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When can we fill up with oil from algae?

It looks like bio-oil from algae is going to be a big hit, and already now, several companies claim that they are close to a commercial breakthrough. As the only country, Denmark has chosen to focus on macro-algae for ethanol – other countries are focusing their efforts on micro-algae for

By Torben Skøtt

As the criticism against the more traditional biofuels is coming to a head, the interest in developing fuels produced on the basis of algae is growing. The advantage is that, with a raw material like algae, you do not have to occupy farm land that can be used for food products, and unlike other plants, algae are able to double their weight in a very short time – usually a day or two, but under very special circumstances, it can happen within a few hours. This is for example possible in plants where you add ample amounts of CO₂ from the flue gas from the power plants and manure in the shape of surplus slurry from farming.

Thus, the perspectives of using algae for production of fuel are significant; but how realistic is it, and when can the first commercial plants be established?

Commercial plant in 2008

According to the Dutch company Algae-Link, oil from algae is no longer a distant dream of the future. The company has started building ten commercial plants in Spain, of which the first two are supposed to be ready for production already this year. Each plant is supposed to be able to produce two tons of dry matter per day.

On the company's web page, a number of turnkey plants for production of algae are presented, including power supply through solar cells, oil presses as well as equipment for harvesting the algae. The smallest plant is a small pilot plant at a price of EUR 69,000 or about DKK half a million. It can produce 2-4 kg of dry matter per day.

In addition to the pilot plant, the company advertises with no less than 8 different production plants that can supply from 1 to 100 tons of dry matter per day. The prices start at EUR 125,000. No prices are quoted for the largest plants that take up an area of up to 56 hectares. All plants are delivered complete with solar panels, which means

On the island of Mors in Denmark, Danish researchers are investigating how much energy you can extract from macro-algae such as sea lettuce. From the right, it is Anette Bruhn from the Danish National Environmental Research Institute, Peter Daugbjerg Jensen from Danish Technological Institute and Michael Bo Rasmussen from the Danish National Environmental Research Institute.



Photo: Lars Nikolaisen/Teknologisk Institut

▶ that they can run independently from the electricity network.

Moreover, AlgaeLink has started cooperating with the airline KLM on development of aeroplane fuel produced on the basis of algae. In that connection, it is a matter of a more long-term strategy, where the two companies will promote research within algae-based aeroplane fuel together over a period of 5-15 years.

Furthermore, AlgaeLink is negotiating with an unnamed shipyard about establishing a plant on the world's largest cruise liner. The plan is to utilise the large amounts of CO₂ from the ship's engines and also make use of the ship's wastewater. The plant must be so compact that the oil can be extracted, refined and used in the ship's engines.

Six pilot plants

One of the companies that currently have significant experience with production of algae is GreenFuel Technologies, which has its headquarters in Cambridge in the state of Massachusetts, US. Since 2001, the company has established no less than six pilot plants and has experience utilising CO₂ from gas-fired as well as coal-fired power plants.

According to the company's website, they are currently negotiating with a number of interested plant hosts about establishing the first commercial full-scale plant. It is going to be a plant taking up at least 100 hectares, and they hope to be able to build it within a few years.

GreenFuel Technologies works closely together with several American electric companies, including Arizona Public Service Company, which is the largest elec-

tric company in that state. At the company's natural gas-fired power plant in Phoenix, GreenFuel Technologies has established a pilot plant that for example shows that the daily production of dry matter is at an average of almost 100 grams/day. On some days, the production reached 174 grams/day, which is considered very satisfactory.

Oil companies want to join in

Today, research and development within algae-based oil has reached a level where the large oil companies also want to join in. Therefore, Shell is establishing a demonstration plant in Hawaii together with

HR Biopetroleum. The two companies have established the company Cellana together, with Shell as the majority shareholder. HR Biopetroleum, which is working on development of plants for production of algae, is a small, local company founded by a group of marine biologists.

The Cellana plant will be placed close to an existing industrial plant producing algae for food products and pharmaceutical purposes. A group of researchers will be working at the plant, where they will continuously study which types of algae that provide the best yield and which types that contain the most oil.

The algae will be grown in open reservoirs, and at first, the company will use micro-algae, which occur naturally in the waters around Hawaii.

How far are we?

Offhand, it all sounds very simple. Algae grow everywhere, there has been production of algae for food products for several decades, and micro-algae can rather easily be converted into oil with an ordinary oil press.

Here in Denmark, Energinet.dk has recently granted DKK 8.5 million for a consortium that is to investigate whether it is practical and financially possible to use macro-algae such as sea lettuce for production of ethanol. The consortium includes several researchers from Risø,

Useful links

www.algaelink.com

– Dutch company that sells turnkey plants

www.oilgae.com

– debate page about oil from algae, filled with useful links and interesting discussions.

www.greenfuelonline.com

– company in Massachusetts that has established six pilot plants since 2001 and has experience utilising CO₂ from gas-fired as well as coal-fired power plants.



Photo: AlgaeLink

AlgaeLink's pilot plant, which can produce 2-4 kg of micro-algae per day. Price: EUR 69,000 or about DKK half a million.

DONG Energy, the Danish National Environmental Research Institute and Danish Technological Institute.

According to Peter Daugbjerg Jensen from Danish Technological Institute, who has been appointed project manager, there is hardly any experience growing that type of algae, and there is only limited knowledge of how the algae can be converted into ethanol.

– It is probably not going to be difficult to get the process to work in a laboratory or a smaller pilot plant, says Peter Daugbjerg Jensen. He suspects that the main problems will not occur until it is time to build a larger plant and ensure stable operation.

– One of the problems of growing algae is to keep them as a monoculture, where you only have this specific species. When you add CO₂ and manure, you also promote other species that feed on the algae - particularly if you are dealing with open plants. This corresponds to also fertilising the weeds when you are fertilising the plants in your garden, explains the

project manager, who is very sceptical about whether the research in micro-algae is close to a commercial breakthrough.

The manager of GreenFuel Technology, Cary Bullock, agrees that the main problems occur when you go from a pilot plant to a full-scale plant. For example, he says the following in a presentation video on the company's website:

It is easy to get algae to grow on a small scale - on a larger scale, it is difficult. Algae grow quickly, but so do the plants that feed on the algae. The goal is to find the right species and create an environment where only those plants will thrive, says the manager.

Experience shows that you should take various predictions about when a technology is commercially available with a pinch of salt. For example, a group of researchers concluded in 1995 that six Danish gasification technologies were 1-2 years from being commercially available. Not until today – 13 years later – is one of the technologies close to a commercial breakthrough. ■

Algae can produce hydrogen

Using gene manipulation, American scientists want to promote the properties that make some algae produce hydrogen.

At Argonne National Laboratory, which is the US Department of Energy's largest research unit, they are constantly looking for new ways to produce fuel. The latest initiative is genetically modified algae that can be used to produce hydrogen.

– We see major perspectives in being able to utilise photosynthesis to produce

hydrogen through algae, says chemist David Tiede in a press release on the research centre's website.

The researchers want to exploit the fact that some types of algae contain an enzyme that can produce small amounts of hydrogen. According to David Tiede, it is nature's own way of regulating the "metabolism", if the plant gets too much sunlight, and he imagines that you can isolate the enzyme and use it to produce hydrogen on a larger scale.

