

Third volume
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FiB
Bioenergy research



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Should FiB continue?

Energy Research has now been out for well over two years and a new application must be submitted to the Danish Energy Agency before 15 September if the magazine is to continue. In this connection, we need your opinion. Do you find the magazine relevant and is there anything you feel we can improve?

By Torben Skøtt

Bioenergy Research was published for the first time in April 2004 with the support of Denmark's Energy Research Programme, Elsam and Energi E2. The purpose was and is to ensure an improved presentation of the Danish efforts within bioenergy research and development. The grants for Bioenergy Research run out in May next year, so if the magazine is to continue, applications for more funds must be submitted no later than 15 September this year.

In this connection, we need your help. First of all, we need to know the

readers' level of interest in the magazine. Furthermore, we would like to have your comments on the magazine. Is there anything you particularly like and is there anything you miss in the magazine?

Give us your opinion on our website www.biopress.dk. We have prepared a questionnaire that can be completed in a few minutes, but we would of course be grateful if you are prepared to spend a few more minutes on good ideas and suggestions for improving the magazine.

So far, Bioenergy Research has been published as a separate publication and as an insert in the Danish magazine, Dansk Bioenergi. However, the latter has been discontinued, so today the magazine is sent to the original subscribers as well as the readers who have subscribed to Dansk BioEnergi until June this year. If you are not interested in receiving the magazine any more, please send us an e-mail or give us a call. Today, postage is a large item in the budget, so we would like to avoid sending out too many copies. Please contact us at:

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Would the Chinese be interested in buying this?

If the answer is yes, the chances of obtaining support for research and development are good. Research projects are not just about developing new technologies. The researchers should also consider how the results can be used in practice. In addition, they should make sure that patents are taken out for the results so that the good ideas are not copied freely.

By Torben Skøtt

Danish researchers are competent when it comes to developing various technologies, but the gap between research and industrial production is too large. This means that more funds will be made available for demonstration projects, and it will be possible to obtain support for the preparation of actual business plans.

– We are well aware that it requires a lot of money. Therefore, additional funds are required in Denmark, otherwise we have to consider the opportunities available internationally. This may for example be support from the EU's seventh framework programme, said Kim Behnke, head of department at Energinet.dk, at the annual meeting on



photo: torben skøtt/biopress

On the information day, the participants had the opportunity to address questions to the representatives of the various energy research programmes.

energy research programmes, which was held on 15 August in Fredericia.

– The world is craving for new, environmentally friendly energy sources, so this is an area with large business potential, and recently the Globalisation Council has suggested that it is something Denmark should focus on. The main reason is that we remain the only country in the world which has proven that the gross national product can be increased without increasing the energy consumption.

– However, in future we have to be more aware of business plans and patents to avoid that we develop everything in Denmark and sell one prototype abroad, whereupon they run off with the entire production, explained Kim Behnke.

Where to buy a lottery ticket?

Today, there are five different programmes in Denmark which support energy research as well as a Nordic energy research programme and EU's framework programme, which also supports energy research.

- In future, we must also look at business plans and patents to avoid that we develop everything in Denmark and sell one prototype abroad, whereupon they run off with the entire production, Kim Behnke explained at the information meeting.

– An applicant may find it difficult to work out the best place to buy a "lottery ticket" as Kim Behnke put it. He recommended that applicants use the Internet portal www.energiforskning.dk and he also pointed out that applications can be switched between the individual programmes if this proves to be expedient. Applicants therefore should not despair if they have submitted an application to for example a PSO programme and it subsequently turns out that it falls under the Danish Energy Authority's programme.

“..... we remain the only country in the world which has shown that the gross national product can be increased without increasing the energy consumption..”

Head of department Kim Behnke

Today, there is close cooperation between the various energy research programmes, and methods are continuously being developed to make it easier for the applicants to understand the area. The common Internet portal www.energiforskning.dk will also be developed, and today the sets of rules applying to the programmes ELFORSK, ForskEL and EFP are virtually identical.



photo: torben skøtt/biopress

To a large extent, the choice of energy research programme depends on whether the project in question involves basic research or a technology which is almost fully developed. If basic research is involved, it will be sensible to go for The Danish Council for Strategic Research. If, on the other hand, the technology is close to being tested in practice, it is better to choose one of the other programmes. Finally, it is possible to apply to the Danish Fund for Industrial Growth for support if the project in question is almost ready for a big export adventure.

