exploitation for the benefit of Danish earnings, employment, security of supplies and environment requires purpose-oriented research and development as well as a dialogue between the actors who together must bring bioenergy into daily life. Today biomass makes out six percent of the total Danish energy consumption. To this must be added waste exploitation, which to a great extent is of organic origin.

Although Denmark, seen from an international point of view, has a very strong position within both research and development, the need for presenting research results to small and medium-sized enterprises is greater than ever. Many of these enterprises are adaptable. They are innovative enterprises that are ready to seize the opportunity and create special products for the energy sector.

Overview and contact

The newsletter will contribute to an updated overview of the current research and development, both concerning specific projects and research programmes. Denmark's Energy Research Programme governed by the Danish Energy Agency as well as the PSO programmes administrated by the systems responsible power producers are purpose-oriented. Therefore, one of the strong ambitions is to create a profitable contact between researchers and practicians. Furthermore, the newsletter will have room for debating points on the priorities within research and development and for bringing up subjects for discussion with the authorities. Provisionally, the newsletter is to be published 12 times.

Jan Bünger is a Research Coordinator at the Danish Energy Agency.

DKK 200 million a year for bioenergy research

- With total grants of nearly DKK 60 million in both 2003 and 2004, bioenergy is the largest single-area under Denmark's Energy Research Programme and the PSO programmes.
- The projects will bring results now and in the years to come.
- The public Danish research centres and The Danish Ministry of Science, Technology and Innovation spend DKK 30 million a year from their own resources.
- Private enterprises with a profound scientific knowledge are estimated to invest up to DKK 100 million a year in research and development within bioenergy.
- Every year Danish competence paves the way for considerable EU grants for Danish projects.

Denmark's Energy Research Programmes

The Energy Research Programme of the Danish Energy Agency

The Energy Research Programme of the Danish Energy Agency is focused on purpose-oriented research into energy, which is carried out in co-operation between public research centres and the private trade and industry. The Energy Research Programme has a capital of DKK 65 million a year at its disposal in the years 2004-2008.

The power plants' PSO arrangement

Eltra and Elkraft, who are the system responsible power producers in Denmark, administrate the PSO (Public Service Obligation). Under a public obligation, the enterprises are responsible for the carrying out of research and development within the environmental-friendly technology of power production, including especially renewable energy. The new state network enterprise EnergiNet Danmark will take over the system responsibility in 2005.

The Ministry of Science, Technology and Innovation's pool for strategic research into renewable energy

The Ministry of Science, Technology and Innovation has earmarked a pool of DKK 125 million for strategic research within renewable energy, etc. From this pool, support for research within the fields of wind power, bioenergy, solar cells, fuel cells and energy saving technologies can be granted. Research and development can involve technical, environmental, sanitary, social, financial and political aspects.

Further information in Danish about the energy research support can be found via the Internet at the following homepage: www.energiforskning.dk

The world's first eight-cylinder Stirling engine was put into operation just before Christmas, and the preliminary results are very promising. So far the engine, which has been developed at The Technical University of Denmark, has run for approximately 1,300 hours with an electricity output of 76kW. Thus this engine holds the record for woodchip Stirling engines.

photo: henrik carlsen

Stirling engine for biofuels
- *now it works*

Many years' efforts in research into small CHP plants, based on Stirling engines, are now close to a commercial breakthrough. The latest plant has now run for 7,000 hours using woodchips as fuel. The plant did not need any service inspection until around 5,000 hours' run. This corresponds to the run of a small car round the world 15 times without having changed oil or spark plugs.

By Henrik Carlsen

Hotel Burg in Oberlech is no ordinary Austrian skiing resort. It is one of the most exclusive resorts in Austria, and there is a woodchip-burning CPH plant with a Danish Stirling engine in the boiler room under the hotel.

The small CPH plant supplies around 32kW of electric power and 280KW heat for Hotel Burg and the neighbouring hotels. Till now the plant has run for more than 7,000 hours using woodchip as fuel. The plant did not need any service inspection until around 5,000 hours' run. This corresponds to the run of a small car at 120km/h round the world 15 times without changing oil or spark plugs. Thus the Danish Stirling engine has proved that there is a basis for granting the usual guarantees on operation. This means that the Stirling engine is close to being launched on the market.

The numerous operating hours without problems make out a breakthrough in the use of biomass fuel for Stirling engines. The results up till now from other projects in Europe and in the USA have been depressing, because tests have had to be stopped due to slagging after only few hours' operation.