Source: www.anl.gov

Recipe for algae oil



If you are planning to make an algae pond in your backyard and produce your own fuel for your car, you can find plenty of tips in the book Making Algae Biodiesel At Home

Gradually, several books have been published about how to make your own biodiesel, and now, you can also get instructions on how to become self-sufficient with biodiesel from algae.

And according to the publishing company behind the book, it is a lot easier than you would think.

– If you can make barbecue sauce, you can make diesel. It is easy, it is inexpensive, and it is safe, writes the publishing company in a press release and states that you can even make bio-diesel in your own kitchen.

However, judging by various comments about the book, it is probably not as easy as the publishing company indicates. According to www.global-greenhouse-warming.com, it is definitely not for cissies. It is quite a challenge to plough your way through the 550 pages, but if you are up for it, the book is quite a gold mine, and it covers practically all topics, right from growing of the algae to pressing the oil.

You can find further information about algae-based bio-diesel and other types of bio-diesel on the following address:

www.making-biodiesel-at-home.com

Convert the hay baler into an oil press

A group of researchers at DTU (Technical University of Denmark) are working on designing a mobile plant that can produce oil directly from the field. The oil can be used as fuel at power plants or be converted into diesel, and the coke fraction will be suitable for carbon storage and improvement of soil's fertility.

By Torben Skøtt

– We still need to find the perfect method for converting biomass into liquid fuel, and therefore, we have to keep all our options open.

These words come from lecturer Peter Arendt Jensen from the Department of Chemical and Biochemical Engineering at DTU. He is part of a team of researchers that have chosen to find new ways of producing oil on the basis of biomass. Instead of a large factory plant, the researchers want to construct a mobile plant that can convert straw into liquid fuel directly on the field. The process, which is called flash pyrolysis, makes it possible to convert about half of the straw's energy content into oil. The residual product mainly consists of coke, which can be used to store carbon in the soil and improve the soil's fertility.

Niels Bech from the Department of Chemical and Biochemical Engineering is the instigator of the project. When he presented the idea to the researchers at the department about three years ago, he was met with some scepticism at first. However, after a critical review, his colleagues found it so interesting that he was given the opportunity to write a ph.D. thesis about the process, and today, the researchers at the Department of Chemical and Biochemical Engineering agree that this is a project that can have very large perspectives.

In connection with the ph.D. project, which Niels Bech is defending this June, he has created a plant that can treat 3 kg of straw per hour. This is currently being

scaled up to 300 kg per hour, and the next step will be an even larger plant, which must also be portable.

– The machine is intended to be a replacement for the hay baler, but you could also imagine that it can be connected to a combine harvester in order to get a system that can supply grain, oil and coke for soil improvement, all at the same time, explains Niels Bech. He sees great possibilities in being able to use the plant in a country like Denmark, but he sees even larger perspectives in other countries. In other countries, there are significant straw resources that are not being utilised because of the high transport costs, but that problem will be solved if you can just transport the oil instead of the bales of straw.

From biomass to oil

During pyrolysis, a partial conversion of organic material without supply of oxygen takes place. Conversely, you supply so much oxygen during incineration that the material is completely converted. In a gasification plant, you are somewhere in between – you supply limited amounts of oxygen or steam, which means that the main part of the energy is converted into gas.

Flash pyrolysis is a special type of pyrolysis where heating of the biomass and cooling of the gas takes place within a few seconds. Thus, you can get up to 50 percent of the heating value out in the shape of oil and up to 65 percent if you are using wood.

– That is not a process that we have invented. Our project is about constructing a mobile plant and finding the best method of using the oil and coke fraction in Denmark, explains Niels Bech. He is familiar with the fact that several sawmills in Canada use flash pyrolysis to produce oil on the basis of wood waste, but hardly anyone has experience with straw as the raw material.

Oil for power plants

At Risø DTU (national laboratory for sustainable energy), senior researcher Helge Egsgaard is working on analysing the oil that has been produced at the test plant at the Department of Chemical and Biochemical Engineering.

– The oil is not comparable to diesel or ordinary fuel oil. It contains some water and oxygenous compounds, which can lead to corrosions, among other things. Furthermore, there are hundreds of different chemical compounds, which means that it is an extensive task to make a thorough analysis and find out what the oil can be used for, explains the senior researcher. However, he has a good feel for what to look for based on the many experiences Risø DTU has with analysis of various types of bio-oil.

Helge Egsgaard estimates that it would be rather unproblematic to burn the oil in power plant boilers. Another possibility would be to use it in large marine engines, but this is probably not as straightforward, as the water content can cause problems.

Finally, there is the possibility of refining the oil in order to use it as a replacement for diesel or in the petrochemical industry. However, this would require that you have very large amounts at your disposal, so at first, the researchers will primarily focus on power plants.

Carbon storage in the soil

Coke has been used for soil improvement in South America before the arrival of the Europeans. Back then, the Native Americans produced coke out of wood and worked it into the ground with livestock manure in order to increase the fertility of the unfertile rain forest soil. Umber, as it

FiB in Danish and English

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is called, is still very fertile, and in several places, it is being dug up and sold as potting soil.

– When you add carbon to the soil in the shape of coke, hardly any decomposition takes place, explains Erik Steen Jensen, who is the programme manager for the Biosystems Department at Risø DTU. He became aware of the phenomenon while Niels Bech was working on his ph.D. study, and now, they are working together on creating a concept that can provide the most optimal use of the straw for energy production and soil improvement.

Throughout the last 50 years, the amount of organic material in the soil has been reduced, and it is regularly being discussed whether it is irresponsible to remove straw from the farm land, because you reduce the humus content even further that way.