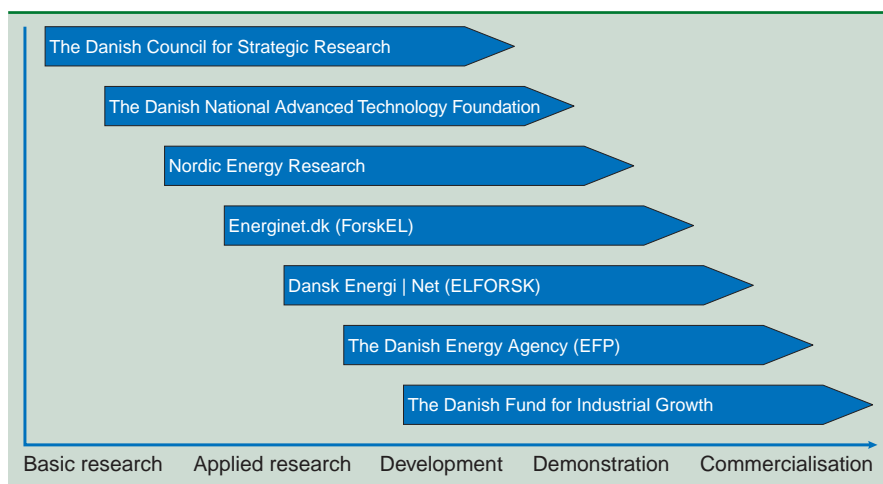
This year, part of the research funding will for the first time be directed towards consortiums where private companies work with universities and other research institutions on large projects. The consortiums can expect a more flexible framework but must, in return, be prepared to accept more co-funding.

In English, please

Globalisation is here to stay - also within research. Future applications will therefore primarily be in English, and the applicants are encouraged to apply for funds from the EU or Nordic Energy Research whenever it is relevant. However, these both operate with deadlines different from the Danish research programmes, which may sometimes cause problems.

– However, this should not prevent anyone from applying. We discuss it and find a practical solution to the problems, said Kim Behnke. He encouraged the participants to start with the Danish research programmes before submitting an application to for example the EU.

Experience has shown that many people avoid submitting applications to the EU simply because the work involved in preparing the application may appear overwhelming. As a result, the Ministry of Science, Technology and Innovation has earmarked a pool of DKK 10 million to help researchers and companies that are unable to prepare applications for the EU system themselves. On 6 September, EuroCenter which is governed by the Ministry of Science, Technology and Innovation will hold a conference on the EU's seventh framework programme and on 13 September, a course on how to



Programme	Description	Amount	Deadline
EFP	The Danish Energy Agency Programme supporting energy research	DKK 55 million in 2007	15 September
ELFORSK	Dansk Energi Net PSO programme for efficient use of electricity	DKK 25 million in 2007	15 September
ForskEL	Energinet.dk PSO programme for environmentally friendly electricity production technologies	DKK 130 million in 2007	15 September
EnMi	The Danish Council for Strategic Research Research into renewable energy and environmentally sustainable energy production	DKK 109 million in 2006	24 May
	The Danish National Advanced Technology Foundation Programme which also supports energy research	DKK 200 million in 2006	4 April
	Nordic Energy Research Programme for energy research	NOK 75 million in 2006	19 May

Overview of energy research programmes. To the programmes mentioned should be added the EU's seventh framework programme, but its support amount and deadlines will not be determined until this autumn.

write applications for the EU will be held. You can find further information at www.eurocenter.info.

The four code words

15 September at 3 pm is the deadline for applications for funds from Denmark's Energy Research Programme (EFP) governed by the Danish Energy Agency, and the two PSO programmes ELFORSK and ForskEL, which are administered by Dansk Energi | Net and Energinet.dk, respectively.

Kim Behnke ended the information day by outlining the "code words"

which will be normative for the processing of the applications to the three programmes. They are:

- Demonstration projects
- Consortiums
- Internationalisation
- Growth and business.

– You will not automatically receive support when these words are mentioned, but you should be aware that these are areas which we wish to promote. DKK 210 million is waiting to be distributed during the winter, was Kim Behnke's closing remark. ■

"Popeye plant" as energy source

Everybody knows that Popeye became strong from eating spinach so why not use the spinach plant as energy source, for example as fuel for district heating plants, raw material for biogas plants or for the production of ethanol.



photo: foulum research centre

By Torben Skøtt

One of the plants which the researchers are considering for the production of energy is sorrel with the Latin name: *Rumex patientia* L. x *Rumex tianschanicus* A. Los.

Sorrel is related to spinach, which is probably familiar to most garden owners, but unlike spinach, sorrel is about 2.5 - 2.8 metres high.

It is the company Danish International Consulting which has come up with the idea of using sorrel for the production of energy. For many years, the owner of the company, Arne Jørgensen, has worked as consultant for district heating plants in for example the Czech Republic, where he saw the plant for the first time.

– Sorrel originates from China but I have become familiar with it through tests in the Ukraine and the Czech Republic over the past 12 years, says Arne Jørgensen, who have obtained permission from the Danish authorities to use the plant in Denmark.

– Originally, I imagined that it would be an obvious fuel in district heating plants, but much seems to indicate that it may be more suitable as "concentrated

Sorrel, which is related to spinach, is a perennial, environmentally friendly plant, where the loss of fertilizer and the consumption of pesticides are limited. Once the plant has been established, a reasonable yield can be expected for the next 12-15 years.

feed" for biogas plants or for the production of ethanol, explains Arne Jørgensen. He has received product development support to examine the possibilities of using the plant for energy production and has, in this connection, entered into a cooperation with the Czech University of Agriculture in Prague (CUA) and the Foulum Research Centre, which is governed by the Danish Institute of Agricultural Sciences.