However, the numerous operating hours are not the only news. The first eight-cylinder Stirling engine in the world has been put into operation with the Austrian collaborators just before Christmas, and the preliminary results look promising. Till now the engine has been operating for around 1,300 hours supplying 76kW of electric power, which means that it holds the record for woodchip Stirling engines.

Many years' efforts

The successful test in Oberlech is the result of nearly 15 years' research, development and innovation at the Institute for Mechanics, Energy and Construction at The Technical University of Denmark. The first prototype in working order was ready for a trial run at the laboratory in 1996, and the engine in Oberlech makes out the third generation in the development process.

Since 1996, development has been concentrated on the improvement in performance, efficiency, operational reliability and serviceability. The Danish Energy Agency first and foremost has contributed financially to the development, but so have Elkraft, EU and other foreign financial sources. The close co-operation

The Stirling engine is especially convenient for biomass fuels, because the combustion takes place outside the engine. The heat is transferred to the engine through a heat exchanger placed in the combustion chamber of the woodchip combustion plant. The heat from the flue gases is used to preheat the combustion air to 400 -600°C prior to the inlet into the combustion chamber. This improves the efficiency of the plant, however, it is still difficult to exploit more than 50 per cent of the energy from the woodchip feed to the heater of the Stirling engine. The remaining part is transformed into heat in a so-called economiser, whereas a minor amount is lost in the chimney.

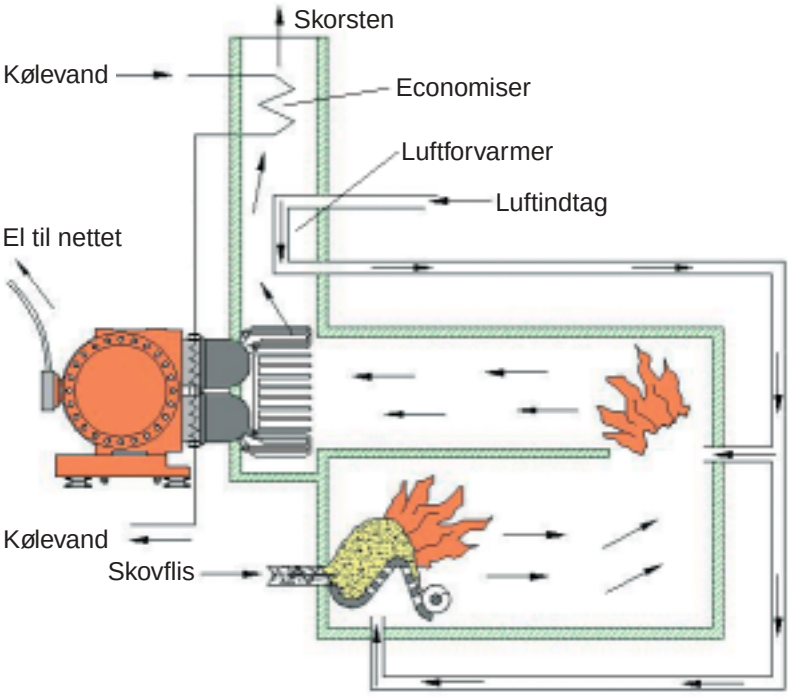

illustration: henrik carlsen

On the market

The Stirling technology has now matured and is ready for industrial exploitation. There is still a lot of work to do within the field of research, but this work must take place along with the production of electricity on the first small power plants. Consequently, The Technical University of Denmark, via DTU Innovation, has contributed the first million Danish kroner to an enterprise, which is going to launch a series of Stirling engines on the market.

This enterprise, STIRLING.DK, must form the legal and practical framework for the activities that do not belong to a research environment: raising of capital, development of organization, marketing, production and distribution, only to mention the most important activities.

In co-operation with the Institute of Mechanics, Energy and Construction, and supported by several investors, the new enterprise must prepare the launch of the 35kW Stirling engine on the Nordic market in 2005. Quite soon after this launch, more variants of the 75kW and 9kW engines should be put on the market. The plants will be marketed all over Europe.

between the Danish and the Austrian partners now results in the future publication of the results from the plant in Oberlech in the Danish magazine Dansk BioEnergi.

Like a steam engine

The Stirling engine is especially convenient for biomass fuels, as the combustion does not take place in a cylinder like in a conventional piston engine, but outside the engine. The heat is transferred to the engine through a heat exchanger placed in the combustion chamber of the woodchip combustion plant. Thus the Stirling engine is more similar to a steam engine than to an internal combustion engine.

