Fourth volume
20th issue
June 2007

FiB
Bioenergy research



Focus on biomass gasification

In this issue, FiB - Bioenergy Research focuses on the area of gasification technology where Denmark is already playing an important role internationally, however, without having had a significant breakthrough yet.

By Torben Skøtt

We are moving extremely slowly. Describing the developments within the area of biomass gasification plants in few words, it is as simple as that.

Throughout the 1990s, we believed that biomass gasification would turn out to be the new windmill adventure and at some point, the Danish Energy Agency had in fact made plans for converting 100 small district heating plants into CHP-plants running on biomasses, mainly based on gasification technology. Such gasification plants are much more efficient than traditional steam turbine plants when it comes to converting small district heating plants into CHP-plants.

A so-called follow-up programme on CHP-plants based on biomasses supplemented the plans by the Danish Energy Agency. Furthermore, special electricity billing rules were drawn up for the plants, subvention arrangements were established, and financial grants were allocated to a variety of research and development projects.

Today, we have to admit that we are still very far from meeting the goals of the 1990s. Whereas one single plant, located in Harboøre, has been running steadily for several years and another two plants are being constructed in Skive and Gjøl, the plant in Høgild by Herning was closed down in 2003.

Considering the fact that between DKK 300 million and DKK 400 million have been spent on research and development, it gives food for thought that only one single plant has been able to establish a steady operation throughout the last few years.

But what exactly is the problem? Is gasification technology simply a hopeless matter? Are the researchers useless? Are the businesses unable to get their act together or could it be that politicians are unable to create the necessary framework?

Missing market

If you ask the various players in the market, you will not get an unambiguous an- ▶

swer; however, all the answers have one connecting thread: Technically seen, we have come a long way. In many ways, we are world leaders; however, we are missing the market needed to be able to carry the development all the way through.

– Danish researchers have presented some of the most epochal results in the area of gasification technology, but we are not using these results. Instead, other countries use them, says senior lecturer Ulrik Henriksen from the Danish University of Technology, who, amongst other tasks, is heading the team behind the "Viking-vaporizer".

Those companies expected to develop further and construct the plants obviously share the frustration.

– I am sick and tired of this topic and for the future, I have decided only to deal with plants that I deem likely to be interesting to the market for at least another ten years, says Thomas Koch. Owner of the company TK Energi, which constructs gasification plants, he experiences the problems first-hand, pulling no punches when describing the Danish efforts within this area.

– Developing new technology for a non-existing market is a waste of money that makes no sense. We will never know who has in fact developed a useful technology and who is only letting out empty words.

– This industry is loaded with fraud and swindle. A lot of people claim to have implemented a range of vaporizers across the world; however, when you visit their plants, hardly anything is actually working, concludes Thomas Koch.

A lot of people claim to have implemented a range of vaporizers across the world; however, when you visit their plants, hardly anything is actually working, says Thomas Koch from TK Energi (right). Next to him engineer Lars Sabro.

FiB – Bioenergy Research

– will be published four instead of the usual six times a year. Each issue will, however, be more comprehensive and we will publish more themed issues.

The deadlines for future issues are August 15th, November 15th, February 15th and May 15th. The magazine will reach the subscriber around four weeks after each deadline.

BioPress
✆ +45 8617 8507
www.biopress.dk

We believe in it

The Danish Energy Agency is, however, not willing to let the gasification technology go. According to Henrik Flyver Christiansen, who has been heading the agency's follow-up programme for CHPs based on biomasses, such plants carry certain obvious advantages compared to traditional steam plants.

– These plants are very effective and flexible and they have the ability to utilise many different types of biomasses.

As an example, he mentions current promising research into degasification of sewage slurry as well as long established proof that pressure-impregnated wood, chicken droppings and manurial fibres can be turned into combustible gas.

– Plant flexibility is the most important issue. We desperately need to create a more flexible electrical system in order to be able to fit in higher electricity amounts stemming from sun, wind and wave power, says Henrik Flyver Christiansen.

Energinet.dk, who has been donating large amounts of money towards the development of gasification plants for many years, does not want to let go of the idea either.

– We believe that gasification plants have the potential to turn into a promising line of business over the next few years, says programme coordinator Lise Nielson from Energinet.dk. Amongst other reasons, she highlights the fast that applicants have become better at attracting private investors, however, at the same time, she admits that it is very difficult to identify those projects with the highest potential.

– Today, everybody is fighting over the biomasses. Therefore, it would be particularly useful to develop plants with an ability to utilise more problematic types, says Lise Nielson and continues:

– Furthermore, we support projects on plants producing clean gas for usage in gas engines. Denmark is at the forefront of this area, close to reaching our goal of creating fully commercial plants. ■

Photo: Torben Skøtt/BioPress

The largest gasification plant in Europe

Skive has seen the first trial runs of a large gasification plants, which is meant to provide the inhabitants of Skive with electricity and district heating in the future. The DKK 185 million plant has been given a total plant subsidiary of DKK 35 million from the Danish Energy Agency, the EU and USA.

By Torben Skøtt

Skive has been given a new landmark: A huge gasification plant that is supposed to convert 30,000 tons of wood pellets to combustible gas per year. In the middle of June, the vaporizer was filled with fuel for the first time and if everything goes according to plan, the plant will be hooked up to the electrical network before the end of the year.

The plant is a so-called fluid bed plant, produced by the extremely experienced Finish/American company Carbona. Whereas the vaporizer part is based on known technology, the gas cleaning process, which makes the gas usable in an engine, has only been tested in a small pilot plant within the Finish research institution VTT. This is why only one of a future total of three engines has been installed so far.

– One thing at a time, explains Benno Jørgensen, CEO at Skive Fjernvarme (Skive District Heating Company).

– The first phase will be the vaporizer commissioning, which allows us to get the heating production for the future heating season up and running. Afterwards, we will start installing the gas cleaning and engine units. We are hoping to finish that phase by the end of the year and once we have tested the first engine, we will order the remaining two, says Benno Jørgensen. On the one hand, he is confident that the project will work out; however, he also admits that a trouble-free process will not get him the subsidiary of a double-digit million DKK.

A fluid bed vaporizer is very well suited to large plants; however, as the gas contains quite a lot of tar, direct usage in an engine is not feasible. Normally, the tar content is below one percent and significantly lower than that of a counter-flow vaporizer. At the same time, the fuel is dry and creates hardly any condensation. In this way, the typical wastewater problems produced by counter-flow vaporizers are avoided.

In Skive, the gas is cleaned in a catalytic converter, which basically converts tar materials to innocuous materials that may be injected into the engine along with the gas. This is a well-known principle, however, practical experience with this plant size is very limited and the scale of maintenance costs pertaining to the district heating plant is still unknown.

– We know that VTT in Finland has carried out tests on a smaller version of the catalytic converter during 3,600 hours without detecting any kind of deposits or other operational problems, states Benno Jørgensen. He does not expect operational costs to exceed those of a normal bag filter or similar equipment used for waste gas cleaning at modern district heating plants.