At Foulum, senior research associate Uffe Jørgensen confirms that there may be several reasons to focus on biogas or ethanol instead of boiler plant fuel.

– If the plant is to be used as fuel, it has to be harvested when it is dry - typically at the end of July before the seeds start to fall from its top.

A problem in connection with "dry" harvest may be that the stems break very easily. The crop is harvested with a swath forming mower and the harvest has to be correctly timed - otherwise many of the stems will be crushed, which will result in a relatively large loss of biomass.

Environmentally friendly plant

The main advantage of sorrel is that is a perennial, environmentally friendly plant in line with many other energy crops. The loss of fertilizer and the consumption of pesticides are thus limited, and once the plant has been established, a reasonable yield can be expected for the next 12 - 15 years.

Tests carried out at the Danish Institute of Agricultural Sciences show that first year's yield is minimal, but already after the second year the plant has a yield which is close to the yields of willow and elephant grass where a high yield cannot be expected until the third year after the establishing.

Both establishing and harvest are relatively easy, as normal agricultural machines can be used. This means that expensive special-purpose machines are not required.

Green harvest

Instead of harvesting sorrel at the end of July, there may be several good reasons for swathing the plant approx. one



photo: foulum research centre

Swathing of sorrel at the end of June.



photo: foulum research centre

Raking of sorrel in August.



photo: foulum research centre

Baling in August.

month earlier. At this time, the crop is still green and has a high water content. This means that it will not be suitable for fuel, but may be used in biogas plants or for the production of ethanol. The harvest may be performed with a swath forming mower for rape and should subsequently be collected by a forage harvester.

In the autumn, the crop is expected to be ready for a second harvest, so that a yield in line with other energy crops is achieved.

The establishing of sorrel may be carried out with ordinary equipment. It is possible to sow with a large distance between the rows in order to allow mechanical weed control, but the tests at Foulum show that a distance of about 25 cm between the rows and no weed control is cheaper.

The plant has been given a nitrogen norm, which provides good opportunities for spreading manure. ■

Biofuels in the EU

Danish Novozymes, which is far advanced in the development of biofuels, has been appointed chairman of an industrial task force in "European Biofuels Technology Platform" set up by the European Commission.

In cooperation with other companies, authorities and non-governmental organisations, Novozymes will be working for a large-scale introduction of biofuels in the EU transport sector.

The specific idea is to try to realise the vision that 25 per cent of the total European consumption of fuel for road transport will be based on environmentally friendly biofuels by 2030.

Via "European Biofuels Technology Platform", Novozymes will also work to ensure that a large part of the biofuels comes from European biomass. The means include strengthening the research into new technologies and the European industry's competitiveness in the global market.

According to EU calculations, the strengthening of the sector may result in up to half a million new jobs.

TS

More money for research - especially from the EU



photo: novozymes

This year, the public research grants have increased by more than four per cent, but the Government still lags behind its own objective. The EU is rather more ambitious, as the Council of the European Union recently decided to increase the research grants by 75 per cent between 2006 and 2013.

The Danish Centre for Studies in Research and Research Policy has now calculated the total public research grants for 2006. The calculation shows that almost DKK 500 million has been granted for research and development in 2006 compared to last year, namely DKK 12.3 billion compared to 11.8 billion in 2005.

However, it will still take some time before the Government lives up to its own objective of spending one per cent of the gross national product on research and development by 2010. In 2006, we still need DKK 4 billion before the Government has reached this level, as the public research grants in 2006 only represent 0.76 per cent of the gross national product. The equivalent figure for 2005 was 0.75 per cent, so we are heading in the right direction.

Most of the research grants are allocated through the Finance and Appropriation Act, while the other grants come from the EU's framework programmes, the Nordic Council of Ministers, counties and municipalities

as well as The Danish National Research Foundation.

While the increase in the Danish research grants is modest, it is quite the opposite in the EU. At the end of July, the Council decided to allocate approx. DKK 400 billion for research and development in the seventh framework programme, which runs from 2007 to 2013. Compared to the sixth framework programme, this is an increase of 75 per cent between 2006 and 2013.

In the sixth framework programme, the headline for the energy grants was: Sustainable development, global climate changes and ecosystems. The almost DKK 16 billion allocated was to be divided between the areas of transportation and environment.

In the seventh framework programme, energy has its own budget of approx. DKK 17 billion, which is expected to be divided between the following areas:

- Hydrogen and fuel cells
- Renewable electricity production
- Renewable fuel production
- Renewable heating and cooling technologies
- Retention and storing of CO₂
- Clean coal technologies
- Energy efficiency and energy savings
- Knowledge of energy policy.

In addition to a larger research budget, the seventh framework programme implies a strengthening of the companies' participation in European research. TS



photo: torben skott/biopress

It takes more than new technology

Biofuels have been placed high on the political agenda, but so far the debate has been concentrated on which technologies to promote. The question of choice of raw materials has hardly been mentioned even though it would be possible to kill three birds with one stone: The consumption of pesticides can be significantly reduced, nitrate leaching can be reduced by 70 per cent and the emission of greenhouse gasses can be reduced by 60 per cent.

