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FiB
Bioenergy research

PSO-2005 postponed

The allocation of PSO funds for research and development in 2005 has been postponed. The Danish minister of economic and business affairs would like a debate about target investment areas for 2005 with the parties behind the energy agreement. Consequently, information meetings will not be held until immediately after the summer break, at the earliest.

Each year, Eltra and Elkraft are responsible for preparing recommendations for the allocation of PSO funds for the coming year, i.e. guidelines describing the areas within environmentally friendly electricity production that should be promoted under the PSO scheme, which is financed by the electricity consumers.

In 2004, the budget was DKK 100 million, but according to the energy agreement of 29 March, the budget for the next four years will be DKK 130 per year.

In 2005, the submission process is expected to be divided into two stages: a call for submissions for the first DKK 100 million followed by a call for the remaining DKK 30 million.

Eltra and Elkraft have been preparing the ordinary round for the first DKK 100 million for 2005 for quite a while. The proposal has been heard by experts and coordinated by the people who are responsible for the system It now merely awaits the approval of the minister of economic and business affairs.

Eltra has just published the report "Miljøvenlig elproduktion 2004" (Environmentally friendly energy production 2004) which includes a description of the projects covered by the 2004 PSO programme. In addition, Eltra has assessed the results of past PSO projects.

In the 2004 programme, biomass energy is once again the area receiving most support. Support has thus been granted to a large project regarding biomass standardisation, and to another project that examines the material problems involved in biomass combustion.

Denmark is the undisputed market leader in straw-fired heat and power stations. This is particularly because of the Biomass plan that forces power plants to buy large amounts of straw for power production. The picture was taken at the Masnedø power plant that began operation in 1996.

photo: torben skøtt/biopress

How do we best develop the technology?

Experience with the Danish Energy Agency's follow-up programme for biomass heat and power production

photo: torben skøtt/biopress

Thanks to the wood-fired heat and power station in Assens, the amount of CO_2 released into the atmosphere has been reduced by 40,000 tonnes per year. The power station is very popular in the town. 98% of all households are connected to the power plant, which is among the 25 cheapest district heating plants in Denmark.

By Henrik Flyver Christiansen

It takes time to develop new energy technologies. This is particularly true of biofuel plants, where what appears to be a minor change between different types of fuel can cause new and unforeseen problems.

The conversion to new energy technologies requires stable and long-term framework conditions. Many of the companies that will market the new technology have only been around for a couple of years. In order to survive, they need to be able to pace their manufacture and sales. Funding over a short period would be counterproductive, and problems may also arise if the market develops so fast that the companies are unable to keep up.

Often, the debate about the framework conditions focuses on one aspect at a time. However, to properly promote the development, it is important to consider the conditions as a whole. Without an active research and development environment and conditions that allow cost-effective establishment and operation of the plants, the development will come to a standstill.

So what technologies should we promote? There are as many opinions as there are players, each with a well-thought-out suggestion.

The experience with the Danish Energy Agency's follow-up programme shows that it is impossible to determine beforehand which technologies deserve to be promoted. It is therefore necessary to promote more than one technology. By evaluating the results on an ongoing basis, it is possible to stop the development of some technologies and speed up the development of others.

Development

The technological development will typically consist of the following stages:

1. Process technology breakthrough
2. Laboratory-scale testing of the process
3. Demonstration of the process in a pilot plant

The follow-up programme

The Danish Energy Agency's follow-up programme for biomass heat and power production began in 1995 and was completed in June 2004. Among other things the programme funded many development projects and ensured the sharing of experience between projects.

4. Establishment of a first generation plant where the technology can be tested long-term
5. Demonstration of up to five subsequent generations of plants where the technology is optimised.

Independent experts should evaluate the technology in each stage. In the past, this evaluation has taken place in connection with the processing of applications for continued support. At this stage, the development of some types of plants has been stopped for the benefit of other more promising technologies.

The first three stages often require funding of all net costs. In the following stages, the project or plant subsidy can be reduced according to the amount of income the plant is expected to generate from the sale of electricity and heat, etc. The aim is therefore to calculate the amount of subsidy so that the plant breaks even. Otherwise, operation would be discontinued and with that the long-term testing that is necessary to evaluate the prospects inherent in the technology. In stage three and four, additional grants are often necessary due to teething problems that require changes/restructuring of the plant.

photo: torben skott/biopress

The heat and power plant in Harboøre, which is based on the gasification of wood chips, has the largest number of operating hours of any gasification plant in the world.