The plant in Skive cost DKK 185 million and was supported financially by the Danish Energy Agency (DKK 11 million), the EU (DKK 12 million) and the American Ministry of Energy. This is the first example of USA supporting an energy project within the EU. ■

The tar-free vaporizer – and the ultimate vaporizer

Tar-free gasification is a Danish area of specialisation developed on "Halmfort" (the straw fortress) within the Danish University of Technology, where a variety of successful tests on degasification of straw and animal manure have been carried out. Now, the researchers would like to develop the ultimate vaporizer – a plant possessing the ability to gasify anything for any purpose.

By Torben Skøtt

Converting biomasses into gas is neither complicated, nor does it constitute a new invention. What is complicated, however, is producing a gas clean enough to be utilised as engine fuel. Managing that, one could then connect an engine to an electric generator and create a small but highly efficient CHP-station.

– The cool thing about gasification is that even a small plant is able to provide a high electrical efficiency. In turn, this makes it easier to utilise waste heat from a district heating network and get the most out of local biomass resources, explains senior lecturer Ulrik Henriksen who works on the so-called "Halmfort" at the Danish University of Technology. In cooperation with students and other researchers, he is internationally known in the area of gasification technology development - particularly with regards to plants producing clean, tar-free gases.

"Halmfort" belongs to and enjoys a completely independent status within the Institute of Mechanics, Energy and Construction. A mixture of mobile workmen's huts, laboratories, workshops, coffee makers and various Heath Robinson inventions create the type of environment needed for ideas to blossom and results to derive.

One of the most famous plants developed at "Halmfort" is the "Viking-vaporizer", the researchers' first successful proof that utilisation of suitable technology can convert wet wood chips into tar-free gases in a two-stage process. Although this is a small pilot plant with a thermal input of just 70 kW, the electrical efficiency has been measured at an extremely satisfactory 25 %.

– The "Viking-vaporizer" still holds the world record in electrical efficiency for plants of that size, explains Ulrik Henriksen. He is expecting an electrical efficiency of more than 35 % once the plant has been scaled up to a thermal input of around 1 MW.

Gasification and fuel cells

– By converting gases, we will probably be able to reach around 50 % of the electrical efficiency in fuel cells, adds Jesper Ahrenfeldt who recently received his PhD degree at "Halmfort". It has taken a long time, but it finally seems that fuel cells are going to be used more widely for commercial purposes.

– Whereas research on fuel cells used to focus on identifying suitable materials, we are now trying to improve storage life and reduce the price, says Jesper Ahrenfeldt.

A fuel cell is an electrochemical unit that has the ability to convert gas to electricity, as an example, without prior combustion and without utilisation of mobile parts. This invention dates all the way back to 1839, however, fuel cells were not really utilised until they were integrated into NASA's space exploration programme. Researchers are confident that in the future, fuel cells will take on the function as small-scale power plants based on the application of a simple electrolysis principle.

The ultimate vaporizer

Ulrik Henriksen, working at "Halmfort", would like to start developing the ultimate vaporizer, as he calls it.

– In cooperation with "Halmfort", Peder Stoholm from Danish Fluid Bed Technology has developed a vaporizer that is basically able to gasify anything (refer also to the article on page 8). We have a plant where gas may be used for electricity, heating, liquid fuels purposes or whatever else we might need. The idea is to combine the best parts of both plants in order to create the ultimate vaporizer, i.e. a plant with an ability to vaporize almost anything for the

This is how the "Viking-vaporizer" works

The "Viking-vaporizer" is based on a two-stage process: Pyrolysis and coke gasification. Wet wood chips are led into the pyrolysis reactor where a powerful heat-up process makes the water evaporate and settles out a coke fraction and a tarry gas. Air is added between the two reactors in order to break down the tar materials. When the products are then led through the coke reactor, the coke is converted into gas. Afterwards, the gas is cooled down by a heat exchanger and sooty particles are collected using a normal bag filter.

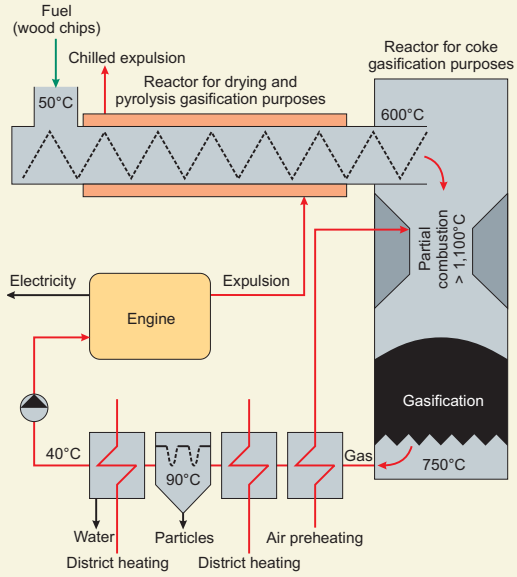


Photo: Torben Skøtt/BioPress

Ulrik Henriksen and the "Viking-vaporizer" engine unit that holds the world record in effective electricity production.

purpose of whatever you can imagine, explains Ulrik Henriksen.

Already back in autumn 2006, "Halmfort" applied for financial aid for the development of the ultimate vaporizer, however, the application was rejected. This rejection did not exactly strengthen the morale within the researcher group where this project is considered one of the most promising of all "Halmfort"-projects.

– I am afraid that the funding authorities do not understand the idea behind the project and have no faith that we would be able to turn the project into a success. Obviously, this is extremely frustrating because we know more about gasification than most people worldwide, says Ulrik Henriksen, and continues:

– Financial aid is mainly granted to whatever our politicians are preoccupied with at the moment and right now, most of the money is given to the area of biofuels.

– One should not forget, however, that the research, which we are living off these days, was carried out when Poul Schlütter was prime minister and that today's research will not become important until Anders Fogh Rasmussen has retired. Therefore, the reasons for turning down research projects possessing the potential to put Denmark at the forefront have to be very good, says Ulrik Henriksen. ■

The phase of jaws

Known as "the phase of jaws", a critical phase has evolved among small and medium-sized companies dealing with gasification plants.

The notion "the jaws" is used to describe the process facing companies once they have developed a certain type of technology and want to establish the first demonstration plant. Whereas it might be fairly easy to obtain financial support for the technological developments, it often proves extremely difficult to finance the first plant with a view to demonstrate the technology in question on a larger scale.

The most obvious thing to do is apply for EU grants; however, as a rule, subsidiaries can only make up a maximum of 50 % of the total plant expenses. The other half of the costs has to be financed in alternative ways and that is no easy task. In Denmark, it is close to impossible to find sufficient capital to cover that part of the project because investors are primarily interested in market-ready technologies that carry only a small risk of experiencing technical problems.