By Torben Skott

– Of course we have to discuss technology, but the question of biofuels should be considered in a far broader perspective. It takes more than technology. It is incredibly important that we are aware of the many opportunities offered by basing the production on perennial energy crops.

This is the view of Jørgen E. Olesen, research professor at the Danish Institute of Agricultural Sciences, who has made a detailed study of the energy crops' influence on the environment in cooperation with senior research associate Uffe Jørgensen.

– If we make the right choice, we will not only obtain a high biomass produc-

There are several indications that nitrate leaching can be reduced by 70 per cent by replacing ordinary agricultural crops with perennial crops such as willow.

tion. We will also be able to reduce the nitrate leaching, displace larger amounts of greenhouse gasses and reduce the consumption of pesticides. This will make it easier to comply with for example the Water Framework Directive, the Kyoto Protocol and the Pesticide Action Plan, the two researchers agree.

It is especially perennial crops such as willow, elephant grass, sorrel, reed canary grass and ordinary silage grass which have these advantages. The perennial crops have deep roots all year round and are often resistant to weeds, pests and diseases.

“ the difference in the total transfer of greenhouse gasses between annual and perennial crops of 60 per cent.

Research professor Jørgen E. Olesen

At the same level as nature areas

– For a period of seven years, measurements from willow and elephant grass have shown very low levels of nitrate leaching, also in optimally fertilised crops. For many years, the leaching was at the same level as the leaching from nature areas and forest, says Uffe Jørgensen, and he suggests that the nitrate leaching can probably be reduced by 70 per cent by replacing ordinary ag-

ricultural crops with perennial energy crops. The long growth season for the perennial crops makes them particularly efficient at minimising the nitrate leaching from livestock manure.

The perennial crops are also better at reducing the emission of greenhouse gasses than ordinary agricultural crops. This is due both to storing of carbon in the soil and minor leakages of laughing gas, which is a strong greenhouse gas.

An attempt to add up these different factors has shown that the difference in the total transfer of greenhouse gasses between annual and perennial crops may amount to 60 per cent.

– This means that perennial energy crops are one of the cheapest means to reduce CO₂ in the agricultural industry, says Jørgen E. Olesen, who stresses that these calculations are subject to some uncertainty.

Furthermore, experience shows that the so-called pesticide treatment index, which is a measurement of how often the fields are treated with pesticides, may be significantly reduced if perennial energy crops are chosen.

One of the few willow growers, who has planted willow on most of his farm land, has achieved a pesticide treatment index of 0.9, while a number of tests at the Danish Institute of Agricultural Sciences show an index of between 0 and 1. This should be compared to the aver-

age treatment index in the agricultural industry of 2.2 (year 2004) and the reduction goal in the Pesticide Action Plan of 1.7 by 2009.

Barriers

So far, there are only approx. 1,000 hectares of perennial energy crops in the Danish agricultural industry. The practical experience of growing and especially of harvesting and handling the large amounts of biomass is therefore limited.

– Many farmers prefer to cultivate what they are used to, but continuing with the traditional crops involves various problems. The requirements for reduced supply of nitrogen and pesticides are continuously strengthened which means that increased focus on the environmentally friendly crops is necessary, explains Jørgen E. Olesen.

He explains that a number of barriers probably have to be removed if perennial crops should have a chance of making a break through:

– The farmers are not familiar with the crops and probably neither they nor the machine pools have the right ma-



photo: torben sløtt/biopress

Uffe Jørgensen in one of Foulum's elephant grass plantations. The plants have deep roots and are often resistant to weeds, pests and diseases.

chines. In addition, it is often the livestock production that determines which crops are cultivated - in other words, how the farmers can most easily dispose of the manure produced on the farm.

Finally, it is also a question of having a guarantee that the crops can be sold. Many of the perennial crops represent a 20-year investment, and some farmers are naturally reluctant to make such an investment as long as the future of bioenergy is uncertain, says Jørgen E. Olesen. He refers, among other things, to the fact that the Government last year decided to stop further use of biomass in the district heating sector and that Denmark is far behind in its use of biomass in the transport sector.

Both Jørgen E. Olesen and Uffe Jørgensen hope that large demonstration projects with perennial energy crops can soon be established - for example in the surrounding area of some of the inlets where something has to be done soon in order to comply with the requirements of the Water Framework Directive. ■

Denmark triples its energy export to China

USA and China are very large export markets for Danish energy technology. The export of energy equipment to China has more than tripled over the past decade and now amounts to more than DKK one billion.

It makes sense for researchers to consider the possibilities of exporting different forms of energy technology. Consequently, one of the key speakers at the information meeting on the energy research programmes on 15 August was first secretary Morten Bæk-Sørensen from the Danish Embassy in Washington.

His message was clear: The USA is now ready to move their energy supply away from the fossil energy sources, which gives Denmark a unique opportunity to sell energy equipment and enter into cooperation on the development of new technologies.