The Danish Stirling engine differs from the «conventional» Stirling engines in several other respects. The engine is constructed in the same way as a semi-hermetic cooling compressor for a supermarket. The whole engine makes out a closed unit, where the generator has been placed in a closed crank house in the same way as the electric engine of the cooling compressor. The only connection to its surroundings is three electrical connections leading into the three phases of the generator from the network.

Four cylinders

The four double-acting cylinders of the Stirling engine use helium as working gas. The maximum mean pressure of the working gas is 4.5 Mpa, and the engine has been designed for an electric power output of 35 kW. The encapsulated asynchronous generator is connected direct to the network, which entails a speed of a little more than 1,000 revolutions per minute.

The heat exchanger, which transfers the heat from the woodchip combustion, consists of four heating panels made from 14mm heat-resisting tubes. The four heating panels make out the end of the woodchip combustion chamber so that the combustion radiation can be transferred direct to the panels. Flue gases continue through the convection section of the panels, where additional heat is transferred to the working gas of the Sterling engine.

The power and efficiency of the Stirling engine depend strongly on the temperature of the heating panels and the cooling water. When the four heating panels have a temperature of 740°C, and the temperature of the inlet and outlet-cooling water of the engine is 55°C and 70°C respectively, the engine generates 35 kW. The efficiency of the engine itself is approximately 30 per cent. This means that 30 per cent of the heat transferred to the engine will be transformed into electricity.

Eight cylinders

In principle, the eight-cylinder Stirling motor can be compared to two four-cylinder engines that are connected to each other with one common generator. The advantage of this construction is first of all the fact that you get an engine with an electric power, which is very attractive and applicable for several purposes without having to develop a new engine from the very beginning. Another advantage is the quieter run of the eight-cylinder engine as this engine has a better balance than the four-cylinder version. On the other hand, it is much more difficult to develop a heating system that can supply eight heating panels equally with combustion heat.

The eight-cylinder engine makes out the fourth generation of the development concept. This means that the engine is equipped with new heating panels, which improves the efficiency of the engine. During the first 1,300 hours' test, it turned out that the efficiency per cylinder had been improved by nearly 20 per cent. The efficiency of the four-cylinder engine now corresponds to an electric power of 38kW.

The firing system

As previously mentioned, the heating panels of the Stirling engine must have a temperature of approximately 740°C when running to achieve a satisfactory power and efficiency. This is a very high temperature for a woodchip combustion plant.

One of the problems is that the flue gases from the heating panels have a temperature of nearly 800°C. To exploit this heat, the flue gases are used to preheat the combustion air to 400°C-600°C prior to the inlet to the combustion chamber This improves the efficiency of the plant, however, it still is difficult to exploit more than 50 per cent of the energy from the woodchip feeding to the Stirling engine heater. The remaining part is transformed into heat in a so-called economiser, and a minor amount is lost in the chimney.

The Danish engine maker Maskinfabrikken REKA in Aars developed the first firing system of the four-cylinder Stirling engine. Later the co-operation between The Technical University of Denmark and both the Austrian companies MAWERA and BIOS about the development of a plant for the Central European market was instituted.

At the Austrian plant the primary woodchip combustion takes place on a fixed grate. The Stirling engine has been placed horizontally at the end of the part of the combustion chamber, where the burning of the gases takes place after inlet of secondary air. Consequently, there is a direct contact between the flue gases from the woodchip burning and the heating panels of the Stirling engine.

This means that ashes and slag deposit on the heater. Therefore, an air pressure cleaning system, which can remove the deposits of ashes in operation, has been installed at the plant in Oberlech. Furthermore, it is necessary to carry out a manual cleaning after 500-700 hours depending on the fuel. Therefore, the heating panels of the fifth generation have been changed in order to reduce the need of manual cleaning.

Gasification

Another way of reducing the need for cleaning of the heating panels is to gasify the woodchips in a simple updraft gasifier.

The updraft gasifier is a closed container, into which the woodchips are fed from the top. In the container, the inlet of oxygen in a very small amount heats up the woodchips. Thus carbon monoxide, hydrogen and tar matters in the form of gases will be released, whereas the dry matter (ashes) will be collected and removed from the bottom of the container.