> ***"There is a huge difference between making a pilot plant work and delivering a fully commercial plant to a project owner.***

One of the companies approaching this critical phase is BioSynenergi Process who has managed to develop a gasification plant producing clean gases to be utilised in an engine. Their small pilot plant has already done 1,200 running hours and the next phase would be establishing a plant running on an electrical effect of 300 kW or four times as much as the current plant.

– It takes a lot of money to move from our current level to the construction of a fully commercial plant, says Henrik Houmann Jakobsen, CEO at BioSynenergi Process.

– We do not believe in forcing developments by skipping a couple of steps in order to reach the market as fast as possible. Scale enlargement takes times and is very costly because all the components need to be enhanced and adjusted continuously.

In recent years, BioSynenergi Process has been experiencing a vast amount of interest in their products from foreign countries; however, without a domestic market, export will take its time.

– We cannot export any plants until we have established the first 5-10 plants in Denmark, explains Henrik Houmann Jakobsen. He is frustrated that the Danish government still has not created the necessary framework and highlights the fact that Danish windmill producers would never have become worldwide market leaders without a solid domestic market.

Half in reserve

– There is a huge difference between making a pilot plant work and delivering a fully commercial plant to a project owner, says Ole Kristensen.

Today, he works for Kommunekemi as technical manager, but he used to work as development manager at Vølund during the time when they headed the construction and implementation of a gasification plant for Harboøre DHP.

– Whenever there is a problem, the customer picks up the phone and calls the producer. This very expensive service requires the producer to keep at least half of the development funds in reserve for the plant run-in procedure, explains Ole Kristensen.

Today, Vølund is part of the Babcock & Wilcox Vølund group, presenting a yearly turnover of more than DKK 700 million. Unforeseen expenses for a gasification plant will probably not shake up this group; however, very few Danish companies are as financially strong as that, particularly not when it comes to new technological developments in the field of energy. This area is mainly made up of small and medium-sized companies, often short of the capital needed to finalise the projects.

TS

Photo: Torben Skøtt/BioPress

Stabile operation following ten years of commissioning

It took four years to make the vaporizer work properly, three years to make the plant produce electricity and another three years to solve the wastewater problems. Now, the gasification plant in Harboøre is working according to plans and no other plant worldwide has completed as many running hours as this one.

By Torben Skøtt

– We mainly have to thank Vølund for making everything work out in the end, says Jørgen Snejbjerg, production manager at Harboøre DHP. Along with his friend Kim Jensen, he has been involved in dismantling the plant several times and these two operators know better than anyone that theory is one thing - practice is something else.

The history of the Harboøre gasification plant dates back as far as 1993 when the DHP signed a deal with Vølund involving the delivery of a gasification plant for wood chips. Under this deal, Vølund was liable to own and run the plant until the technology was working optimally and furthermore, the heating price was not allowed to exceed the production costs of a well-functioning boiler plant.

The first contract was due to expire after three years, however, nobody had imagined that it would take more than three years to sort out the initial problems and optimise the performance.

– Reality turned out to be quite different. We experienced a lot of problems with the feed system and the plant was constantly blocked because of a very tarry gas, says Jørgen Snejbjerg. He clearly remembers those years and admits that Vølund was often close to throwing in the towel, scrap the vaporizer and install a traditional boiler plant instead.

Photo: Torben Skøtt/BioPress

Jørgen Snejbjerg (left) and Kim Jensen in front of the vaporizer. The piping for wood chip feeding is located in the top left corner.

Luckily, it never came that far. The Harboøre plant has now been running for around 100,000 hours, a number that no other plant in the world is able to match. This fact has not remained unnoticed in the rest of the World and Vølund has later signed licence agreements with Japan and Germany, amongst others.

Following three problematic years, large parts of the plant were reconstructed in 1996, leading to performance improvements. After another commissioning period, it was concluded that the vaporizer was at least as reliable as a traditional grate-firing boiler and although the final goal was to produce electricity and heating, the plant had proven its abilities as a pure heating production unit as well.

This type of plant is extremely flexible compared to a boiler plant. Start-up and close-down procedures are very fast, the effect may be regulated from 10 % to 100 %, and the percentage of uncombusted elements in the waste gases is much lower than in a grate-firing plant.

Gas cleaning

Once the vaporizer had proven itself, Vølund obtained financial aid from the

Danish Energy Agency and embarked on another big project: Developing a gas cleaning system that would make it possible to produce heating and electricity in an engine generator plant.

Jørgen and Kim have a lot of stories to tell from that period. Such as the time when a Norwegian company was supposed to install a so-called RO-plant for wastewater cleaning, which ruined all plant membranes after a couple of hours of operation.

– They kept quite calm although that experience cost them around DKK 3 million, says Kim. He is not sure just how money has been invested in the plant throughout the years, but his guess is around DKK 150 – 200 million.

– The catalytic converter alone, which made up the first gas cleaning attempt, cost around DKK 10 million and I recon that the Danish Energy Agency has granted some DKK 70 – 80 million for plant development purposes, states Kim.

Following several reconstruction procedures and trials involving various technologies, the year 2003 finally saw the establishment of a complete plant that has been constantly running ever since.

One of the main challenges has been the recycling of the large amounts of wastewater and tar that make up the residual products of gas cleaning procedures. The fuel itself contains up to 50 % water, which is recovered as water vapour in the gases. Also, the large amounts of tar must be filtered out in order to avoid engine damages. A process, involving two gas coolers and an electric filter, separates out the tarry water. Afterwards, the water is vaporized through the use of heat from the gas engine exhaust and in the end, the tar may be utilised as peak or reserve loads in the oil boiler. Alternatively, the wood tar may be sold as wood preservative, which has proven to be a very suitable purpose. A yearly tar production of around 350 tons means quite a large energy potential.

Once the water has been vaporized, it is heated to around 600 degrees and the water vapours are combusted in a reactor. Initially, this sounds like a very energy-intensive process, however, the use of a condenser, which follows the reactor process recuperating the vapour energy content, reduces to a minimum the amount of energy utilised in the process.

Still Vølund's plant

To an outsider, the Harboøre plant construction might seem extremely complicated, but to Jørgen and Kim, it is all pretty simple.

– For instance, the principle behind the gas cleaning process is not that complicated at all. Basically, it is all about gasification, combustion and condensing, and as it does not involve any moveable parts, no maintenance is required, explains Kim. He does admit, however, that it looks a bit unclear, the reason being that it is only a demonstration plant that has been developed along the way.

– We know that the Japanese plant, which was produced under licence, is equipped with a slightly different type of water cleaning unit, says Jørgen. In his opinion, this is one of the areas in need of further research and he himself has various ideas on how to simplify the system.

The Harboøre plant has never been passed on to the district heating company, i.e. it is still run by Vølund. Technically seen, it works according to plan, however, the economic aspects of it are still not as lucrative as those of a traditional boiler plant using wood chips.