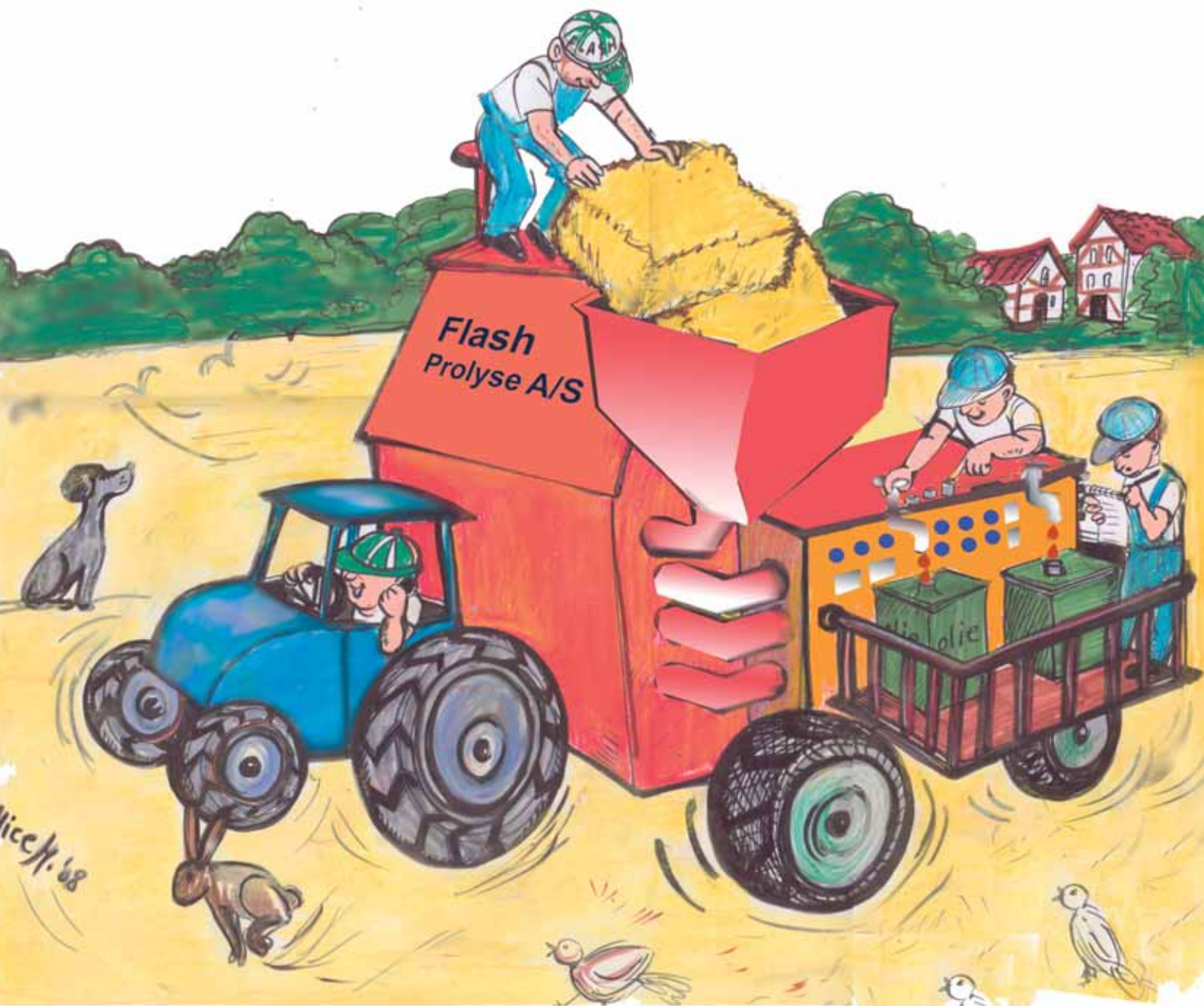
– From a climatic point of view, the humus or carbon content of the soil is crucial when trying to avoid worsening the greenhouse effect, says senior researcher Henrik Hauggaard-Nielsen from Risø DTU. He is responsible for the activities in the project that are related to supply of coke to soil, and he is also familiar with the arguments for planting more forest, but this increases the conflict between production of food products and energy even further.

According to Henrik Hauggaard-Nielsen, the effect of incorporating straw is rather limited. About half the carbon content is converted into CO₂ during the first year, but if you supply the carbon in the shape of coke instead, only very limited decomposition takes place, according to the literature on the subject. In this way, you can build a

significant carbon pool in the soil. Furthermore, a number of studies indicate that the washing out of nutrients is reduced, but this is not as well-documented as the building of carbon storage in the soil.

Thus, there is significant indication that flash pyrolysis of straw and other types of biomass can be an unexpectedly simple solution, but Erik Steen Jensen thinks that it is too early to recommend to the farmers that they use coke on a large scale.

– We have to investigate whether harmful compounds can occur when the straw is converted into bio-oil and coke. In South America, this technique has been used with great success, but we want to be absolutely sure that it is not harmful before being able to recommend it, says Erik Steen Jensen. ■



Germany is converting wood into diesel

Germany has spent 800,000 man hours on developing and establishing the world's first factory that can produce diesel on the basis of wood waste and wood chips. By using wood as the raw material instead of oil-containing plants, the necessary area for cultivation can be reduced by two thirds.

By Torben Skøtt

While Denmark uses significant resources on developing 2nd generation bio-ethanol, Germany has chosen a somewhat different route. In Germany, there is particular focus on production of bio-diesel, and in the middle of April, the German chancellor, Angela Merkel, could inaugurate an entirely new factory plant that is supposed to produce synthetic diesel through the so-called BTL method. This stands for Biomass to Liquid and briefly means that the biomass is first gasified, after which the gas is converted into liquid fuel.

The next phase will be running-in of the no less than 113 sub-processes that are necessary in order to be able to convert wood into diesel. The goal is to be able to reach full production within 8-12 months, which corresponds to 18 million litres of diesel oil per year. This will require supply of approx. 65,000 tons of wood chips or wood waste.

The technology for production of synthetic diesel is well-known in many ways and was for example used by Germany during World War II. Back then, coal was gasified and then converted into diesel through a catalytic process. Today, biomass is the product that is to be gasified, and this should result in a CO₂ reduction of up to 90 percent compared to traditional diesel oil.

The new factory plant, which belongs to the company Choren Industries, is located in Freiberg. Volkswagen, Daimler and Shell are co-owners, and Shell also has shares in Choren Industries.

Pilot plant

Prior to the inauguration of the plant in Freiberg lies very extensive development



Photo: Choren Industries

Installation of low-temperature gasifier on the plant in Freiberg.

work. Among other things, this includes establishment and operation of a pilot plant for over 22,000 hours as well as testing of the fuel in a number of automobile engines that are produced by Daimler and Volkswagen.

– The plant in Freiberg clearly shows how far we can get with the development of a new technology for protection of the climate when government, industry and researchers work together hand in hand, said the German chancellor, Angela Merkel, at the inauguration on the 17th of April 2008.

The establishment of the factory has been a demanding process, which has involved about 150 sub-contractors. The first phase consisted of establishing a low-temperature as well as a high-temperature gasifier patented by Choren Industries. Af-

ter that, Shell started installing equipment for the so-called Fischer-Tropsch process, which converts the gas into liquid fuel. It is a chemical process that was invented by the German researchers Franz Fischer and Hans Tropsch in 1923. The process has particularly been used by Germany and South Africa, but the main part of the large oil companies has now invested in the technology. The reason for this is that the emission of harmful substances is smaller than for traditional diesel oil, just as the CO₂ emission can be reduced significantly if the production takes place on the basis of biomass.

Choren Industries estimates that the total development work comes to about 800,000 man hours, and that they have worked together with 600 different companies during the process. ■

– the Swedes want to do the same

With help from German researchers, Sweden wants to establish a factory for production of synthetic diesel made from wood chips and household waste. According to plan, the first factory is to be inaugurated during the autumn of 2009 in Åsele in Norrland.

The Swedes, who already have a significant production of ethanol as replacement for petrol, now want to start producing diesel on the basis of wood chips and household waste. The technology will be purchased in Germany, which could recently inaugurate the world's first factory for production of synthetic diesel on the basis of wood and other types of biomass.

It is the environmental debate, the rising oil prices and the significant resources within biomass that have made the Swedish company Eco-Oil become interested in synthetic diesel. The product is cur-

rently more expensive than traditional diesel oil, but Eco-Oil expects that it will be the other way around when the plant is ready in the autumn of 2009.

According to plan, the factory will be established in Åsele in Norrland, where significant amounts of biomass are available. This biomass is primarily various residual products from forestry, such as branches, twigs, top ends and roots, but also household waste and waste from the paper industry have been mentioned as possible raw materials.

Already today, several trucks in Sweden are running on synthetic diesel produced on the basis of natural gas. It costs one Swedish krone more per litre than ordinary diesel oil, but it provides a better working environment, cleaner exhaust and thereby a better image for the companies that have chosen the natural gas-based fuel.