Subsequently, the gas is burned in a fuel compartment mounted below the heating panels of the Stirling engine. This procedure is under development in a co-operation between the enterprises Babcock & Wilcox Vølund. The preliminary results are very promising, and it is expected that the plant can be put into commercial operation in 2005.

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photo: henrik carlsen

The four-cylinder Stirling engine is ready to be mounted to the woodchip firing system. The heat exchanger, which transfers the heat from the woodchip combustion, can be seen at the top.

photo: henrik carlsen

Close-up of the heat exchanger, which consists of four heating panels made from 14mm heat-resisting tubes. The four heating panels make out the end of the woodchip combustion chamber so that the combustion radiation can be transferred direct to the panels.

Biogas plants can play a decisive part in the development of the organic farming. Biogas plants can utilize the manure and straw, which are already found in organic farming. In addition, grass from the grass-clover fields or from the meadows, which would alternatively grow weedy because the EU agricultural reform makes it unprofitable to crop them, can be utilized.

photo: biopress

Bioenergy for organic farming

Organic farming has potential of becoming a large-scale supplier of renewable energy, not least bioenergy. This appears from a so-called synthesis of science made at the Danish Research Centre for Organic Farming.

photo: biopress

Biogas can be exploited without compromising the nutrient balance in organic farming.

By Uffe Jørgensen, Tommy Dalgaard and Jørgen E. Olesen

For a number of years, organic farming has made out a strong, environment-friendly alternative to conventional farming. During the nineties, even with such success that the area used for organic farming was doubled in the course of few years. Today the organically cultured area makes out 6 or 7 per cent of the total Danish agricultural area.

Till now, organic farmers have not directed much attention to bioenergy. Focus has especially been on animal welfare, supply of nutrients and on the alternative pest and weed control.

However, the EU reform of the European agriculture politics opens up for new prospects. Previously, subsidies for grain crops were larger than for grass-clover, whereas in future the crops will be given equal subsidies. For the organic farmers it will thus be profitable to cultivate crops that partly ensure the supply of nutrients and partly make it possible to produce renewable energy.

Today organic farming stands a good chance of becoming self-sufficient in renewable energy from e.g. biogas, rapeseed oil, alder and wind energy. One of the interesting perspectives, when introducing new energy technologies in organic farming, is that simultaneously it can contribute to the achievement of other aims of a high priority within the sector: Reduction in the import of nutrients and animal feed, reduction in greenhouse gases and minimizing of nitrate leaching.

Biogas plants as organic fertilizer factories

Biogas might become a vital technology in organic farming. Biogas plants utilize the easily reacting organic matter in the production of biogas that can be exploited for the production of electricity and heating. At the same time, the nutrients from the organic matters will be maintained in such a form that it can be utilized as fertilizer.

The biogas plants can utilize the manure and straw, which are already found in organic farming. In addition, grass from the grass-clover fields or from the meadows, which alternatively would get weedy because the EU agricultural reform makes it unprofitable to crop them, can be utilized.

Thus biogas can be exploited without compromising the nutrient balance in organic farming. In fact, biogas plants can work as small organic fertilizer factories by releasing nutrients from the grass fields. In this way the need for using conventional animal manure in the organic plant growing farms can be reduced.

If biogas is produced from organic animal manure left in the cowshed, 0.8 PJ of fossil energy used in electricity production can be replaced. If biogas from grass-clover cultivated on approximately 10 per cent of the organic area is produced in addition to this, the potential transfer of fossil energy will increase to around 1.8PJ corresponding to the power consumption of more than 50,000 households. As only 0.6PJ is used for the production of the direct power consumption

in organic farming, it is thus possible to produce an amount of energy from biogas that is three times larger than the amount used within the sector (see table 1).

Green oil for the tractor

When cultivating rapeseed oil or other hardy oil plants on approximately 10 per cent of the organic area, a half part of the present oil consumption for running the tractor can be replaced. At the same time approximately 22,000 tonnes of rape seed cakes can be produced making out an important support to being self-sufficient in concentrated feed for the cows.

It must be noted that in this connection it is not a question of producing biodiesel on large central plants, where a part of the energy profit will be lost as process energy. However, it is a question of installing a rapeseed oil squeezer locally at each farm or in co-operation between more farms for the use of raw oil direct in the tractors.

Taking into consideration the rotation of crops, it would be a major and risky change to cultivate rapeseed on more than 10 per cent of the organic area and therefore, replacing of the present diesel consumption is the biggest challenge. Biogas, however, can also be used for the running of the tractor, but it is technically more difficult to carry out locally.