– We are very close, and slightly higher electricity prices would mean that our economy would make sense, explains Jørgen. He also says that if the electricity prices would be similar to those of Germany and Italy, the plant would constitute a good business. ■

Photo: Torben Skøtt/BioPress

Production manager Jørgen Snejbjerg demonstrates the very small amount of ashes resulting from the gasification procedure. Normal production conditions create around 0.6 % ashes.

Photo: Torben Skøtt/BioPress

The wastewater cleaning plant. To an outsider, the Harboøre plant construction might seem extremely complicated, but to Jørgen and Kim, it is all pretty simple.

Briefing on the energy research programmes

Wednesday, August 15th 2007 from 9.30 am to 4.00 pm
Trinity Hotel, Gl. Færgevej 30, Snoghøj, Fredericia, DK

Organisers: EUDP within the Danish Energy Agency
ELFORSK within Dansk Energi - Net
EnMi within the Danish Strategic Research Council
ForskEL within Energinet.dk

Registration: Karen Marie Dinesen • kmd@energinet.dk • 0045 7622 4509
no later than August 1st 2007

Programme: www.ens.dk • elforsk.dk • www.fist.dk • www.energinet.dk

Today, we are not only able to convert wood ships and dry wood to gas, but also more problematic types of biomasses such as straw and animal manure are used in gasification processes. Experience gained from various tests carried out at the Danish University of Technology supports this claim. The technology applied has a large potential, however, Danish tax burdens and legal requirements with regards to self-contained waste disposal plants make it extremely difficult to establish the first full-scale plants.

Photo: Jørgen Schytte

Gasification of problematic biofuels

By Peder Stoholm

It is widely known within the power station industry that the so-called circulating fluid bed (CFB) vaporizer may be utilised as a pre-firing head for power plant boilers. In this way, the ashes do not enter the boiler room, enabling exploitation of a long list of different biofuels without creating powerful and corrosive deposits inside the boiler. As an example, the system may be used for co-firing of biomasses and waste using existing coal boilers because the two different types of ashes are kept in two different containers and may later be used separately.

However, traditional CFB vaporizers require a temperature of 850 – 900 °C, which implies a considerable risk of the ashes actually melting when using agricultural biomasses. Also, high concentrations of vaporized ash components may lead to problems when the gas is cooled down and cleaned.

At Danish Fluid Bed Technology ApS, we have spent years working on developing a fuel-flexible version of the CFB vaporizer. In 2000, the concept was initially tested by means of a small 50 kW plant at the Danish University of Technology, followed by the establishment three years later of a 500 kW plant with an ability to gasify up to four tons of fuel per 24-hours. Later, a 6 MW demonstration plant was designed and economic calculations for plants up to 12 MW were drawn up.

Although we have not been able to establish a demonstration plant yet, we are keeping the pot on the boil through continuous optimisation and testing as well as a range of activities, which will hopefully lead to the construction of a 5 – 15 kW plant one day. This project has been given DKK 4 million for the period 2007 – 2008 by Energinet.dk.

The concept

The new vaporizer has been given the very verbatim name LT-CFB meaning Low Temperature Circulating Fluid Bed. Just like in traditional CFB vaporizers, the biomasses are led into a reaction chamber where they are quickly heated up through sand and ash particles circulating throughout the plant. In the LT-CFB vaporizer, however, we have included a smaller primary reaction chamber and lowered the temperature in order to obtain a fast pyrolysis process instead of using a more time-consuming coke gasification procedure. The lack of oxygen prevents the biomasses from catching fire; instead they turn into around 80 % pyrolysis gas and 20 % coke. The coke particles are gasified by adding air and possibly water vapour in a separate coke reactor. Inside the coke reactor, the speed is much slower than in a traditional CFB vaporizer, one of the reasons why these

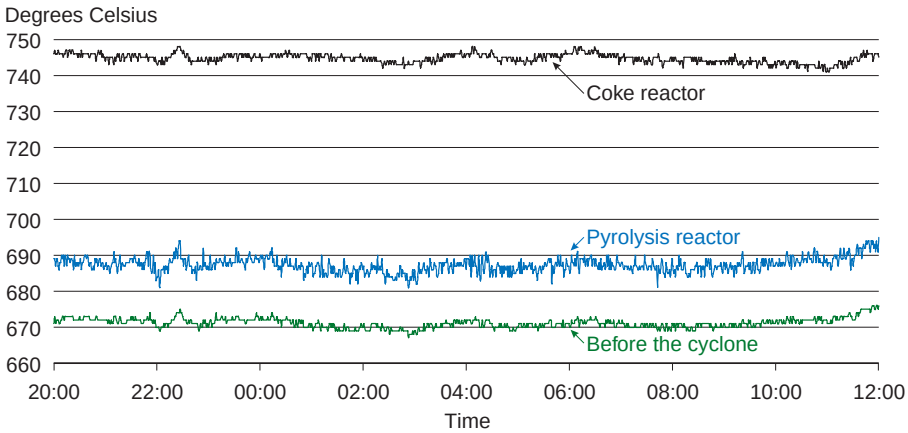


Figure 1. Temperatures measured during the most recent 500 kW test using manure fibres from the biogas joint facility in Fangel, which involved several days and nights.

particles obtain a much longer retention time, and in turn facilitating the conversion of coke at a lower temperature. This makes it possible to utilise more problematic types of biomasses, which often contain a lot of salty KCI that in a pure form will melt at 773 °C.

A further advantage is obtained by leading the coke gas through the upper part of the cooler pyrolysis chamber whereby the gas is cooled down to such a level that KCI, amongst other things, mainly exists in a solid form and may later be filtered out in a cyclone or removed via the bottom ashes.

Testing the vaporizer, an almost extreme degree of operating stability was detected. In this way, problems related to sudden temperature increases and melting ashes are avoided (see also figure 1).

Utilising manure as fuel

The main advantage of the LT-CFB vaporizer is its apparent ability to gasify most types of biomasses. So far, it has been able to cope with all the tested fuel types, including wooden pellets, two problematic straw types, chicken droppings and four different types of manure fibres from agriculture and biogas plants.

Fibres stemming from livestock manure is just one of many potential fuel types, but one that carries a very high potential. The energy production potential is at the same level as that of straw and many farmers and biogas plant managers are interested in giving away the fibres for free in order to rid themselves of the problem of excess phosphorus. In this manner, even small LT-CFB plants will turn out to be feasible. The most recent calculations have shown that a 12 MW plant will be able to produce electricity at around DKK 0.35/kWh, including expenses related to collecting and drying the fibres. One of the prerequisites for this calculation is the absence of waste fees and that every ton of CO_2 displaced by the plant will bring in earnings of DKK 100.

Furthermore, nutrients contained in the ashes may be utilised as well. Using them in the production of artificial manure would be the obvious thing to do, however, it also seems that the ashes may be spread out directly onto farmland without exceeding the upper PAH and heavy metal limits.