Until the 1990s, the interest in renewable energy was sporadic in the USA,

but after Hurricane Katrina, which destroyed several oil installations, the war in Iraq, environmental problems, the terror threat and the increasing oil prices, the Americans have become aware of the fact that reliance on the fossil energy sources is far too risky. Since 1999, the investments in renewable energy have therefore quadrupled, and 2005 was a record year with investments of more than USD 900 million in 80 new renewable energy companies.

However, not only highly industrialised countries such as the USA are thirsting for energy. In China, the consumption of energy is increasing explosively and the Danish export of energy equipment to China has tripled over the past decade. This year, the export is expected to amount to more than DKK one billion, and much seems to indicate that the development will continue in the coming years.

The export to Russia follows the same pattern. In 2005, the export of en-

ergy equipment reached DKK 322 million, which is almost three times as much as in 1996.

According to the Danish newspaper, Berlingske Tidende, this has made the Minister for the Environment Connie Hedegaard suggest that the most of the DKK one billion which the politicians are to distribute from the Globalisation Pool will be allocated to energy and environmental technology.

– It is necessary to focus consistently on research and development if Denmark is to continue to wear the "Yellow Jersey" within energy and environmental technology, says the Minister for the Environment.

Last year, Denmark's energy technology exports amounted to almost DKK 40 billion. This is a 16 per cent increase on the previous year, which means that the export of energy technology is increasing much faster than the total export of Danish goods.

TS

The pellet burner now produces electricity

In cooperation with Nordic Bioenergy, a group of researchers from Aalborg University and the University of Aarhus has succeeded in making a wood-pellet boiler produce electricity. In many ways, the technique is very simple, as it is based on thermoelectric elements that are also used in ice-boxes for cars and caravans. The difference is that the difference of temperature is now used for producing electricity instead of using electricity for the production of difference of temperature.

By *Torben Skøtt*

- Actually, it is just an ancient invention we use, says Jannich Hansen from Nordic Bioenergy when asked to explain how to make a wood-pellet boiler produce electricity. He has both feet on the ground, which is typical of many people from North Jutland, however, he makes it abundantly clear that this may very well turn out to be brainwave.

In cooperation with Aalborg University and the University of Aarhus, the

entrepreneurial company from North Jutland has constructed a wood-pellet boiler which is capable of producing both heat and electricity. This is done by means of so-called thermoelectric elements, which consist of two types of material with a surplus and a deficit of electrons. When one side is heated, the amount of energy increases, whereupon the electrons start to migrate between the two types of materials.

The electricity production from the prototype is by no means impressive, but we believe the latest nanotechnology research will make it possible to increase the efficiency, so that a simple boiler capable of covering the heat and electricity consumption of a normal household can be produced.

- We have always dreamt of constructing a small CPH plant for a normal household, but we have never had the necessary resources. Now that we have entered into a cooperation with Aalborg University and the University of Aarhus, our goal is within reach, says Jannich Hansen, who has developed numerous interesting pellet burners together with his colleague Kim Gregersen. Today, these pellet burners

are sold through an extensive dealer network.

German invention

The principle behind the new wood-pellet boiler is so simple that it is surprising nobody else has thought of it. As Jannich Hansen quite correctly mentioned, the invention dates back to 1823, when the German physicist Seebeck demonstrated that a tension is generated in a circuit between two types of materials, if one side is heated while the other side is cooled. Twelve years later, the French physicist Peltier demonstrated that the process can be "reversed" in order to obtain a difference of temperature by sending a current through different types of materials. Neither of the two physicists seems to have realised the potential of their inventions, and the thermoelectric elements were not extensively used until the last few decades. We know them best from the small ice-boxes which are mainly sold to campers, but the elements are also used for temperature measurement and in space research.

- When using thermoelectric elements, the only limitation so far has been the low efficiency, but this is of minor importance when they are installed in a boiler where the heat loss is utilised, explains associate professor Lasse Rosendahl from the Institute of Energy Technology at Aalborg University. Together with professor Bo Brummerstedt Iversen at the University of Aarhus, he is the anchorman of the project, which also involves a group of students at Aalborg University, who have been in charge of constructing the prototype in connection with an exam project.

- The first test showed that the system functions as intended and that it will not be difficult to construct a boiler which is self-sufficient in electricity which means that it will function during a power cut. The next phase is a boiler which is capable of covering part of the power consumption of a normal household, and this is where the nanotechnology must prove its true worth, explains