Greenhouse gases

The implementation of energy production in organic farming may entail positive operational and environmental effects. Thus biogas from one or two grass- clover fields out of a ten-field rotation of crops at a plant growing farm will result in an improved yield and less nitrate leaching.

In the grass-clover field the nodule bacteria of the leguminous plants will accumulate atmospheric nitrogen and store this in the plant mass. In the green fallow fields of plant growing farms the grass-clover is led back to the earth as fertilizer for the coming crops. If the grass-clover will be degassed instead, the distribution of the degassed product will be improved by the rotation of crops resulting in a favourable effect on both yield and nitrogen utilization.

Biogas has another positive side effect, as the release of methane from the storing of fertilizers will be reduced. As methane is a strong greenhouse gas substance, this will reduce the climate influence of organic farming.

According to model prediction, the organic plant growing has a slight climate lead compared with conventional growing, as organic cultivation leads to storing of CO2 in the earth's pool of organic matter. However, if organic farming is to set a really good example of climatically neutral farming, further documentation must be worked out to find out how extensive the release of laughing gas is, as laughing gas is an even stronger greenhouse gas substance.

Recirculation

Household waste, sludge, and other waste products containing nutrients can be recirculated on biogas plant. By improved recirculation from town to country, it will be possible to close the hole in the organic cycle. However, this will require a re-discussion of the principles behind organic farming, which today do not allow for the use sludge.

photo: torben skøtt/biopress

When cultivating rapeseed or other hardy oil plants on approximately 10 per cent of the organic area, half the present oil consumption for running the tractor can be replaced.

photo: torben skøtt/biopress

If biomass from unexploited meadows were utilized at biogas plants, it would be possible to kill more birds with one stone: Renewable energy would be produced, discharge of nutrients would be reduced, and better conditions would be created for a varied flora.

Energy consumption in organic farming	Pet joule
Electricity	0.6
Oil	0.7
Indirect energy consumption	1.2
Total	2.5

Energy production in organic farming	Pet joule
Biogas from all animal manure from cowshed	0.8
Biogas from grass-clover from 18-19,000 hectares	1.0
Cultivation of rapeseed from 18-19,000 hectares	0.4
Household wind turbines at a fourth part of the properties	0.3
Total	2.5

Table 1. The energy consumption in organic farming and the possibilities of replacing the fossil fuel with renewable energy.

Free-range pigs and bioenergy

photo: torben skøtt/biopress

Happy pigs are healthy pigs, and there is no doubt that they have a splendid time being in the open. There is only one problem: The pigs' droppings contribute to the pollution of our waters. Pigs love to root around and consequently grass and other vegetation that could have accumulated the nutrients disappear. If the pigs instead root around in areas forested with alder, which could be exploited for energy production, it is likely that the trees could tolerate the pigs' behaviour and prevent nitrate leaching.

If the biomass from unexploited meadows were utilized in biogas plants, it would be possible to kill more birds with one stone: It is important to remove the nutrients from the meadows, partly to reduce the discharge to the small rivers and lakes, and partly to provide favourable conditions for the varied flora, which could otherwise be smothered by the nutrients. On the order hand, organic farming is in great need of the nutrients, as it needs the energy, which can be supplied by the biogas plants.

Free-range pigs

It is also possible to combine the production of energy with the production of foodstuffs within the same area, e.g. by keeping free-range pigs in areas forested with alder. This will improve the pigs' conditions, and the alder can be utilized for the energy production in the same way as energy willow.

Keeping pigs in areas forested with alder means that the pigs can find places in the shadow and hide away, and they get the opportunity of rooting in the earth, which is their natural behaviour. Today it is a matter of common practise that free-range pigs get rings in their snouts, making out a compromise between environment and animal welfare. The fact is that the ring ensures that the pigs by their rooting do not lift up the grass resulting in an increase in the nitrate leaching. It is likely that the alder will be able to stand the pigs' rooting around, because of their deep striking roots and strong stems and thus prevent nitrate leaching.

Common plants

It is possible to produce biogas, rapeseed oil as well as heat and power from wood locally on each farm. However, as for any technology, it is more or less typical that advantages could be taken from the concentration of the energy conversion on a major common plant still covering only a minor local area.