Demonstration and export

The economic details behind a gasification plant constructed in connection with a power plant is probably going to mirror that of a manure-based plant given that waste products from the food industry, organic fraction of household waste or sewage sludge are being used.

On the contrary, plants for wood, straw, energy crops and similar expensive biofuels are only of interest to those power plants running at 50 MW or above. Such a significant scale enlargement of the 500 kW plant is, however, rather risky, i.e. initially, only small plants for cheap fuel types are of interest.

In other countries, many types of other low-value, technically seen complicated fuel types such as rice straw and rice peel as well as cotton sweepings are available. Nowadays, only a minor part of such fuels are put to use, leading to a high potential for exporting the LT-CFB technology to areas featuring large biomass resources.

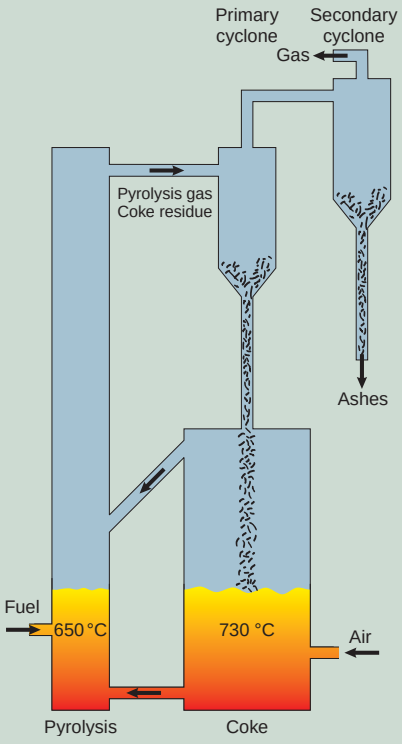
Danish barriers

Based on the convincing test results and the above-mentioned perspectives for the future, constructing a demonstration plant within a power station with a view to carry out co-firing with manurial fibre has long been a primary goal. Livestock manure falls outside the scope of the Danish statutory order of biomasses, which means that as a rule, waste fees are due. The government has removed fees on fibres stemming from biogas plants, but so far, the amounts in question have been too limited. As an example, a 12 MW plant would have to receive dry material from around half of those 150,000 tons of fibres that are filtered out per year in Danish biogas plants.

The situation is at a deadlock. As long as disposing of the very phosphorous fibres constitutes a problem, no more biogas plants are likely to be constructed and without sufficient amounts of fibres, establishment of gasification plants remains difficult. In order to cut this Gordian knot, charges on raw manure must be removed for a suitable number of years.

The formal status of livestock manure as a type of waste also entails that the power plant will be ordered to apply the so-called "self-sufficiency" economy, i.e. the plant is not allowed to make a profit, in turn making it an uninteresting investment to potential commercial owners.

How the vaporizer works



Comminute fuel is fed into the bottom of the pyrolysis chamber and heated up to around 650 °C. As no oxygen is present, the straw will not catch fire but is converted to 80 % pyrolysis gas and 20 % coke instead. A stream of circulating sand particles carries along the coke particles, which are then filtered out by a primary cyclone separator and recirculated back to the bottom of the pyrolysis chamber through a reactor converting coke into gas.

When gasifying the coke particles in a separate chamber, the processing temperatures are kept at such a low level that the ashes do not melt. In this manner, the ashes, including alkaline salt and phosphorus, are filtered out in order to create a gas that does not cause deposits and corrosion. These nutritious ashes may later be utilised as manure and probably also as part of the production of commercial manure.

These barriers seem paradoxical viewed in the light of the increasing consensus among politicians that there is a need for:

- substitution of fossil fuels with CO_2-neutral ones
- a competitive and sustainable agricultural industry
- increased efforts to solve the growing problems in our aquatic systems
- more biogas plants
- extended export of Danish energy and environmental technologies.

If in the future we manage to switch from electricity production based on fossil fuels to making more use of sun and wind, we are going to need a more flexible electricity system. The LT-CFB vaporizer will be an obvious choice because of its ability to stop and start very quickly as well as the possibility of adjusting its load conditions on a continuous basis.

The vaporizer is well insulated, i.e. the temperature level inside the plant is not going to decrease much during a night, especially in large plants. For this reason, the power-up to a level of, say, 100 % may be completed within a few seconds by adding air and then fuel.

Further applications

The LT-CFB vaporizer produces a warm, tarry gas that may also be used for Stirling engines, as an example, whereas usage in gas engines, gas turbines, fuel cells or cold pipework requires further gas cleaning procedures. The vaporizer will probably also be able to serve in the production of bio-oil and synthesis gas, however, for the time being, we are focusing on an efficient and adjustable production of electricity and heating.

The development efforts are mainly being carried out in cooperation with the Biomass Gasification Group within the Danish University of Technology, FORCE Technology, Anhydro A/S and DONG Energy. Since 2000, the efforts have been financially supported by the Energy Research Programme and the PSO-programme, administered by Energinet.dk.

Peder Stoholm is CEO at Danish Fluid Bed Technology, e-mail: dfbt@catscience.dk

Natural gas is out – wood gas is in

Soon, the local power station in the village of Gjøl west of Aalborg will be able to produce electricity and heating using gasification gas. This will be the first plant of its kind in Denmark producing a tar-free gas that may be utilised in existing natural gas plants.

By Torben Skøtt

– Basically, I am sure that this is a good plant, however, I am worried that we are going to have a lot of problems if we have too many hick-ups and the commissioning process turns out to last a long time, says Calle Østergaard, CEO at Troll Company and a member of the board of directors at Gjøl Private Kraftvarmeværk (private CHP-plant) in the North of Zealand. Here, technicians are currently finishing a gasification plant for wood chips. The plant was supposed to be ready for commissioning in autumn 2005; however, the adjusted goal is to get it ready for the up-coming heating season.

TK Energi has produced the plant and everybody involved in the project, including producer, project owner and advisors, admits that they have had to deal with a lot of problems ever since the initial agreements were signed almost five years ago.

The EU, the Danish Energy Agency, and various commercial investors financially support this project, consisting of various sub-contracts that make it difficult to keep an overview. At the same time, the cooperation between the project owner and the initial project advisor turned into an arbitration case, which did not facilitate the process either.

Who carries the responsibility?

Recently, the board of directors at the Gjøl CHP-plant went on a field trip to the Harboøre gasification plant. Calle Østergaard makes no secret of the fact that he is slightly jealous of the deal drawn up between the people in Harboøre and the plant producer. Firstly, that deal clearly places full responsibility with the producer and secondly, it states that the plant will only be passed on to the DHP-plant once the heating prices are at the same level as those of a boiler plant based on wood chips.

– When entering this project, we actually believed that we were dealing with a mature plant and that we would just need to press the start button to get it going. Today, we know that it is probably not going to be as simple as that, says Calle Østergaard.