The Swedes are familiar with the process of converting gas into liquid fuel, but when it comes to gasification of biomass, there is still some way to go before the

technology can be considered fully commercially available. In Värnamo, work has been carried out since 1994 on achieving stable operation of a large gasification plant, in Piteå, a group of researchers are working on gasifying waste from the paper industry, and in Väster-norrland, they have the project BioFuel Region, where 18 municipalities work together on promoting the use of biofuels.

Sweden is not planning to use synthetic diesel to replace any of the other types of biofuels that they are currently working with. Synthetic diesel based on biomass is a supplement that is supposed to make the transport sector independent from fossil fuels.

Here in Denmark, a group of researchers from DTU (Technical University of Denmark), Dong Energy and Haldor Topsøe are investigating how gasification gas is best converted into methanol and DME. This project, which is supposed to be finished in 2009, has been given DKK three million in support from the energy research programme EFP. TS

– and Shell is going to test the fuel in the Le Mans

At the legendary 24-hour race in Le Mans on the 14th of June, Shell is going to test how diesel produced on the basis of wood waste will cope in a race for the first time.

Shell is working closely together with German Choren Industries on the development of new types of biofuels, where the biomass is first gasified, after which it is converted into liquid fuel, also called Biomass to Liquid (BTL). Within a year, a large factory plant in Freiberg is supposed to be able to supply 18 million tons of BTL per year, and the engineers are already testing the fuel in various automobile engines.

And what could be better than testing the fuel on the Le Mans race track in France when the legendary 24-hour race is held on the 14th of June? It will not be pure BTL, but Audi is prepared to try a mix of BTL and Shell V-Power Diesel in their racing car.



On the 14th of June, Shell and Audi will be testing a mix of biofuel and Shell V-Power Diesel in the 24-hour race on the Le Mans race track.

In 2006, Shell and Audi made motor-ing history by being the first to win the Le Mans race with a diesel-driven racing car. This success was repeated in 2007, and this year, they will be trying out a mix of BTL and traditional diesel, and they will also be testing GTL, which stands for "Gas to Liquid". In that case, it is not bio-

mass but natural gas that is converted into liquid fuel.

Audi is part of the Volkswagen Group, which, just like Shell, has shares in the BTL factory in Freiberg. The 14th of June will be the first time that a 2nd generation biofuel is used on the Le Mans race track and probably also the first time in a race at all. TS

Massive support for DONG's ethanol

DONG Energy was given more than DKK 54 million when the special funds for promotion of 2nd generation biofuels were distributed. Biogasol's project on the island on Bornholm, however, was not given anything at all, which means that Denmark will probably only be able to show one demonstration plant at the Climate Summit in 2009.

By Torben Skott

DONG Energy's subsidiary Inbicon is now speeding up the establishment of a demonstration plant for production of 2nd generation bio-ethanol at Kalundborg. This is happening after the company was recently awarded a grant of more than DKK 54 million from EUDP (Programme for Energy Technology Development and Demonstration). Simultaneously, one of Inbicon's business partners, the company Terranol A/S, was given more than DKK 11 million. Terranol A/S does research in the development of new types of yeast, which for example Inbicon can use in their plant.

However, Biogasol, which is responsible for the establishment of a demonstration plant on Bornholm, was not given anything at all from the funds allocated for 2nd generation bio-ethanol in 2008. Thus, everything seems to indicate that the company will have to drop their plans of having a plant ready for the Climate Summit, because without public funds, it will be almost impossible to find private investors.

– Denmark is missing out on an export adventure by opting out of BioGasol's demonstration plant on Bornholm, it is stated in a press release from Biogasol. In that press release, the company's managing director, Birgitte K. Ahring, is not mincing her words and for example accuses EUDP's board of having made a decision that is not based on facts. In that connection, she is referring to the fact that BioGasol has already developed the technology in which Terranol is now given money to do research.

The funds for 2nd generation bio-ethanol come from the globalisation funds,



Photo: Torben Skott/BioPress

DONG Energy's test plant for 2nd generation bio-ethanol at the power plant Skærbækværket. The next phase will be establishment of a demonstration plant in Kalundborg.

where DKK 200 million are allocated for the area over a four-year period. In 2007, DKK 50 million were awarded, which were distributed almost equally among Inbicon and Biogasol. The funds were provided for project engineering of the two demonstration plants. After the current allocation of the 2008 funds, there are approx. DKK 85 million left for distribution in 2009 and 2010.

Not enough independent financing

Obviously, the decision to support only one of the large ethanol projects has resulted in quite a bit of debate, and the TV station Danmarks Radio recently chose to air a one-hour programme on DR1 with the title: The elephant against the mouse.

In that programme, the chairman of EUDP's board, Torkil Bentzen, said that Biogasol's project is basically good, and that they would like it to be supported.

– But we had to make a choice. We have received applications for a total of DKK 240 million, and we have 50 million to spend this year, said Torkil Bentzen. He said that the reason for the rejection of Biogasol was that the company's independent financing for the project was not adequate, and they were worried about what would happen to the plant after the demonstration phase.

– Basically, we were worried who would be left to carry the can on Bornholm. If the plant ends up not working,

then who is supposed to deal with that, asked Torkil Bentzen referring to the failed project in Gjøel, where a small heating plant is left with a gasification plant that is not working.

Torkil Bentzen was not given an answer to his question. However, he was promised by the chairman of the Danish Parliament's Energy Committee, Jens Kirk (from the Danish political party Venstre), that he will work on expediting the grants for the ethanol area in order for the EUDP programme to get more money to work with this year.

This point of view was fully supported by Anne Grete Holmsgaard, who is the energy policy spokesperson for the party SF:

– The money must be given early. That is what makes other investors step forward, said Anne Grete Holmsgaard. She argued that you should always have at least two projects that can compete against each other. Otherwise, you will be choosing a specific technology in advance, without knowing if it is the best solution.

So maybe there is a chance after all that BioGasol's plant on Bornholm will become reality. If further grants are given this year, and if the company can get the necessary independent financing, Denmark will have the opportunity to show two plants that each have a method of producing ethanol on the basis of waste and residual products from farming. ■

New research portal



In April, a new research portal called videnskab.dk was opened. Thus, Denmark has a new web media providing popularly mediated stories about what takes place in the laboratories and behind the books.

The primary target group for videnskab.dk is young people trying to choose their path in life. In a wider sense, it is for all citizens that are eager to learn. Roughly speaking, the goal is to make it popular to know something.

As something very important - and extraordinary for research communication - videnskab.dk covers a wide spectrum. The focus is not only on the natural sciences, but just as much on the research carried out in the culture and society areas.

Videnskab.dk is a content service with daily news from the world of research as well as large cross-disciplinary themes across the sciences and entertainment content such as quizzes, competitions and problem pages. The page is also open for

debate and blogs, and several interactive initiatives are in the pipeline. In line with the media development, sound and live images will also be cranked up on videnskab.dk.

Videnskab.dk has an editorial staff of five journalists, and in addition to this, two journalists from the news department of Experimentarium will be contributing with content. Apart from the editorial staff's own material, videnskab.dk will also be showing articles from the universities and research institutes that wish to co-operate.