Apart from the technical large-scale production advantages from a common plant, such a common plant has the possibility of employing a plant manager who has technical knowledge and can concentrate on optimising the energy production. On a common plant the energy production could be combined with other types of production, e.g. drying of grains or green pills so that «waste heat» from the biogas production or from a wood burning Stirling engine can be exploited in an optimum way. Such a concept has been described in a concrete common biogas project among farmers from Give in Denmark.

Economy

It is difficult to form an estimate of the economy in producing and exploiting renewable energy in organic farming. It will depend on the rate of development as well as the value of the different synergy effects. However, as the energy costs of organic farming only make out approximately five per cent of the total running costs, any increased price that may arise on energy will not entail major change in the product price. An increased price must then be evaluated against the improved environmental value when creating a better product image for an organic product produced without the utilization of fossil energy.

As mentioned, the potential for the production of energy in organic farming is so big that, seen from a theoretical point of view, it is rather easy to become self-sufficient in direct energy consumption. Generally speaking, the technology for exploiting the possible energy sources of biomass, wind and sun has developed into a commercial level. Whether the organic farms become self-sufficient in energy is, therefore, very much a question of political priority, new models for collaboration, operating economy and continued research and development of technology. ■

The authors of this article are all scientists at the Danish Institute of Agricultural Sciences. Together with experts within energy production the authors have participated in the work of making a statement, a so-called synthesis of science, which has been made at the Danish Research Centre for Organic Farming (FØJO). The work will be published in a report in the middle of April. The report can be seen at the following homepage: www.foejo.dk

Ethanol project is making good progress

photo: elsam

The construction of the pilot plant at Fynsværket in the summer of 2003.

Elsam's big ethanol project with a budget of DKK 100 million is making good progress. For quite a long time, a laboratory plant, which can process approximately 100kg straw per hour, has been under test run at the Danish power plant Fynsværket. The next step will be the construction of a pilot plant that can process one tonne of straw per hour.

By Torben Skøtt

If we can produce ethanol on the basis of straw and household waste, and the remaining product is an even more convenient type of fuel, then we have created a technology of enormous importance for the exploitation of biomass all over the world. This is why Elsam, in collaboration with actors in Spain as well as in Britain, has chosen to be the head of EU's biggest ethanol project.

- We aim at being able to exploit biomass in a more intelligent way, explains Carl Nielsen, engineer at Elsam, who is the head of the ambitious project.

- In the beginning we have chosen to focus on straw and household waste, but we aim at developing a multi-plant that can convert a wide range of different biomasses into animal feed as well as liquid and solid bio fuels.

By now Elsam has gained a good deal of experience in the burning of different types of biomass, such as straw, wood and household rubbish. However, the straw has often caused problems at the power plants, as straw contains potassium chloride, which can entail corrosion.

However, potassium chloride can be removed by means of a simple cleaning process or simply by letting the straw lay on the fields for a while before it is gathered in.

On the laboratory plant at Fynsværket the leaching out takes place by means of pressure-cooking. In this way we get a better fuel and a liquid fraction that can be used for the production of ethanol.

The laboratory plant was built last summer, and since then we have had the opportunity of running a series of tests with pre-processing and pressure-cooking of the straw as well as tests with household waste. Next step will be the development of the ethanol process itself, where one of the topics must be the research into the development of microorganisms, which can optimise the process. After that a pilot plant must be built for the handling of approximately one tonne of straw per hour. Last step, before the project can be terminated in the spring of 2006, will be to design a full-scale plant, which can handle 450,000 tonnes of biomass a year.

- We would like to establish a full-scale plant in Denmark, but this is not realistic as long as the government continues its policy of maintaining the same taxes on liquid biomass fuels as on fossil fuels. Nearly all other countries within EU have exempted biomass fuels from taxation and therefore, it would be natural to place a plant in one of the other countries, says Charles Nielsen, who cannot hide that he is frustrated by the Danish policy within this area. ■