The CEO at TK Energi, Thomas Koch, agrees:

– When you receive DKK 7 million in financial support, it is obvious that you are not dealing with a fully com-

Photo: Torben Skøtt/BioPress

Production manager Torben Brand Andersen at the crane, which supplies wood chips to the vaporizer and the boiler.

mercial plant. We have tested the technology in our own pilot plant and in a small plant that we produced for Hitachi in Japan; however, this is the largest plant we have ever constructed. Commissioning problems are bound to arise and the advisors should have warned the board of directors in Gjøl of this possibility.

Tar-free gasification

Today, Gjøl owns a CHP-plant based on natural gas, which produces electricity to the public network and supplies 325 households with district heating. The original plan was to construct a large biogas plant in order to obtain cheaper and more environmentally friendly district heating, but the problem was that nobody wanted to live next to a plant primarily using manure from numerous mink farms in the area.

Instead, it was decided to construct a gasification plant for wood chips, which – as opposed to the Harboøre plant – converts the tar components inside the vaporizer itself. In this manner, there is no need to establish a separate gas cleaning plant, thereby saving both plant expenses as well as operational and maintenance costs.

– If you split the process into several steps, you may obtain tar-free gasification, explains Mads Nielsen from TK Energi and continues:

– In the first phase, fuel is heated to 500 – 600° C by adding air. This is where the so-called pyrolysis takes place, converting the wood chips into coke and tarry gas. In the next phase, more air is added and the temperature rises to 1,200 – 1,300 °C. Afterwards, the hot gas passes by a coke bed, which

Photo: Torben Skøtt/BioPress

The tar-free wood chip vaporizer constitutes "the heart" of the new plant. Mads Nielsen from TK Energi (left) and production manager Torben Brand Andersen (right).

cools the gas down to around 750 °C. At the same time, the coke particles are converted. In this manner, the removal of residue sooty particles only requires a gas cooler and bag filter instead of expensive gas cleaning units, explains Mads Nielsen.

Tar-free gasification is a Danish speciality developed at the Danish University of Technology. TK Energi has enhanced the process and the companies Weiss and BioSynergi Process are currently working on their individual versions of a tar-free gasification plant.

Wood gas and wood chip heat

The vaporizer from TK Energi is placed in a completely new building just a few hundred yards from the existing natural gas plant. Placing the unit within the existing building would have made more sense, however, the local authorities opposed to that plan. Apart from the vaporizer and a wood chip storage area, the new buildings also contain a traditional boiler plant for peak and reserve loads.

Soon, technicians working at this CHP-plant will embark on the reconstruction of one of the two natural gas engines in order to enable it to run on gasification gas. If it later turns out that there is sufficient gas for more than one engine, the second engine will be converted for the purpose of using gasification gas as well.

– We hope that this plant is able to produce sufficient gas for us to avoid natural gas altogether. Only using wood chips would be a clear advantage, says Arne Nielsen, chairman at the Gjøl CHP-plant.

According to Arne Nielsen, the gasification plant, including buildings, wood chip boiler and storage facilities, has cost DKK 13 – 14 million. Whereas EU has granted DKK 3.2 million, the Danish Energy Agency has provided DKK 4.2 million and Energinet.dk an amount of DKK 1.9 million. Thomas Koch recons that the project as a whole amounts to around DKK 30 million, including plant development costs.

If everything works out according to plan, the first gasification gas test runs will take place in July or August this year.

Photo: Torben Skøtt/BioPress

The existing natural gas CHP-plant. One of its engines will now be converted to run on gasification gas.

Photo: Torben Skøtt/BioPress

The new plant contains the vaporizer, a wood chip boiler and a storage area.

Useful addresses

Production & sale

Babcock & Wilcox Vølund develops and sells gasification plants under licence. Amongst other things, they have constructed the Harboøre plant (see article on page 6).

www.volund.dk • ✆ 0045 7614 3400.

BioSynergi Process ApS develops and markets the so-called "Open Core vaporizer", which produces a tar-free gas based on wood chips. The company owns a demonstration plant in Græsted in the north of Zealand.

www.biosynergi.dk • ✆ 0045 4586 1430.

Stirling Danmark develops and markets a smaller counter-flow vaporizer in connection with their primary business area, which is selling stirling engines. The company owns a small demonstration plant in Ansager in the south of Jutland.

www.stirling.dk • ✆ 0045 4525 9370.

TK Energi AS develops and markets various types of gasification plants, including a two-step vaporizer producing a tar-free gas. The company has sold a plant to Japan, as an example, and is currently finalising a plant for the village of Gjøl in the north of Jutland (see article on page 10).

www.tke.dk • ✆ 0045 4618 9000.

Weiss A/S is currently scaling up the "Viking-vaporizer", which was developed at the Danish University of Technology. Ten times bigger than the "Viking-vaporizer", the first plant will be tested in autumn 2007.

www.weiss-as.dk • & 0045 9652 0445.

Research and consultancy

COWI A/S has carried out a variety of projects on gasification, cooperating with the Danish University of Technology and the company Weiss A/S, amongst others.

www.cowi.dk • ✆ 0045 4597 2211.

At the **Danish University of Technology**, several projects on gasification have been carried out, amongst other things, leading to the development of the "Viking-vaporizer".

www.et.mek.dtu.dk • ✆ 0045 4525 4122.

Force Technology has completed a number of projects on gasification and works with TK Energi A/S, amongst others. Currently, the company provides advice to the private CHP-plant in Gjøl.

www.forcetechnology.com
✆ 0045 4326 7000.

Plants

In a couple of months, **Gjøl Private Kraftvarmeværk** will be inaugurating a new gasification plant, provided by TK Energi. For now, the company Nyfors will be running the plant.

www.nyfors.dk • ✆ 0045 9882 1311.

Since 1993, **Harboøre Fjernvarme** (Harboøre District Heating) has been running a gasification plant for wood chips, consisting of a counter-flow vaporizer and an adjacent gas cleaning unit, and having completed more than 100,000 operating hours so far.

✆ 0045 9783 5200.

In a few months, **Skive Fjernvarme** (Skive District Heating) will be placing into operation the largest vaporizer in Europe. This fluid bed vaporizer for wood chips produces a tarry gas that is later cleaned in a catalytic converter plant. The plant is expected to be hooked up to the electricity network by the end of 2007.

www.skivefjernvarme.dk
✆ 0045 9752 0966.

Stable operation at the Græsted-plant

The gasification plant at Græsted Fjernvarme (Græsted District Heating) in the north of Zealand has now completed 1,400 operating hours and is running under steady-state conditions.

– They just called me from the plant to tell me that I might as well go and buy the next cake, says Henrik Houmann Jakobsen, CEO at BioSynergi Process, a gasification plant developing company. The company's pilot plant in Græsted in the north of Zealand had just completed 1,400 operating hours, when we called the CEO, and such events are always celebrated with coffee and cake.