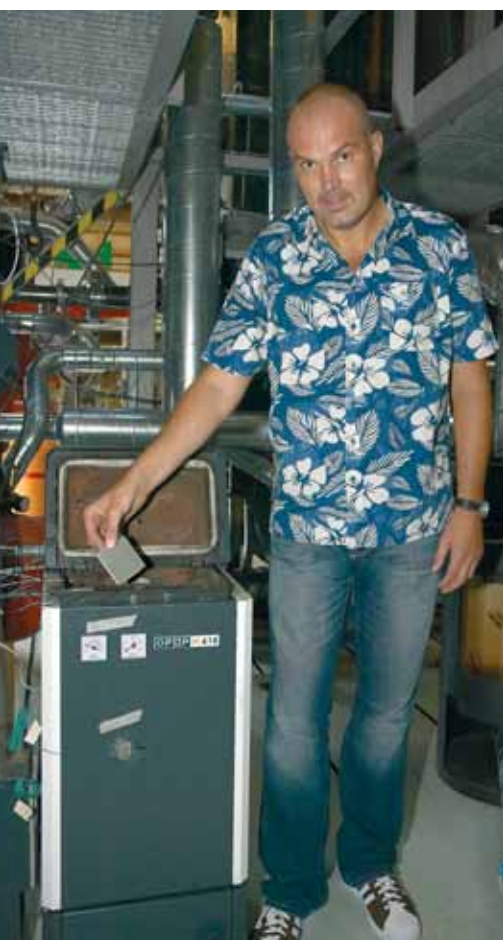


photo: torben skøtt/bioPress

Associate professor Lasse Rosendahl from the Institute of Energy Technology at Aalborg University with one of the small thermoelectric elements that convert heat into electricity. The boiler in which the elements are mounted is a rebuild wood-pellet boiler from Nordic Bioenergy.

Lasse Rosendahl. This part of the work is mainly carried out at the University of Aarhus, while Aalborg University tends to work on design and adjustment of the different materials.

The price is crucial

The great advantage of using thermoelectric elements is that there are no moving parts, which results in a very robust and compact construction. One of the disadvantages is the price, which is closely connected with the efficiency and the use of the elements. If the purpose is electricity production, they are relatively expensive, whereas cooling materials are at the cheap end of the price scale today.

The materials which the students have chosen for the prototype are capable of converting approx. five per cent of the heat into electricity, but in Japan they have found elements with a 12 per cent efficiency, and international research groups are aiming for an efficiency of approx. 15 per cent within the next few years. In addition, Japan is one of the leading countries within the exploitation of thermoelectricity, and it has also opened the world's first power plant where the excess heat is converted into electricity by means of thermoelectric elements.

– The costs may be a decisive factor for the success of the project and as a result a large part of the job is to find

cheaper and more efficient materials, says Lasse Rosendahl, but at the same time he stresses that much could also be achieved with a better design using the existing materials in a better way.

– The prototype is based on an existing boiler which was originally designed for coke and later modified for wood-pellets. It is obvious that we will be able to obtain a better efficiency if we choose a boiler originally designed for combined electricity and heat production, says Lasse Rosendahl.

On the other hand, the researchers are also aware of the potential of using the many existing boilers, and this is the reason why the project includes the development of the so-called power-packs which can be installed in existing plants. However, their efficiency is likely to be lower, so that the electricity price becomes slightly higher.

Follow the development on our website

In connection with the project "Design, modelling and utilization of thermoelectric materials and devices in energy systems", we have set up a website at the address www.thermoelectric.dk where it will be possible to follow the development continuously. The total budget of the project is DKK 6.7 million of which The Danish Council for Strategic Research has granted DKK 3.7 million. The rest is financed by the University of



photo: torben skott/biopress

Jannich Hansen (left) and Kim Gregersen from Nordic Bioenergy

Aarhus and Aalborg University as well as by a number of minor contributors. According to the plan, the project will be completed on 31 July 2008. ■

Thermoelectric elements

A thermoelectric element consists of two different types of materials with a surplus and a deficit of electrons. When one side is heated, the amount of energy increases, whereupon the electrons start to migrate between the two types of materials. The principle may also function reversed by creating a difference of temperature between the two materials by adding electricity.

Thermoelectric elements are mainly used in small ice-boxes and for cooling laptops. The systems have also been used for electricity production within space research and Japan has the world's largest power plant converting excess heat into electricity by means of thermoelectric elements. As a matter of curiosity, it may be mentioned that the company Thermo Life Energy Corp in the USA has taken out a patent on a small electricity generator which is operated by body heat. The vision is that the generator will be able to replace the batteries needed by people with pacemakers.

The potential for thermoelectric elements is huge within cooling as well as electricity production. The systems are simple, robust and completely non-polluting and the nanotechnology is expected to speed up the development significantly.

Biodiesel is popular

While the debate on biofuels in Denmark mainly has focused on various technologies for the production of ethanol, it turns out that the Europeans' favourite biofuel is in fact biodiesel. This is reported in the Energy Industry's newsletter on the basis of a report from EuroObserv.

According to the report, biodiesel represents 81.5 per cent of the EU's total production of biofuels. In 2005, 3.2 million tons of biodiesel were produced in the EU, with Germany responsible for more than half of the production.

The production of bioethanol amounted to 721,000 tons, with Spain and Sweden supplying 240,000 and 130,000 tons, respectively. TS

Ethanol and biogas plants can be optimised and tested on the basis of type of environment. Torben Lund Skovhus, laboratory manager at the Danish Technological Institute studies the bacterial environment on the basis of a DNA analysis of a sample of water from an oil rig.