Biomass plant integrated in CHP plant

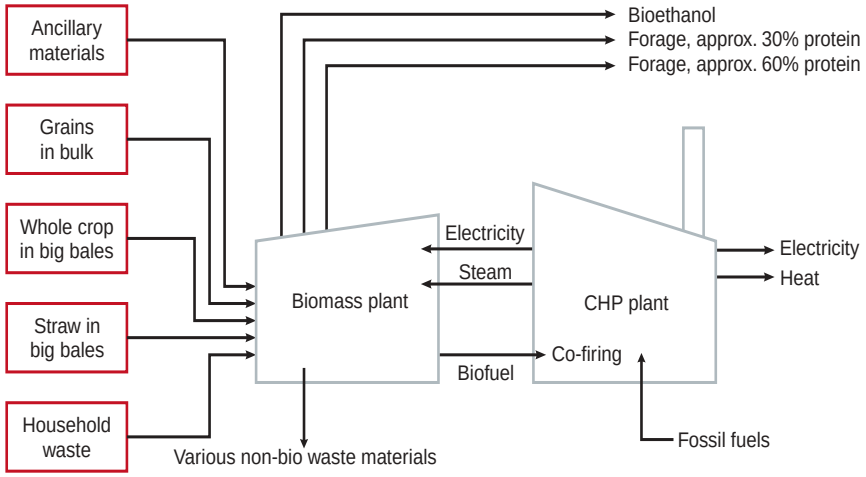

illustration: elsam

Continued access to international research

The Danish Energy Agency has decided to provide capital for the main part of the Danish participation in the International Energy Agency's working group concerning biomass combustion and co-firing for the next two years. Thus Denmark's continued access to this goldmine of information about biomass fuel combustion has been ensured.

By Anders Evald

The undersigned has been appointed as the Danish representative for the coming period. In the working group concerning biomass combustion and co-firing the following countries will still be present: The Netherlands, Denmark, Austria, Switzerland, Norway, Sweden, Australia, Canada, the Commission and probably Belgium and Great Britain. But New Zealand, USA and Finland are withdrawing from the group.

The working group held a meeting in Japan at the end of October together with two other groups who work with biomass gasification and waste incineration respectively. Meetings were held, partly in the respective groups, and partly in common with different interesting speeches. Furthermore, an excursion to a gasification and combustion plant as well as an open seminar took place. During these arrangements we received a good impression of the highly efficient waste combustion systems and the general energy situation in Japan. The rate of self-sufficiency within energy is only four per cent, and the country has entered into an engagement to reduce its emission of greenhouse gases.

Regarding waste combustion especially two aspects attracted great attention. First, it seems to be a commercial technology that the plants after-process the slag in a melting process. During this process, oxides and gaseous heavy metals will be separated in three fractions, each undergoing further processing/re-utilization. Secondly, the waste combustion plants were prepared for welcoming guests in clinically clean departments, where all sections of the process could be seen without getting into contact with any dirt at all. The idea is to create public acceptance of a completely necessary technology for the handling of waste/energy production.

photo: martin wittrup hansen

Mitsubishi's test plant for highly efficient waste gasification in fluid bed with steam and oxygen as fluidisation medium is situated close to Tokyo.

New reports

The working group concerning biomass combustion and co-firing has recently published two interesting reports by Ingvald Obernberger and his colleague Gerold Thek in Austria respectively. These are the result of a project about practical experience in biomass-related CHP plants in the member countries who participate in the working group.

Denmark plays an important part in the reports, to which especially John Jessen from the Danish plant Assens Fjernvarme has contributed with valuable information. The two reports contain various details which can be downloaded from the following homepage: www.ieabbcc.nl or ordered through the following e-mail address: hje@force.dk.

News

The next meeting in the working group is to be held on Friday 14 May in connection with the biomass conference in Rome. Please also note that the conference workshop on biomass co-firing is to be held on the same day.

News from the working group is forwarded to anyone in Denmark who might be interested via e-mail. We aim at sending out 3 or 6 e-mails a year including

From manure to hydrogen or crude oil

It is a well-known fact that biogas can be produced from manure, but it might also be possible to convert manure into both hydrogen and crude oil.

photo: biopress

Scientists at The Technical University of Denmark have found a way of producing hydrogen by means of manure and household waste. If the technology works in practise on a larger scale, the way will be paved for an environmental breakthrough, as the main part of hydrogen produced today is manufactured by means of natural gas.

By means of microorganisms it is possible to convert organic matter into hydrogen in a closed tank. However, in the course of one or two days other microorganisms starts converting the biomass into methane, and during this process the hydrogen disappears. Therefore, the idea of the project is to construct a pretank for the existing biogas plants, where the hydrogen is separated from the biomass before it is pumped in.

In connection with the test construction at The Technical University of Denmark, the scientists have used a membrane for the separation of the hydrogen in the pretank. On this occasion, it also turned out that the biogas production is increased by approximately 20 per cent because a number of the hardly convertible manure matters are degraded during the hydrogen production. In this way it becomes easier for the methane bacteria to transform the remaining biomass into gas.