The Græsted plant is located within the local district heating plant, collecting the heating but passing on the electricity to the public electricity network. This is a so-called Open Core vaporizer that allows the upper fuel feed unit to remain open during operation. It uses wood chips, which are dried by means of the engine exhaust heat to a water content level of around 20 %, thereby avoiding the need for an expensive and complicated gas cleaning procedure.

Looking into the Græsted vaporizer.

Recently, BioSynergi Process received DKK 3 million from Energinet.dk in financial support of a project that partly aims at improving and simplifying the existing pilot plant and partly constitutes the basis for the construction of the first commercial plant.

– Some of this grant is earmarked for an economic advisor who is going to assist us in locating investors for a new and larger plant. The idea is that those investors will own and run the plant and sell the heating to a district heating plant, says Henrik Houmann Jakobsen. He expects the new plant to have an electricity efficiency level of 300 kW or four times as high as the Græsted plant. *TS*

Turning research into business

In the future, some of the applicants within the PSO-system will be invited to provide business plans for their projects. The goal of this initiative is to make sure that fewer projects end up gathering dust on the shelves but are in fact supported all the way and turned into business opportunities.

By Torben Skøtt

Every year, Energinet.dk grants DKK 130 million to research and development measures within the area of environmentally friendly electricity production. In order to enhance the commercial payoff from these PSO-funds in the up-coming application process, Energinet.dk wants to strengthen its effort to reach the markets available to those projects possessing the right potential.

– We allow the applicants to explain their strategy with regards to reaching the full potential of their project. Afterwards, we will support them through the possibility of obtaining PSO-funds with a view to draw up detailed business plans as part of the project, says programme coordinator Lise Nielson from Energinet.dk.

By adding business plans and commercial goals to the technical content of the applications, Energinet.dk expects that fewer projects will end up gathering dust on the shelves instead of being supported all the way and turned into a business opportunity. One of the goals is to foster more new companies and spin-offs from universities and companies, another is to attract other types of financial support, e.g. venture capital. Energinet.dk will ask the applicants behind those projects involving commercial goals to outline the type of products or services that the technological development is expected to provide and furthermore, customers and markets for this particular project must be defined. The applicants will also be asked to perform a SWOT analysis of the potential road to commercial success.

Søren Houmøller from 1st Mile.

1st Mile

Søren Houmøller from the company 1st Mile has helped Energinet.dk to implement commercial criteria for the future supply. Formerly CEO at the venture company EGJ Udvikling (EGJ Development), he has, amongst other things, carried out investments into the company Stirling that produces CHP-plants running on biomasses.

– In order to create a commercial success, it is of utmost importance that commercial and technological developments are considered simultaneously. Therefore, the first step is to ask the applicants to outline the expected commercial developments, explains Søren Houmøller.

Energinet.dk places great emphasis on the applicants perceiving this initiative as a helping hand on their way to reaching their goal of creating a business. For this reason, Energinet.dk has also asked Søren Houmøller to create a business plan framework.

1st Mile

1st Mile links research and development within new energy and environmental technologies to capital. Founded by Søren Houmøller, this company identifies business cases for investors, looks for capital for start-up companies, and assists research programmes in securing its business success based on technology.

www.1stMile.dk
✆ 0045 4044 6714

– You may use our framework or your own. A lot of applicants have already prepared their business plans and obviously, we do not want to impose our format onto those people, says Lise Nielson who, by the way, does not see business plan confidentiality as a problem because Energinet.dk and the applicant are able to set up separate publication agreements.

Not all projects are linked to commercial goals: When it comes to fundamental research, solutions for plant-specific problems or standardisation procedures, business plans do not fit into the picture.

To Søren Houmøller it is of utmost importance that the Danes improve their ability to link technology and business.

– It is often said that we need to create a new windmill adventure based on other, new technologies, however, the model used back then either does not fit the current market situation or cannot be copied directly onto other types of technology. The rules of the game have changed, says Søren Houmøller, pointing out that just in the third quarter of 2006, investors in Silicon Valley invested US$ 300 million of venture capital into energy and environmental technology. During that same period, the Danes invested no more than DKK 50 million or 3 – 4 % of the investment scope in Silicon Valley.

– If Denmark wants to foster new export adventures and identify the winning technology of the future for the benefit of the environment and the security of supply, we simply have to improve our innovation skills and find better ways to attract external capital, e.g. from venture capital companies. Financing technical research and development is insufficient. Other countries are hitching up many horses and it would be totally naive to believe that we will be able to maintain our current leading position if we do not improve our ability to shift focus from technology to product and switch the organisational format from project to organisation. Technological considerations are no longer sufficient; we need to consider market, economy and management as well, says Søren Houmøller. ■

Remove the stench - add an alga to your tank

Algae such as sea lettuce contain considerable amounts of biomasses, which, amongst other things, may be utilised in the production of biofuels. Whereas traditional farming practices only render around 10 tons of dry material per hectare, sea lettuce would be able to contribute up to 500 tons per hectare. At the same time, harvesting naturally occurring algae and sea lettuce would remove the stench from many inlets and closed bodies of surface water.

Photo: Michael Bo Rasmussen, DMU

Sea lettuce and other types of algae constitute a big problem for the marine environment and the bathers in the summer. According to the Danish National Environmental Research Institute, some 80,000 – 100,000 tons of sea lettuce would be available per year to be used in the production of biofuels, amongst other things.

By Torben Skøtt

Over the last couple of years, the fight over available biomass resources has intensified significantly. Biofuel production ties up an increasing amount of land and an increasing number of countries have come to realise that biomasses may contribute significantly to the production of electricity and heating.

The rising demand for biomasses leads to certain problems: The UN has drawn up a new report warning us that recent years' considerable price increases relating to maize and corn might lead to serious food shortages and poverty. In the USA alone, one third of the total maize harvest of 2006 was used in the production of ethanol and many countries are clearing huge forest areas in order to use them for palm oil production.

The researchers have now started looking for alternative types of biomasses for energy purposes. Michael Bo Rasmussen from the Danish National Environmental Research Institute spoke of this trend during a conference in "Industriens Hus" in the middle of May:

– The so-called marine biomasses carry a considerable potential, explained Michael Bo Rasmussen at the conference, organised by VE-Net. He was particularly interested in various types of algae, such as sea lettuce, but mentioned that basically, anything living in the sea containing organically combined carbon may be utilised.

In actual practice, however, certain requirements must be fulfilled. First of all, it must be ethically acceptable: You cannot stuff a whale into a biogas plant or make ethanol out of baby seals. Secondly, you should primarily use non-food products with a high growth rate and a significant energy content, i.e. through carbohydrates or fatty acids, and thirdly, you should preferably use items that are easy to grow and manage.

Sea lettuce

Considering above-mentioned criteria, it seems that sea lettuce is an obvious choice as the energy crop of the future. These green lettuce leaves grow naturally in Danish waters, double their weight within 3 – 4 days and keep on growing without problems even if they have been torn apart and are floating around in the water.