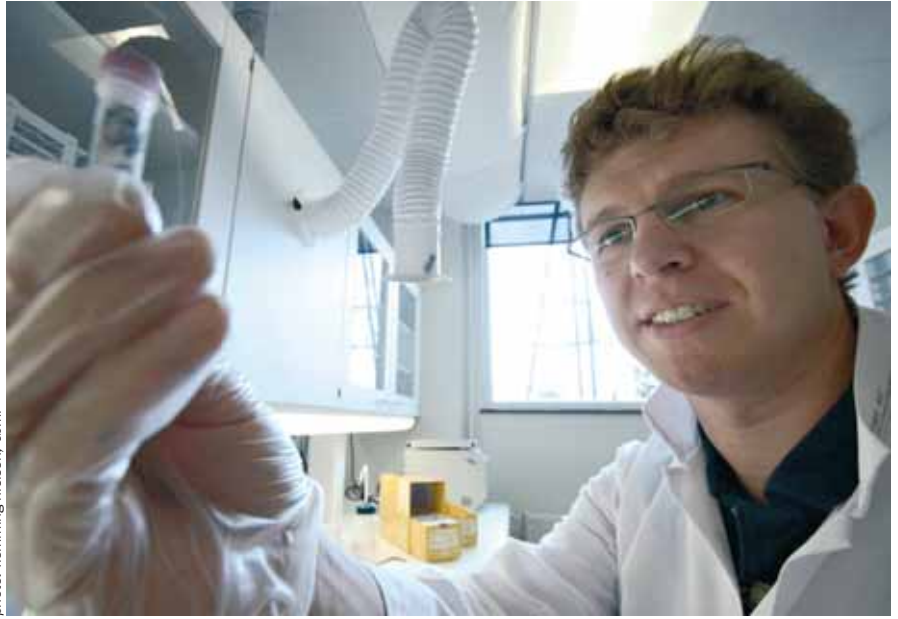


photo: Flemming Nielsen, cbmi

Bioenergy equipment should be off-the-shelf

The purpose of a project governed by the Centre of Bioenergy and Environmental Technology Innovation is to establish standards for the certification of biomass equipment as well as rules for the declaration of biomass, livestock manure

By Flemming Nielsen

The insecurity which arises when a new biogas plant is ordered must end. A new testing and certification programme is to ensure that bioenergy and environmental technology equipment is comparable for the benefit of manufacturers, buyers and authorities.

– With a certification of components for handling biomass and livestock manure, it will no longer be necessary to guess the effect of the environmental technologies in which companies have to invest, says Michael Støckler, who is in charge of the Centre of Bioenergy and Environmental Technology Innovation (CBMI).

The certification project is one of the four new projects initiated by CBMI on 1 August. The project manager will be the Danish Technological Institute in Aarhus, whose core competencies in-

clude microbiology, chemistry and mechanical tests.

– We will set up a team which will attack the project from several angles. We need developers as well as practitioners, says Bo Frølund, head of centre for the Danish Technological Institute.

During the next four years, the institute will become able to test various types of equipment in cooperation with the Danish Agricultural Advisory Service and the Danish Institute of Agricultural Sciences.

Aggressive process environment

The equipment used for handling livestock manure, chemical and biological

processes is exposed to an aggressive microbacterial environment and considerable mechanical influence.

Each of the areas fall within the Danish Technological Institute's field of activity.

– We carry out comprehensive tests and development of for example equipment for the oil industry, which has extreme working environments. In addition, we have decades of experience of durability tests and material improvements. Experience which is transferable to the bioenergy and environmental area, says Bo Frølund.

The work involved in developing new methods for certification is divided

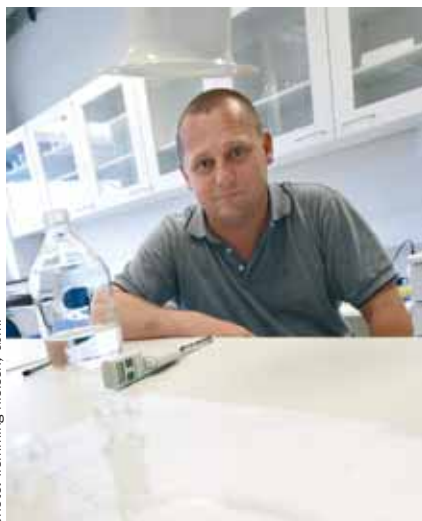


photo: Flemming Nielsen, cbmi

Bo Frølund, head of centre for the Danish Technological Institute, is the project manager of a new CBMI project which among other things is to develop methods for certification, testing and possibly type approval of biomass and livestock manure equipment and components.

into two main groups. The first group concerns certification of plants, equipment and components, while the second group comprises declaration of biomass, livestock manure and products from the plants.

Plants, equipment and components

In connection with the sale of biomass and livestock manure plants, it would be advantageous for all parties if they could rely on a certification or a type approval.

– The advantages of the manufacturers of components and plants are that they spend less time if they obtain a type approval instead of having to apply for approval project by project, explains Bo Frølund.

– In the export markets, a certification or approval arrangement will have a huge impact on sales. It will be easier for the customers to understand the market and finally, the authorities are likely to be able to carry out the approval work more easily and reliably, says Bo Frølund.