From manure to oil

In the USA, a team of scientists at the University of Illinois is working on converting pig manure into a kind of crude oil which subsequently can be refined to fuel oil.

This process, during which the manure will be degraded and converted into oil, requires very high temperatures as well as very high pressure. In principle, it is the same thing that happens in nature when organic matter is converted into oil. However, whereas in nature the process takes place in the course of several centuries, it takes only half an hour in the laboratory.

So far the problem in the laboratory is that only a few amounts of manure can be converted into crude oil at a time. If the idea is to work in practise, methods and equipment that can handle major amounts of manure must be developed.

Source: The Danish newspapers Jyllands-Posten of 24 March 2004 and Landbrugsavisen of 16 April 2004.

the most important news. These e-mails will be followed by a bibliography containing the newest publications from the group. To mention an example, the publication «Handbook of Biomass Combustion and Co-Firing», which is a splendid textbook, has now been reprinted in a paperback version. We still have two versions from the first volume available.

Registration for the newsletter can be made to the following e-mail address: hje@force.dk.

Anders Evald is an engineer employed at FORCE Technology. FORCE Technology took over all activities of dk-TEKNIK ENERGI & MILJØ as per 1 January 2004. Learn more at the following homepage: www.force.dk.

Milestone for ethanol project

The Danish enterprise Novozymes has reached a milestone in the project of converting biomass into ethanol. This enterprise is working on the development of enzymes, which can reduce the costs when producing ethanol, and in 2001 the enterprise was granted the sum of DKK 87 million for a three-year cooperation with the National Renewable Energy Laboratory in the USA for this purpose. The aim was to reduce the costs when producing enzymes by factor 10, however, the enterprise recently succeeded in reducing the costs by factor 12.

At the same time, the Bush government has decided to spend more money on ethanol technology. Car manufacturers, who are still supporting the technology, will still be subsidised in future although the manufacturers do not improve the efficiency.

In 2003 there was an increase in the American production of ethanol by approximately 30 per cent. However, it is still only one per cent of the American cars that can use both petrol and ethanol blends. And less than 200 from the 176,000 petrol stations offer ethanol in replacement of the toxic additive MTBE.

Source: The Danish newspapers Børsen of 10 February 2004 and Økonomisk Ugebrev of 1 March 2004.

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.

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Photo on the front page:
Henrik Carlsen and Elsam

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 June 2004. The deadline for articles is 15 May 2004.

photo: biopress

New centre for biogas and manure processing

An ambitious project will focus on the development of manure processing technology by means of an intensified co-operation between private enterprises and public research. Furthermore, the project is the starting signal for the establishment of a new centre for manure processing and biogas in Foulum.

The Danish county of Viborg, Agro Business Park and The Danish Institute of Agricultural Sciences are the originators of the project. The project has a total budget of DKK 8 million, to which EU and The Danish Ministry of Food, Agriculture and Fisheries have contributed with totally DKK 4 million.

The chairman of the county council Bent Hansen does not conceal the fact that great ambitions lie behind the plans, which the county of Viborg, Agro Business Park and the Danish Institute of Agricultural Sciences are now carrying out and that the concrete project only makes out the pistol shut:

- The ambition is to establish a national centre for manure processing technology in Foulum, which shall be the leading centre in Northern Europe. It is obvious that we cannot do that alone. Therefore, the project brings about a co-operation planned on a generous scale between the enterprises, The Confederation of Danish Industries, the organization Danish Agriculture, the trade organization of biogas and other institutes of research and science as well as the relevant authorities.

One of the aims is to offer co-operation to enterprises and promoters on specific development projects.

- It takes great efforts to break the ground for research-based development projects, and it is often both a heavy and confusing task for the enterprises. Nevertheless, it is a very important part of the process, says the manager of Agro Business Park, René Damkjer.

Biogas and separation plant

The Danish minister for Food, Agriculture and Fisheries, Mariann Fischer Boel has already decided that a biogas and manure separation plant is to be founded at the Danish Institute of Agricultural Sciences in Foulum.

- With this plant we get some very attractive facilities, both for research and for carrying out practical development tasks. The new project will focus on the co-operation with the enterprises and therefore, be in line with the higher priority within the areas of research which is given at the moment, says the assistant general manager of the Danish Institute of Agricultural Sciences, Søren Mikkelsen.

- The longer-term aim is to create a research and development environment for manure processing technology in Foulum. An environment which makes it attractive to Danish and foreign enterprises to establish a business in the area.