There are numerous examples around the word of technologies that were discontinued because the plant in question operated at a loss. The best-known example in the Nordic countries is the gasification plant in Värnamo in Sweden, where a plant worth SEK hundreds of millions has been standing still for 3-4 years because revenues failed to cover the basic costs of operation.

In Denmark, the technological development has been prioritised differently. We have started with relatively small plants and only upscaled them once it was certain that the plant would produce reasonable revenue.

In this way, it has been possible to develop a considerable number of different heat and power plants that produce CO_2-neutral energy on the basis of biofuel. It is also worth mentioning that the investments involved have been very limited.

The straw-fired steam turbine plants are the best known and a field where Denmark is the world leader, but we are also known for our wood-fired steam turbine plants. The development of gasification plants and Stirling motors has also reached a level where the plants are close to a commercial breakthrough.

Henrik Flyver Christiansen, MSc engineering, The Danish Energy Agency, Biomass Division.

How to promote the development

- The Danish Energy Agency's follow-up programme for biomass-based power plants has shown that the development is best promoted with the following initiatives:

- A government scheme supporting plant establishment.
- A sufficiently high price for the electricity produced to allow the plant to break even. A high electricity price is an incentive that promotes effective energy utilisation through a combination of electricity and heat production. The electricity price should be reduced proportionately as the size of the plant increases. This ensures that small plants are viable and that large plants are not overcompensated.
- Individual adjustment of electricity prices based on an assessment of the prospects of the technology to be authorised by law.
- Individual exemption of fees on biofuels to be authorised by law. In Denmark, fees apply to the use of liquid biofuel in motors, as fuel exemption would result in a considerable loss of government revenue. Conversely, the wood oil that is a by-product at the Harboøre gasification plant is not subject to fees as long as the oil is used “in-house”. Consequently, no research is being undertaken to develop the production of wood oil for sale.
- Requirements to the electricity sector to use specific types of fuels. Denmark's position as a market leader in straw-fired heat and power stations is a result of the Biomass Plan that forces the power plants to buy large amounts of straw for electricity production.
- A step-by-step development that allows second-generation plants to learn from the mistakes made in the first generation plants, etc. There are many examples around the world of a “here and now” policy that led to the construction of a large number of plants in the space of a few years; all suffering from the same teething problems.
- Ongoing evaluation of the different technologies, including technologies abandoned at an earlier stage. The Stirling motor was originally abandoned, for instance, due to problems with oil lubrication of the piston rings. However, at a later stage, new materials were developed that could solve the problem, and the development of the Stirling motor was resumed.

Inventor and businessman

It takes a businessman to manage an inventor. Thomas Koch from TK Energi AS, one of the best-known researchers in gasification plants, has had to realise this. After managing his own business for about ten years, he has now employed a managing director to make business sense of his many good ideas.

photo: torben skøtt/biopress

Erik Balck Sørensen (forretningsmanden) og Thomas Koch (opfinderen) i maskinværkstedet, hvor der blandt andet laves forsøg med forgasningsanlæg og indfødningssystemer til biobrændsler.

By Torben Skøtt

You don't have to spend much time with Thomas Koch before your brain starts working overtime: new ideas and inventions pour out in a constant stream, and after a couple of hours in his company you are convinced that one day he will strike gold.

"One of my biggest challenges is not to get so many ideas. I get a new idea every half hour. There is no doubt that we can improve our profitability by narrowing our business focus," says Thomas Koch, who had to admit two years ago that it takes a businessman to manage an inventor. The company therefore started looking for a managing director, and Erik Balck Sørensen was appointed. Today, Thomas has more time to concentrate on developing and testing the many technical solutions that will make it easier to use biomass for energy purposes.

"It is not easy to let go of one's "baby," but it was the right decision, and today I feel very comfortable with the way we share the work," says Thomas.

Before joining TK Energi AS about two and a half years ago, Erik Balck Sørensen worked as a management consultant and EU consultant for companies in the environment and energy sector. Today, he is responsible for all matters of a non-technical nature at TK Energi AS. His main task is thus to make business sense of all the good ideas.

Handling of biofuel

There is certainly no shortage of ideas. The company specialises in advanced methods for biomass handling. That is what Thomas Koch is known for, both in Denmark and abroad, and that is the foundation for the company's profitability. Gasification plants are another core area, but one where the amount of time and money invested has not always produced the desired results.