Output standard

When livestock manure or biomass is processed, the quality of the output is important. The end products will have to compete with or directly replace industrial products. Consequently, they have to live up to a large number of requirements in relation to for example uniformity and purity.

Among other things, this applies to fertilizer, ammonia products and biofuels such as ethanol and biodiesel.

However, it is difficult to establish standards for some products:

– It is doubtful whether separation plants can produce manure concentrates that comply with a narrow industrial composition. The products are more likely to be grouped in classes according to the combination of nutrients, amount of dry matter, etc. This will make it easier to sell the products, predicts Bo Frølund.

Flemming Nielsen is a communication assistance at the Centre of Bioenergy and Environmental Technology Innovation (CBMI), e-mail fn@cbmi.dk. ■

DKK 1.5 billion for research in ethanol

According to the Danish newspaper Jyllands-Posten, the American Government has decided to spend USD 250 million or almost DKK 1.5 billion on speeding up the development of biofuels.

It is the U. S. Department of Energy which supports the construction of two new centres with the primary purpose of developing the so-called second generation technology that will make it possible to produce bioethanol on the basis of cellulosic plant material.

The Department of Energy invites universities, research institutions and private companies to participate in the

development and thus receive funding. The two centres are expected to be established by 2008.

The USA produces more than 15 million litres of ethanol a year. Today, the production is primarily based on maize, but as a result of the increasing demand other raw materials are also needed.

The new centres will among other things investigate how plants convert the sunlight into energy in order to improve the exploitation of nature's own processes for a more efficient conversion of vegetable fibres into ethanol. *TS*

EU's seventh framework programme

Conference 6 September 2006 in Copenhagen

On 1 January 2007, the EU's seventh framework programme will be launched with an expected budget of DKK 380 billion for research and development. In this connection, the Ministry of Science, Technology and Innovation will hold a conference on 6 September 2006, focusing on the opportunities offered by the new framework programme. Discover more about the political visions and the opportunities for companies and research institutions and learn from other people's experiences when applying for research funding from the EU. Participation in the conference is free, but registration is required. For further information, please contact:

EuroCenter, Teknologisk Institut, DK-2630 Taastrup, Denmark
 ☎ + 45 7220 2900 • www.eurocenter.info • ec@eurocenter.info.

Four bioenergy projects in the melting pot

The Centre of Bioenergy and Environmental Technology Innovation initiates four bioenergy projects for a total of DKK 30 million.

On 1 August 2006, the Centre of Bioenergy and Environmental Technology Innovation (CBMI) was officially inaugurated as a regional technology centre supported by the Ministry of Science, Technology and Innovation. At the same time, four new projects for a total of DKK 30 million were launched. The projects which run over four years involve:

- Education and communication
- Production and pre-treatment of biomass
- Company development
- Testing and certification.

CBMI consists of the consortium partners Agro Business Park, the Danish Institute of Agricultural Sciences, the Technical University of Denmark, the Danish Agricultural Advisory Service and the Danish Technological Institute.



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

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New eco-car record



photo: kim rene hansen

The eco-car DTU Innovator, which has been developed by a group of students from the Technical University of Denmark, has beaten its own record by driving what corresponds to 780 kilometres on a litre of petrol. The car runs on DME, which is a non-carbon diesel fuel that can be produced on the basis of biomass.

The students of the Technical University of Denmark are nothing if not ambitious. No less than 30 students are deeply involved in the development of two eco-cars, which will drive almost 2,000 kilometres on a litre of petrol. This sounds completely utopian, but the students are very optimistic and in just a few years they have succeeded in constructing two cars with a fuel efficiency that outrivals anything previously seen in Denmark.

One of the cars, DTU Dynamo, is equipped with fuel cells and a hydrogen tank with a pressure of 200 bar. The fuel cells supply power to a DC motor with a power output of 200 watt, which corresponds to approx. 0.25 horsepower.

DTU Dynamo has won the four consumption tests in France and England in

which it has participated. Most recently, the car won the Shell Eco-Marathon 2006 in the city cars class. At 30 km/h, the car drove 25 kilometres on 8.1 g of hydrogen, corresponding to 810 kilometres per litre petrol.

The other car, DTU Innovator, runs on DME, which is short for DiMethylEther - a non-carbon diesel fuel which can be produced on the basis of biomass. The students have built the world's smallest diesel engine for DTU Innovator, with a stroke volume of just 0.05 litre.

Most recently, DTU Innovation has beaten its own record at a motor race in England, where it drove what corresponds to 780 kilometres on one litre of petrol.

After the first successful test runs, the students were very optimistic and after the first race, the judge established that the car had driven what corresponds to 669 kilometres on a litre of petrol. This result beat the old record from 2004 of 583 kilometres per litre.

The students soon came up with their next goal: To beat the hydrogen car's record of 810 kilometres/litre. They succeeded in driving 780 kilometres/litre, but almost does not count, so the hydrogen car still holds the record by 30 kilometre/litre. TS