Financially, the project is supported by the Danish Independent Research Council, the Danish Council for Strategic Research, the Danish Agency for Science Technology and Innovation as well as the Danish Ministry of Culture, and videnskab.dk also has to gather money from interested parties and funds. There is financing for three years, so already now, they are working on a new business model that can make the research portal sustainable in the long term. *TS*

A financial shot in the arm for centre for bio-energy

The technology centre CBMI is getting DKK 6 million to create networks and co-operation within bioenergy from biomass and waste from farming and industry.

The money comes from EU's Regional Fund and the Danish Enterprise and Construction Agency.

With these new funds, it will now become possible for Danish researchers and companies to participate in large interna-

tional projects. This will provide knowledge and insight that can guarantee a continued Danish leading position within renewable energy.

Apart from CBMI, the participants in the project are the Faculty of Life Sciences at University of Copenhagen, the Faculty of Agricultural Sciences at the University of Aarhus, Danish Technological Institute in Aarhus and Agro Tech A/S. The project will continue until the year 2010. *TS*

Course and seminar in business plans

The public support programmes for development of new energy technologies are making increasing demands on the business aspects of the applications.

The demands are simple: If you cannot write a good business plan for your project, the probability of your application achieving any support will decrease significantly. In co-operation with the EUDP secretariat and Energinet.dk, who are administering the PSO scheme, 1st Mile has now developed a course and a two-day seminar aimed at the applicants for the programmes.

1-day course in Søhuset, Hørsholm, 28th of August 2008

Apart from increasing the quality of the applications through improved capabilities and understanding, the course will also save the participants a lot of time in connection with the formulation of the applications.

The price of the course is DKK 6,900 excl. VAT. We recommend that at least two people from the same company or institute participate in order to benefit optimally from the work on own applications. There is a 10 percent discount for participant no. two and more.

2-day seminar at Helenekilde Badehotel, 1st and 2nd of September 2008

On this 2-day seminar in the scenic hotel Helenekilde Badehotel in Tisvildeleje, the participants will become able to write the business plans that have to be attached to the applications for the EUDP and PSO programmes.

The seminar is placed 2½ week before the deadline for applications of both programmes, which is the 19th of September 2008.

Price: DKK 12,900 excl. VAT, incl. food, accommodations and all activities.

**1st Mile www.1stmile.dk
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☎ +45 4044 6714**

300 heating consumers in Gjør had been looking forward to a lower heating bill with a newly developed gasification plant, but now, it seems that it will probably be scrapped.



Photo: Torben Skøtt/BioPress

Newly developed gasification plant prepared for scrapping

The first commercial plant for production of tar-free gas as a replacement for natural gas is prepared for scrapping before it has even been put to use. The reason is that the running-in of the plant will cost DKK 19 million, and that money is simply not available.

By Torben Skøtt

– It is terribly frustrating, say the people in Gjør as well as the supplier of the plant and the Danish Energy Agency's expert in the area, Henrik Flyver Christiansen. They all agree that, technologically, the plant in Gjør is brilliant. It is based on a so-called multi-step process that makes it possible to produce pure tar-free gas on the basis of biomass, which means that you can avoid expensive and complicated gas purification. The process was originally developed at the Technical University of Denmark, and Gjør was likely to become the first place in Denmark where the technology was really going to prove its worth.

But now, it seems that this is not going to happen. The money has been spent, the local energy company cannot afford to finance the running-in of the plant, the supplier has backed out after having lost DKK 9 million on the project, and there is no prospect of further support from the Danish Energy Agency, EU or the PSO funds that Energinet.dk administers.

For the CHP plant Gjør Private Kraftvarmeværk, which has invested about DKK 8 million in the project so far,

the situation is untenable. The company is currently firing with natural gas and had hoped to be able to lower the price for heating, but now, it is most likely that they will have to increase the price significantly instead in order to be able to pay for the natural gas and pay the debt for the gasification plant at the same time. Obviously, the board is not happy about this, or as expressed by the deputy chairman of the company, Calle Østergaard:

– It is not fair that 300 consumers in a town in Northern Jutland have to pay for the development of a technology that the entire energy sector will benefit from. It must be the public sector that has to perform that task, says the deputy chairman.

What went wrong?

At the Danish Energy Agency, they are perfectly aware that the situation is serious, and therefore, they recently asked the consultancy firm 1st mile to prepare an independent report. This report makes it quite clear that a lot has gone wrong along the way. A complicated structure with many partners, lacking coherence between responsibility, competence and money flows as well as insufficient con-



Photo: Torben Skøtt/BioPress

Installation of the gasification plant during the spring of 2007.

sultancy and project management are stated as the main reasons that the project has been thrown off the track. A specific example of poor management is the construction of the building, which is much too small to accommodate the many plant components and a gas engine that is placed in a completely wrong location.

The conclusion of the 40-page report is unmistakable: Scrap the plant and make sure that Gjøel is given an opportunity to turn off the natural gas and switch to pure heat production based on wood chips instead. This would make it possible to keep the heat price at an acceptable level, there would be no need to put any further money in the project, and in the best-case scenario, it will be possible to sell the pieces to a company that may want to continue the project somewhere else.

The problem with this solution is that it gives the gasification technology a bad image. The thing is that it is not just the reputation of the companies that have been involved in the Gjøel project that is tarnished. Other companies that want to develop and market similar technologies can easily be met with opposition, and it is not easy for them anyway.

Sorry about the development

The parties involved are sorry about the development, but they each find it difficult to see how they could have handled things differently:

– We have acted in good faith from the beginning. We were given the impression by our consultants and the Danish Energy Agency that we were dealing with a technology that there was broad interest in having tested, and that we could expect full support from the public sector, says Calle Østergaard. He had expected a certain running-in period, but he is stunned that it is going to cost DKK 19 million to achieve stable operation of the plant.

The managing director of TK-Energi, Thomas Koch, on the other hand, thinks that he played his cards face up during the whole process:

– I have made no secret of the fact that it was a development project, and it is stated clearly in the contract that we would not guarantee the operation of the plant. If it had been a case of a fully developed technology, there would have been no support from the Danish Energy Agency or the EU – it is as simple as that, says the managing director. ■

New grant scheme can give the gasification technology a lift

Over the next four years, DKK 100 million will be allocated for demonstration of minor renewable energy technologies. As something new, the scheme can be used for operating grants, which will make it easier to get the running-in of new demonstration plants financed.

By Torben Skott

DKK 25 million per year over a four-year period may not be much when it has to cover such diverse technologies as bio gasification, wave power and solar cells; but still, the new scheme has created some optimism among many small and medium-sized technology companies. The reason for this is that, in the future, it will be possible to apply for establishment as well as operation grants for demonstration plants, which will in turn make it easier to get the running-in of a new plant financed.

– The scheme is practically tailor-made for our company, says project manager Bjarne Skyum from the boiler factory Weiss. In recent years, the company has spent significant resources on the development of gasification plants, and before long, they are expecting to be able to establish the first full-scale plant at a plant host.

– It is a step in the right direction that part of the grant will be dependent on successful operation. This keeps the supplier up to the mark and prepared to go to great

lengths to achieve a bonus in the end, says Jens Dall Bentzen from Dall Energy.