"We have spent a lot of time developing gasification plants, but our profit comes from biofuel plants," says Erik Balck Sørensen and continues:

"It is a difficult industry, because it is so dependent on politics. Engineers and inventors have difficulty handling the commercial aspects of the business, because their main concern is product development. However, if we want to continue the growth we have experienced in recent years, we have to manage our finances very carefully and have a good feel for what the future will bring."

One of the projects to which Thomas Koch has contributed is the development of the feed system used in many of the large biomass-fired power plants in Denmark, including the plants at Masnedø, Ensted and Avedøre. Lately, the company has been involved in the development of technical solutions for Køge Biopillefabrik, and in the autumn the company is to install a new feed system at a gasification plant in Värnamo, Sweden.

Värnamo

Värnamo, one of the world's largest biofuel gasification plants, has been closed for a long period of time, but is due to reopen soon. After 8,000 hours of

FACTS

TK Energi AS was founded in 1990 as a one-man company. Today, the company has 17 staff. The company specialises in the development of gasification plants and advanced biomass feed systems.

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operation, the management of the plant had to realise that the plant was unprofitable.

One of the main problems at Värnamo was the feed system, which was too expensive to operate: it accounted for almost 20% of total operating costs. It is therefore imperative that a new and more effective system be developed to reduce costs.

"Biofuel is very bulky in relation to its energy content. The process of feeding the fuel into pressurised processes therefore requires a lot of energy. We expect to be able to install a system that can reduce the energy consumption by a factor 10. The starting point was a halving of operating costs compared with the old system," says Thomas.

The required capacity of the new feed system at Värnamo is six tonnes per hour at 25 bar. That may sound like a lot, but it is nothing compared with another project in Rotterdam for which TK Energi has carried out a feasibility study. In this plant designed by Shell, the production of synthetic gas requires more than 3,000 tonnes of biomass per hour.

"It is a gigantic plant that will be able to cover four percent of the total fuel consumption of the European transport sector. Shell handles almost all aspects of the design, except the feed system. The feed system is an area that requires special research, and this is where we have something to offer," Thomas Koch concludes.

Thomas Koch next to one of the components for the gasification plant. The finished plant consists of 2,800 parts that were packed in a container early June and shipped to Japan. This is quite unusual in many ways, says Thomas Koch. "It is the first time we ship a plant to Japan, and it is the first time we have produced a gasification plan that is identical to our own pilot plant."

From Gadstrup to Tokyo

- Hitachi buys gasification plant developed in Denmark

Few Danes probably know the small town of Gadstrup south of Roskilde, but quite a few people in Paris and Tokyo do. Hitachi Zosen, the Japanese industrial group, and the French Atomic Energy Commission both work with TK Energi in Gadstrup to develop a gasification plant.

By Torben Skøtt

Gasification plants that can convert biofuel to combustible gas are not a new invention, but many plants have problems with large quantities of tar in the gas.

Thomas Koch from TK Energi in Gadstrup has found a solution to the problem. In essence, the biomass is separated into coke and tarry pyrolysis gas. The tarry pyrolysis gas is combusted, and the clean combustion products are used to convert the coke to combustible gases. The result is a gasification gas that is completely free of tar and only needs cooling and filtering before it can be combusted in a motor.

photo: torben skøtt/biopress

The first plant is due for delivery to Hitachi Zosen in Japan in June. Hitachi Zosen has its own energy division that also develops gasification plants, but the company is interested in testing the Danish plant. If the test is successful, the intention is for the Japanese to manufacture the Danish plant under licence.

However, Hitachi Zosen is not the only one to discover the Danish developer company. The French Atomic Energy Commission has worked with TK Energi for a long time - a collaboration that has greatly benefited the company in Gadstrup.

"The collaboration with the French Atomic Energy Commission opens doors. They work with some of the largest electricity companies in Europe and have a considerable amount of technical expertise that we can draw on," says Erik Balck Sørensen, managing director of TK Energi.

Asked what atomic energy has to do with gasification plants, Erik Sørensen answers that they have seen the writing on the wall. Today, the European Union is much more interested in developing sustainable energy resources than atomic energy.