Photo: Peter Bondo Christensen, DMU

Lunch is served! Apparently, sea lettuce is very delicious, however, we primarily want to use the lettuce leaves for the production of bioenergy.

Sea lettuce and other types of algae are normally considered a problem for the marine environment and even more so for the bathers in the summer. For this reason, it may in fact be a good idea to harvest naturally occurring algae, which in Danish waters are expected to make up some 80,000 – 100,000 tons per year. This would lead to a better marine environment, better beaches and less stench in inlets and closed bodies of surface water – or, as expressed by Michael Bo Rasmussen in the conference: Remove the stench – add an alga to your tank.

– Around the world, you can find various machines for harvesting sea lettuce in nature and in other places, such as Italy, people use fishing nets to collect the lettuce leaves in order for them not to bother the bathers. We only have a very limited amount of experience in this area and there is a need for further development, said Michael Bo Rasmussen.

Use liquid manure and carbon dioxide

Sea lettuce may be grown and harvested all year around, however, the produc-

tion obviously peaks in the summer. The growth rate depends on light, temperature, nitrogen and phosphorus nutrients as well as the amount of carbon dioxide in the water.

Throughout the last 20 years, researchers at the Danish National Environmental Research Institute have been studying sea lettuce, but they only recently discovered that it might be utilised to produce large amounts of biomasses given the right conditions. When adding liquid manure, the growth rate increases considerably and recent laboratory tests indicate that adding carbon dioxide increases production ten-fold.

However, this situation requires production to take place in closed basins where the addition of liquid manure and carbon dioxide can be adjusted according to plant absorption abilities. Initially, it may sound like an expensive solution, but seen in the light of the fact that it provides an opportunity to produce bioenergy, take delivery of carbon dioxide from the CHP-plants' exhaust gases and at the same time solve an agricultural problem of excess liquid manure, it might just turn out to be a good business.

We are talking large amounts: According to Michael Bo Rasmussen, a production using 1,000 tons of algae will require seven million litres of liquid manure and 1,500 - 3,000 tons of CO_2. Also, the resulting amounts of bioenergy would be quite considerable: A conservative estimate would be 200 – 500 tons of biomasses per hectare, depending on our ability to utilise CO_2 releases from CHP-plants. This is a completely different scenario to growing energy crops on farmland where a good result constitutes around 10 tons of dry material per hectare.

Development

Michael Bo Rasmussen openly admits that research is still in the early stage and that there is a great need for development to be covered before the first full-scale plants can be established.

– We need to improve the harvesting methods, find out how the growth rate may be increased to the maximum and how to optimise the carbohydrate content in the algae, explains Michael Bo Rasmussen and continues:

– We know that liquid manure and carbon dioxide advance the growth rate, however, we do not know, for example, whether the CO_2 provided by our CHP-plants must be cleaned first, or whether we will be able to use it directly in the basins.

Finally, the question of utilising the algae in the best way for the purpose of energy production must be addressed. Up to 60 % of the dry weight consists of carbohydrates, including a significant amount of glucose, which is easy to convert. Therefore, sea lettuce is well suited for the production of bioethanol, perhaps in combination with the production of biogases.

Photo: Torben Skøtt/BioPress

Laboratory tests seem to indicate that the addition of carbon dioxide from the CHP-plants' exhaust gases increases the production of sea lettuce ten-fold. A production using 1,000 tons of algae will require 1,500 - 3,000 tons of CO_2 and around seven million litres of liquid manure from the farming community.

Great victory for the eco-vehicle

Also this year, students at the Danish University of Technology won several prizes at the Shell race for eco-vehicles in the south of France.

DTU Dynamo, this year using a fuel type called DME, which, amongst other things, may be produced using biomasses, won no less than three prizes. The vehicle won first prize in the category of "town vehicles" with internal combustion engines, the prize for the most environmentally friendly vehicle releasing the smallest amounts of CO_2 as well as a prize for using DME as the best alternative to diesel.

The category “town vehicles” consists of vehicles resembling normal cars. This year, the rules had been altered in order to make the category resemble reality even more: Amongst other things, the vehicles were required to be parked and then re-started three times during the race, but even so, DTU Dynamo did 306 kilometres per litre of DME.

The students had entered yet another vehicle in the race: The DTU Innovator that runs on hydrogen. This vehicle managed to do what would equal 1,617 kilometres on a litre of petrol, and despite several accidents, it finished in 7th place.

Students at the Institute of Mechanics, Energy and Construction, headed by senior lecturer Jesper Schramm, constructed the two vehicles. The students now want to work on improving the vehicles and hope to be able to construct a real car within the next two to three years.

Source: www.dtu.dk

FiB – Bioenergy Research is published with support from Denmark's Energy Research Programme. 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. Further copies of the Danish version can be ordered from BioPress, via the following e-mail address: biopress@ biopress.dk, or telephone nr +45 8617 8507.

Editor responsible:
Torben Skøtt

ISSN: 1604-6358

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

Photo on the front page:
Torben Skøtt/BioPress and Peter Bondo Christensen/DMU.

Next issue:
– to be published in the middle of September 2007. The deadline for articles is 15 August 2007.

Do we need to forget about biofuels?

ArkivPhoto: Torben Skøtt/Biopress

A new research project, which will be running for four years, is going to shed light on the advantages and disadvantages of biofuels. Having been granted DKK 21 million from the Danish Strategic Research Council, this project involves participants from seven of the leading research institutions in Denmark.

At first, it did not seem particularly interesting. Later, using biofuels turned out to be the thing to do, however, sceptic voices then started warning us about rising food prices, poverty and resource waste. Today, supporters and opponents of biofuels seem to have drawn against each other, but one thing is still certain: The general public and politicians alike are finding it very difficult to comprehend the on-going debate and identify the most trustworthy researchers.

A new research project is now going to atone for this situation. The Danish Strategic Research Council has granted no less than DKK 21 million to a project, which will be running for four years and is meant to answers our questions on future energy systems, including the most effective way of meeting the energy needs of the transport sector.

– We are going to analyse the way to reach an energy system that works 100 % on the basis of renewable energy, says professor Henrik Lund from the University of Aalborg who is going to head this ambitious project.

– Our main goal is to provide a coherent analysis of the energy system, but we are particularly going to focus on the electricity network, life cycle analyses, the energy market and the transport sector, explains Henrik Lund. Each area will feature a range of experts and some of the most notable persons within the biofuels debate will participate in the area of transport. This includes senior lecturer Henrik Wenzel who believes that presenting biofuels as a solution to the problems of the transport sector is merely a way of fooling the general public. Amongst the supporters are professor Claus Felby who sees a great potential in second-generation bioethanol and recons that we ought to use biofuels here and now.

Henrik Lund himself is slightly more pragmatic about biofuels:

– I think that we need to bet on a broad range of alternatives, however, in the long run, I believe that electric vehicles will make up the most effective solution. Until then, it might be a good idea to utilise biofuels as well as gas in the transport sector, says Henrik Lund. ■