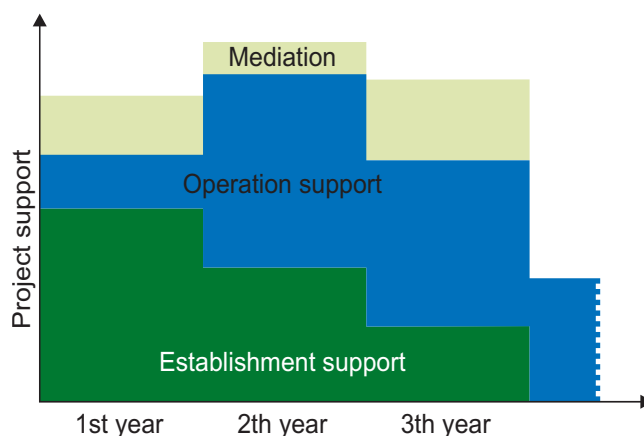
He is working closely together with for example Weiss on the development of the gasification technology and hopes that the new scheme can prevent episodes like the one in Gjøel, where a gasification plant will be scrapped before it has been put to use.

Part of the energy conciliation

The new grant pool, which is part of the energy conciliation of this spring, is administered by Energinet.dk under the name ForskVE. Formally, the legislation still has to be passed, but it is expected to come into place before the Danish parliament takes its summer holiday. After this, the first pool of DKK 25 million for minor renewable energy technologies will be supplied during the summer months, and later this year, there will be another bidding round for the grants of 2009.

In the notes of the legislation, minor renewable energy technologies are defined as solar cells, wave power, biomass gasification and stirling engines, and it is pointed out that the new scheme is aimed at a later phase than the support you can get from the ForskEL programme, which is also administered by Energinet.dk.

According to research coordinator Steen Vestervang from Energinet.dk, there are pretty broad limits to what the money can be used for. No specific distribution of the funds for various technologies has been determined, and there are no specific limits to what can be used for establishment support, operation grants and mediation.. ■



Example of how the support for a demonstration plant can be distributed. Source: Energinet.dk



Photo: Torben Skøtt/BioPress

How does research become business?

Today, researchers not only have to publish thick reports and participate in international conferences. Now, research has to be turned into business, but how is that put into practice? With the Gjøl project as the point of departure, we have asked a number of technology companies what it takes for research to become good business.

By Torben Skøtt

"Denmark has unutilised potential for interaction between the business world and public research. We have to utilise this potential. We have to become even better at getting research and knowledge out into larger parts of the business world."

The quote above comes from the preface of the Danish government's publication "Nye veje mellem forskning og erhverv" (new roads between research and business). In this publication, the government makes it clear that Denmark has to be able to compare with the best of the world when it comes to the interaction between companies and knowledge institutions. Today, Denmark is in the middle field among the OECD countries, and that placement has to be improved!

But how do you put this into practice? The story of the Gjøl project – where a newly developed gasification plant is

Success was achieved in Harboøre. After 15 years of development work, the supplier of the gasification plant in Harboøre can now look forward to export worth billions of Danish kroner.

scrapped before it has been tested – shows that one of the many preconditions for success is tight management and clear distribution of the various areas of responsibility.

– In Gjøl, there have been many deviations from the original project plan. The longer you wait before you intervene, the more expensive it becomes, says Søren Houmøller, who, as the managing director of the consultancy firm 1st Mile, has participated in preparing a report about the gasification plant. He has also taken part in evaluating a number of applications for the new EUDP programme, where much stricter demands are made on organisation and project management than has been the case in Gjøl.

Other demands today

At the Danish Energy Agency, the office manager of the EUDP secretariat, Nicolai Zarganis, confirms that different demands are made on demonstration projects today compared to earlier.

– We demand from the applicants that they have thought through the entire process. It is not enough to build a plant. You also have to be able to keep the plant in operation, and this requires a certain strength from the companies in question, says the office manager. In that connection, he refers to the fact that a rejection was recently given to a large ethanol plant

on the island of Bornholm, because they were not sure if the company behind it could acquire the necessary independent financing and keep the plant in operation.

However, Nicolai Zarganis will not go as far as concluding that only financially strong companies can get support for demonstration plants.

– That is an overly simplistic way of putting it, he says, but you cannot get round the fact that small companies can implement small projects and large companies can implement large projects.

"Jaws of death"

The example from Gjøl is not unique. It has happened before that a demonstration plant has been taken down before it has been put into operation, and those types of failed projects have even been given their own name: Jaws of death.

Many small and medium-sized technology companies fear the phase they have to go through when the first demonstration plant has to be established and run in. The reason for this is that experience shows that it is much easier to get a grant for development of the actual technology than for demonstrating the technology on a larger scale.

– There is a tendency that as soon as the researchers have developed a new technology, it has become outdated. It is no longer "in" to work with gasification

plants. Now, biofuels and fuel cells are on the agenda, says Søren Houmøller. He often wonders why everyone dives into new areas instead of investing in the technologies that we have spent decades developing.

Success was achieved in Harboøre

Not far from Gjøl is Harboøre, where the local heating plant entered into contract in 1993 with Vølund about delivery of a gasification plant for production of electricity and heat. Here, it took 4 years to get the gasifier to work optimally, 3 years to get the plant to produce electricity and another 3 years before a number of problems with the cleaning of wastewater had been solved.

Thus, there have been plenty of technical problems, but there has never been any doubt as to who has the responsibility: During the whole process, Vølund has been responsible for the operation and has guaranteed that the heating plant would never have to pay more for heat than if it had chosen to install a traditional wood chip-fired boiler plant.

According to Ole Kristensen, who was the development manager at Vølund during the years that the company was responsible for the establishment and running-in of the gasification plant, you have to have at least half the development funds in reserve when starting up the plant for the first time.

Political understanding

The Harboøre plant is a good example of how it is worthwhile to be persistent, so why has it not been possible to repeat the success in Gjøl? In many ways, the concept is brilliant, because, unlike the plant in Harboøre, the gasifier will be able to produce pure tar-free gas that can be used in an engine without previous purification.

– When the Harboøre plant was built, there was a completely different political understanding and goodwill with regard to new energy technologies, says Thomas Koch, who is the managing director of TK-Energi, which has supplied the plant for Gjøl.

– The philosophy of the Danish Energy Agency was "in for a penny, in for a pound". It was not just establishment support, like in Gjøl. You kept supporting the project until the goal had been achieved.



That is the type of strategy that gives results, and it could also give results in Gjøl if the Danish Energy Agency or others would make the necessary resources available, says Thomas Koch.

The plant in Gjøl has been established with support from the EU, Energinet.dk and the Danish Energy Agency. The latter acquired means through the pool called Værkpuljen, but that does not exist anymore, and according to Nicolai Zarganis, there are no other schemes that the agency can make use of.

– We cannot support the general operation, just as we cannot support plants that can be perceived as production plants, says Nicolai Zarganis. However, he mentions the possibility that the EUDP programme can provide support for specific test projects that are carried out on existing plants. That model was used extensively at the Harboøre plant, where Vølund was given grants several times

– It is going well, says project manager Bjarne Skyum from the boiler factory Weiss. The company has started the running-in of a new gasification plant, which they have a lot of expectations for. The reason for this is that the plant can produce pure tar-free gas, which can be used immediately in a gas engine that is connected to an electric power generator.

from various grant schemes in order to complete specific development projects.

Distance is important

At the boiler factory Weiss in Hadsund, they are currently testing a new gasification plant that has been developed at the Technical University of Denmark. The plant has been built in connection with the factory in order to make the running-in easier and make it easier to overcome any teething troubles.