TK Energi has also learned that it is often easier to work with business partners abroad than in Denmark. In addition to Hitachi Zosen and the French Atomic Energy Commission, TK Energi also works with TPS (Sweden), Sydkraft (Sweden), Foster Wheeler (USA), and with Dutch and French companies and research institutions in connection with projects in the Netherlands, India and Vietnam.

However, they also find time for projects in Denmark. In the autumn, TK Energi is going to construct a gasification plant for Gjøl in North Jutland. Initially, the plant will be used to gasify wood chips, but if all goes according to plan, the plant will later experiment with the gasification of other types of biomass. ■

The international biomass conference in Rome showed that researchers are most interested in the more exotic bio-energy processes. There is little focus on the more obvious, quick and cheap methods for including large amounts of biomass in the energy supply.

photo: søren houmøller/force technology

Exotic bio-energy research

Impressions from the bio-energy conference in Rome

By Anders Evald

When you participate in this large international biomass conference for the sixth time, you are inclined to think that real news will be few and far between. However, that was far from the case at the 13th European Conference on Biomass for Energy, Industry and Climate Protection that took place in Rome in the middle of May. Maybe the news did not represent major technological breakthroughs, but the industry is constantly changing, and new technologies keep popping up.

The target group for the conference is very broad - ranging from university researchers and developers in private companies to authorities and businessmen. The 1000 participants come from all over the world, so it is not just a European event.

From a technical point of view, the development is moving towards advanced processes for the production of liquid fuel, gas and other products. The development focuses on high performance and a high value output. On the other hand, there is little interest in commercialisation, cost-effective plants, marketing and marketability.

Researchers are mainly attracted to the exotic processes and fuels. Examples of projects are:

- An "ablative pyrolysis reactor" for two kg wood/hour
- Firing with spinach leaves (at the last conference in Amsterdam, thistles were in vogue)
- Hemp growing (once again)
- Gasification of pyrolysis oil
- A gasification system consisting of a reactor measuring 1.5 x 1.5 mm
- 4-5 examples of processes producing hydrogen, ethanol and bio-oil from reactors involving high-pressure processes (more than 200 bar), high temperatures, and enzymes and catalysts to kick off and control the process.

It is not that these processes and the corresponding research and development are uninteresting or unnecessary. Quite the contrary: in the long run, it is imperative that we find solutions for effective use of biomass for transport and small electricity-producing units. But right here and now - with oil prices that have risen by 20% over the past year, and coal prices that have risen by 80%, when the supply of natural gas in North America is in crisis, and the European Union's energy policy and the Kyoto agreement are pushing for fast changes to energy supply, you would have expected more focus on the more obvious, quick and cheap solutions.

A talk on the export of large amounts of Russian wood to Western Europe - we are talking about millions of tonnes - only attracted about 30 people. Similarly, the conclusion to an IEA workshop on the addition of up to 10% wood to coal-fired power plants was acknowledged, but not really accepted, despite the fact that this has turned out to be the cheapest, fastest and most efficient way to include large amounts of biomass in the energy supply.

As at previous conferences, Denmark was well represented with participants, presenters as well as posters. However, the number of Danish participants had declined significantly (30 participants this year against 48 in Amsterdam in 2002 and 74 in Sevilla in 2000). It is obvious that the industry is discouraged by the lack of political interest in Denmark.

Anders Evald, engineer, FORCE Technology.

Emissions from decentralised heat and power plants

The Mapping of Emissions of Decentralised Plants project that was initiated in spring 2001 has now been completed. The Danish Gas Technology Centre was responsible for the project that received DKK 2.4 million in support from the PSO scheme and a similar amount from Eltra.

The project reports on emissions from waste, straw and wood-fired heat and power plants, natural gas motors and turbines as well as biogas motors.

Gas motors are the main sour of NOx, UHC, CO, N2O, CH4, aldehyde and PAH emissions. Waste combustion plants are the biggest source of particle, SO2, dioxine, HF and metal emissions, whereas straw-fired plants are the main source of HC1 emissions. 80% of CH4 emissions caused by stationary combustion stems from decentralised heat and power systems - primarily gas motors.

Two recent executive orders are likely to cause a further drop in emissions from waste combustion, gas motors and gas turbines in the years to come.

Source: Eltra • Miljøvenlig Elproduktion 2004 - Forskning og udvikling (Environmentally friendly electricity production 2004 - Research and development)

Measurement of the moisture content in bales of straw

photo: torben skøtt/biopress

The Improved Measurement of Moisture in Straw project that was launched at the beginning of 2000 has now been completed. Elsam Engineering and Dansk System Elektronik were responsible for the project that received DKK 1 million in support from the PSO scheme.