– It is going well. Obviously, there are minor things that have to be corrected, but all in all, it is working as it should, says project manager Bjarne Skyum from Weiss. He makes no secret of the fact that it has been a great advantage to have the first plant right outside the factory.

– You should not underestimate this advantage. There are many challenges, and it would have been difficult to spare the necessary staff if the plant had been located far away, says the project manager. He is already in contact with a number of interested plant hosts and expects the company to be able to start establishing a plant at a district heating plant before long. ■

Contract worth billions for Babcock & Wilcox

After 15 years of development work, Babcock & Wilcox Vølund have entered into an agreement with an investment company about establishing 25 gasification plants at a total value of DKK 2.2 billion.

– Our plant in Harboøre is the reason that we have been able to convince investors that the technology is now viable, says John Veje Olesen, who is the managing director of Babcock & Wilcox Vølund. He refers to the fact that there are only 2-3

plants ready for production worldwide, and none of them get anywhere near the 100,000 hours of operation that the Harboøre plant has currently achieved.

The engineers have already started planning the first plant in Italy. It will be a so-called Combined Cycle plant, where you incorporate a small steam circuit that utilises the exhaust heat from the engines and the tar content that exists in the gas. Thereby, you can achieve an electrical efficiency of 45 percent, which is about the same as the largest and most modern steam turbine plants can manage. TS

Touchless gas analysis

Title: 6382 – Online touchless gas analysis in biomass plant

Responsible: Risø DTU, Christian Pedersen
☎ +45 4677 4677

Grant: PSO – DKK 320,000

Touchless quick optical measurements of NO and other gas concentrations at high temperature in boiler room, flames and engines is of great interest. In connection with this project, measurements have for example been carried out at the Avedøre plant and in a high-temperature gas cell from room temperature to 1400-1500°C.



Photo: Torben Skovt/BioPress

The project about gas analyses has for example included a number of measurements at the Avedøre plant

Characterisation of biofuels

Title: 5297 – Biofuel characterisation 2004 – method development

Responsible: DONG Energy, Rudolph Blum,
☎ +45 7923 3333

Grant: PSO – DKK 11,771,000

In Europe, there are a number of standards that are intended to promote the trade with biofuels under development. The purpose of the project has been to maintain a Danish platform within the area in order to be able to influence the future standards. Work has been carried out on developing new methods and techniques for characterisation of biomass. The project has result in seven guides and a technical report.

Lower CO emission through addition of sulphur

Title: 6540 – Emission control through sulphur addition

Responsible: Department of Chemical and Biochemical Engineering, Technical University of Denmark, Peter Glarborg, ☎ +45 4525 2840

Grant: PSO – DKK 499,962

The project has shown that addition of sulphur during incineration of natural gas can lead to extensive CO reduction in the flue gas.

Information meeting about research Wednesday the 20th of August 2008 Trinity Konferencenter – Fredericia

The energy research programmes invite you to a joint information meeting on the 20th of August 2008 from 9.30 AM to 4.00 PM at the conference centre Trinity Hotel og Konferencenter, Gl. Færgevej 30, Snoghøj, Fredericia.

The day will include:

- News and focus areas in the energy research programmes.
- Theme: "The energy conciliation of the 21st of February 2008", including presentation of the new ForskVE programme.
- Theme: "Innovation in the energy sector" with a general introduction to innovation processes and specific examples from companies within the energy sector.
- Information stands for each programme, where there will be plenty of opportunities to ask questions to case workers about application procedures and rules.
- Possibility to network and make agreements with other potential applicants. Five meeting rooms are made available for this, they can be booked according to the "first in, first served" principle on the day.

Participation is free and the final programme will be advertised on: www.ens.dk - www.elforsk.dk - www.fist.dk - www.energinet.dk

Registration on the 6th of August 2008 at the latest on: www.danskenergi.dk/Uddannelse/Konference.aspx

Further information can be acquired from:

Hanne Thomassen, hth@ens.dk, tel. +45 3392 6778
Jørn Borup Jensen, jbj@danskenergi.dk, tel. +45 3530 0934
Inger Pihl Byriel, ipb@energinet.dk, tel. +45 7622 4416

Seminar on biogas research Thursday the 28th of August 2008 Energinet.dk – Fredericia

The research and development programmes EUDP and ForskEL are inviting to a seminar about biogas research and development. The seminar will take place on the 28th of August 2008 at Energinet.dk in Erritsø at Fredericia.

The purpose of the seminar is to get input from players in and around the biogas industry in order to develop a strategy for finding the best way to use research and development funds in the biogas area in the future. The strategy work is intended to be carried out together with players within the biogas area in order to ensure the best possible relevance and anchoring. This also includes discussion of how the utilisation of the agricultural resources for production of biogas can achieve the best possible usefulness for the Danish society.

In the energy conciliation of the 21st of February 2008, it was agreed that the subsidy for electricity produced on the basis of biogas should be increased from the current DKK 0.60 to DKK 0.745 per kWh. Therefore, there is a special need to identify the barriers of spreading and utilisation of biogas which it may be possible to influence through goal-oriented research and development work.

At the seminar, there will be brief presentations from the invited introductory speakers. The presentations will form the basis of discussion and dialogue with the participants of the seminar.

Invitations and programme are being prepared and will be sent out as soon as possible. Keep up-to-date on the web pages: www.energistyrelsen.dk and www.energinet.dk

For further information, please contact: Jeanette Møller Jørgensen, ejm@energinet.dk and Jan Bünger, Danish Energy Agency (jbu@ens.dk)

Dioxins from incineration plant

Title: 5731– Investigation of dioxin formation and decomposition mechanisms in incineration plant with a view to improving residual product quality

Responsible: Rambøll, Thomas Rand, ☎ +45 4598 8610

Grant: PSO – DKK 1,104,431

The project is one out of a total of five projects that are to lead to a better understanding of how dioxins form in a waste incineration plant. The purpose is to be able to design better incineration plants in order to reduce the emission of dioxin. During phase 1 of the project, the fuel and incineration parameters that have the greatest influence on the formation of dioxin have been quantified. These parameters are sulphur and chloride content of the fuel, afterburning temperature and incomplete incineration. The work will be continued in ForskEL project 7170.



Photo: Torben Skott/BioPress

Five projects are now going to lead to a better understanding of how dioxins form in a waste incineration plant.

Grate firing of biomass

Title: 4792 – Grate firing of biomass - measuring, validation and demonstration

Responsible: Dong Energy A/S, Rudolph Blum
☎ +45 7923 3333

Grant: PSO – DKK 6,228,084

This project has included verification of the so-called CFD modelling of grate-fired boilers in two power plants that are fired with straw. The incineration process has been described, and documentation divided the incineration into individual elements, distributed in separate zones above the grate. Furthermore, a model for asymmetrical incineration and flow in the boiler has been described. The developed models can be used in connection with calculations at future wood chip- or waste-fired plants.

Tar content of gasification gas

Title: 5774 – Manual tar method

Responsible: Danish Technological Institute, Industry and Energy, Ken Friis Hansen, ☎ +45 7220 1330

Grant: PSO – DKK 879,000

In connection with thermal gasification of solid biomass, it is often necessary to determine the pollution level of the gas. Unwanted components in the gas can be solid material, fluid as well as a large number of organic components - as a whole referred to as tar. The project has for example tested a so-called GC analysis method in ten European laboratories. The results are still inadequate, but the tar analyses are better than they used to be.

Trade with biofuels

Title: 33031-0058 – Efficient trade with biofuels and analysis of fuel supply. Description of e-trade business models.

Responsible: Danish Technological Institute, Lars Nikolaisen,
☎ +45 7220 1302

Grant: EFP – DKK 263,000

The purpose of the project has been to describe existing and future market conditions for trade with biomass in Europe, assess the usefulness of the CEN 335 standard with regard to trade with biofuels, give an assessment of the fuel supply in 2010, support trade with biofuels and technology transfer through net-based information analysis and select and describe the most useful trade and business models for biofuels. The results of the project have been achieved through co-operation in EUBIONET II, which is a network that has achieved a high professional profile in the European biomass sector. Furthermore, there has been close co-operation with the European biomass organisation AEBIOM, CEPI with close contact to the woodworking industry as well as IEA Bioenergy Task 40. Mediation of the project's results has taken place through conferences, articles, information sheets, research trips and teaching material. On www.eubionet.net, you can find two reports and a knowledge sheet about the project. An application has been made to continue the project in EUBIONET III.

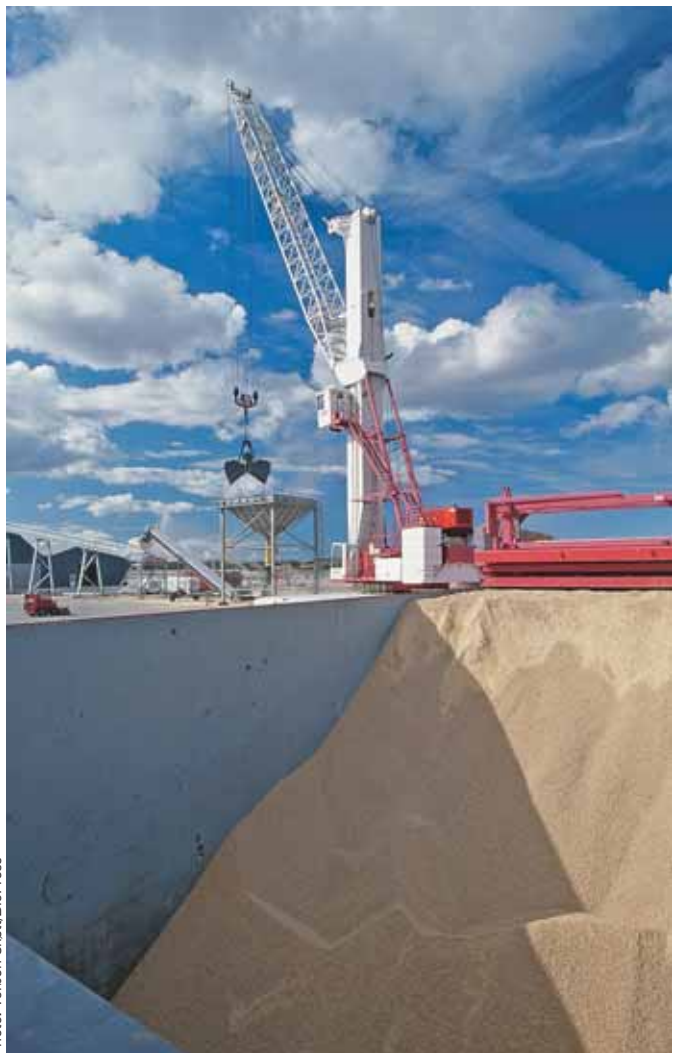


Photo: Torben Skott/BioPress

Among other things, the network EUBIONET works to promote the international trade with biofuels.

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.

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– to be published in the middle of September 2008. The deadline for articles is 15 August 2008.

From algae to petrol

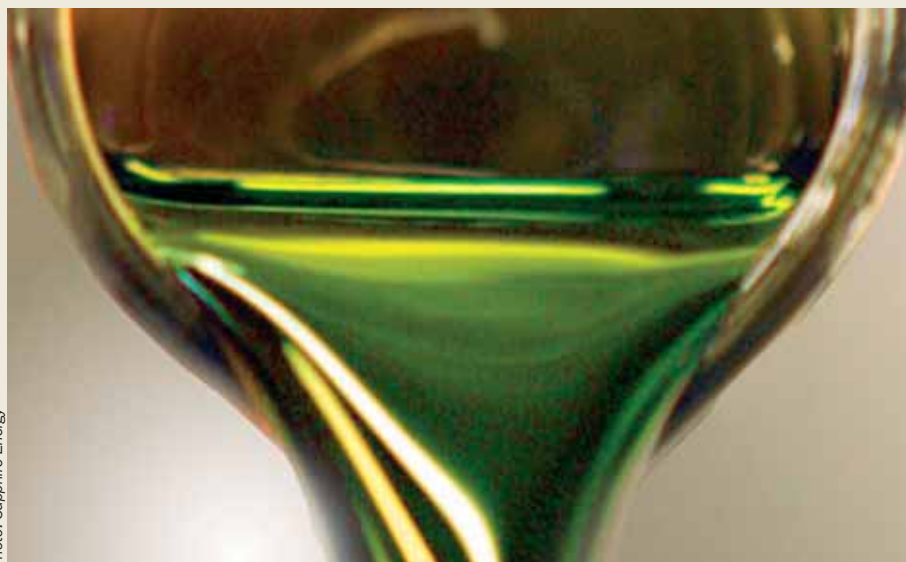


Photo: Sapphire Energy

The American company Sapphire Energy claims that it is now able to produce 91 octane petrol directly from algae.

– It is our goal to become the world's leading manufacturer of renewable petrochemical products, states Jason Pyle from Sapphire Energy in a press release. He is one of the three researchers that have founded the company about a year ago, and he is not particularly keen on biofuels like ethanol and bio-diesel:

– Why does the industry spend so much time and energy on producing bio-ethanol, which is basically a completely wrong fuel, is the statement on the company's website. Completely different technologies are needed in order to make us independent of fossil fuels in a sustainable way, is the opinion of Sapphire Energy.

The solution is to use algae as the raw material. They can produce 10-100 times as much biomass as farming crops, they only require CO₂ and sunlight, and they thrive in wastewater as well as salt water.

This is not really news. Everywhere, researchers are working at full throttle to find the most brilliant way of converting algae into bio-diesel and bio-ethanol, and several companies think that the technology is close to being commercially available.

But Sapphire Energy takes it one step further. They claim that they are already capable of producing 91 octane petrol using algae. How this is actually done is not on record, but the company makes it clear that they are using an entirely new technology and a product that fully lives up to the current standards in the area.

And the investors seem to be thrilled. The managing director of ARCH Venture Partners, Robert Nelsen, who has put USD 50 million in the project so far, says the following:

– When we realised which results Sapphire Energy had achieved in only three months, we sat down across from them and said: The cheque book is open – tell us what you need!

This must have been music to the researchers' ears, because ARCH Venture Partners control seven funds at a total value of no less than USD 1.5 billion.

Thus, Sapphire Energy is probably not going to be short of capital, and everything indicates that they have also been able to attract some of the best employees. For example, Brian Goodall has recently been appointed head of development. Among other things, he is known for heading the team that has developed the biofuels for the aeroplane industry that were tested earlier this year on a Boeing 747-400 plane from Virgin Atlantic. *TS*