The project involved the development of an instrument that makes it possible to determine the moisture content in bales of straw by measuring the attenuation of microwaves through the bales.

When the project began, the researchers presumed that there was a direct relationship between the moisture content in a bale of straw and the attenuation of microwaves through the bale. However, this presumption turned out to be false. Consequently, there still is no satisfactory method for measuring the moisture content in straw. The microwave method is promising, but the final development of the equipment requires a better and more in-depth understanding of the measuring principle and the parameters that impact on the measurements.

A number of relevant universities, institutions and companies in Denmark and abroad have been approached in order to assess the possibilities of continuing with the project.

Source: Eltra • Miljøvenlig Elproduktion 2004 - Forskning og udvikling (Environmentally friendly electricity production 2004 - Research and development)

Manure research

In recent years, Danish know-how and efficiency within animal husbandry have improved to such an extent that the environmental factors now represent the main growth barrier. An investment of up to DKK 200 million aims at developing the necessary knowledge and technology, for instance relating to the separation of manure.

The National Environmental Research Institute and Dansk Jordbrugsforskning have received the first DKK 50 million for pilot projects out of a total research fund of DKK 155 million that forms part of Vandmiljøplan III (Water environment plan III). The rest - approximately DKK 100 million - is likely to be made available to a wide range of industries, thus allowing all research institutions to submit projects.

583 kilometres per litre

MSc students from the Technical University of Denmark have managed to drive 25 kilometres using only 48 g of Di- Methyl fuel. That corresponds to doing 583 kilometres on a litre of petrol.

The achievement took place on Sunday on a racecourse in the south of France. The students with their eco-car, Spirit of Copenhagen, came fifth in the alternative fuel category in the Shell Eco Marathon economy race. Five thousand students and two hundred cars from all over the world participated in the competition.

Di-Methyl fuel is derived from natural gas, coal and biomass.

Source: Næstved Tidende, 17 May 2004

New climate centre

A new research centre in Jaegerspris called "Climaite" will simulate the Danish climate over the next 70 years. By manipulating weather conditions, temperatures and the air's CO2 content, researchers will study the weather's influence on plants, soil and animals on an ongoing basis. Conventional climate research often concentrates on the impact of individual climatic changes, whereas the new centre will study combinations of stress factors. Risø will be responsible for the research centre with the participation of teams of researchers from Copenhagen University, Forest & Landscape and the National Environmental Research Institute.

Source: Politiken and metroXpress, 8 June 2004

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photo: torben skøtt/biopress

China to use Danish ethanol research

Risø and Elsam Biosystems AS has recently entered into a collaborative agreement with a number of institutions and companies in China's Jilin province. As a result of this agreement, collaboration will now be established regarding research, process development and production of ethanol from maize straw.

Jilin produces more maize than any other Chinese province. On an annual basis, the production amounts to approximately 15 million tonnes of maize and 15 million tonnes of plant residue. That equals 15% of the entire Chinese maize production.

The province already has a plant that is capable of converting about 2 million tonnes of maize kernels to ethanol, but the fuel requirement is enormous - especially because the number of cars in China currently increases by 15-20% per year.

The Chinese are particularly interested in the so-called IBUS project in which straw is converted to ethanol at a pilot plant in Odense. The project, which Elsam coordinates with participants from RISØ, amongst others, comprise a so-called wet oxidation process that allows the conversion of a number of different types of plant residue to ethanol.

Both Elsam and Risø are very interested in working with the Chinese because it opens a gigantic market. Maize residue is a very important resource on a global scale, and the Danes hope that the project in China will lead to their inclusion as advisers in other, future projects.

A research team will be put together in Jilin comprising participants from universities, institutions and private companies. Together with researchers from Risø and Elsam, this group will establish a laboratory for bioethanol production on the basis of maize straw. The team's researchers and engineers will spend time at Risø to learn about pre-processing methods, and the Danish expertise will be used in the design and dimensioning of a pilot plant to be constructed in Jilin.

The production of bioethanol in Jilin will help reduce the discharge of greenhouse gases, and Denmark can benefit from that. According to the Kyoto Protocol, we can include the amount of CO_2 reduction that results from our investment in China in our greenhouse gas accounts. *TS*