Fourth volume
21th issue
September 2007

FiB
Bioenergy research



Third-generation biofuels

While we continue to spend vast amounts of money on developing second- generation biofuels, proposals heading directly for third-generation technologies are being put forward. This means converting waste into gasses that are subsequently processed into methanol. Such a process leads to a CO_2-reduction that is four times that of second-generation bioethanol processes and furthermore, it may be put to use as fuel for modern electric cars equipped with fuel cells.

By Torben Skøtt

Each Dane produces around 7 kilos of waste a day, amounting to a yearly waste production in Denmark of some 13 million tons.

Treating the ever-growing mountains of waste in a responsible way is quite a challenge and new strategies and agreements on this topic are regularly drawn up. Recently, Energinet.dk came up with a new waste strategy and at the end of June, most parties in Folketinget (the Danish parliament) entered into an agreement that, amongst other things, is supposed to secure a higher degree of recycling and an increased use of environmentally friendly technologies.

Managing director at TK-Energi, Thomas Koch, specialised in advanced gasification plants as well as biomass and waste management technologies, claims that this is far from sufficient. He says that a large part of our waste ought to be gasified, followed by a process to convert gas to methanol for utilisation in the transport sector. Using just half of our daily waste, we would be able to substitute six percent of our current petrol and diesel consumption, thereby meeting the EU goal of utilising a minimum of 5.75% biofuels by 2010.

– Compared to ethanol, methanol leads to a much more significant reduction of greenhouse gasses, says Thomas Koch, who characterises such a methanol solution as third-generation technology. He is fully aware that certain technical problems are still to be solved; however, perspectives for the future are enormous and it is important to get going as soon as possible.

▶

At first, it might seem both expensive and complicated to convert waste to gasses and then to methanol, but according to Thomas Koch, the economic calculations behind the idea make perfect sense. One of the main reasons for this is the fact that gasses utilised in methanol production are not subject to taxation. If the gasses were simply burned within the plant itself, taxes would be due and a completely different calculation would appear.

Business worth billions

In Denmark, the total amount of waste adds up to almost 3.5 million tons per year. This equals an amount of energy of around 40 PJ or some 20 percent of the amount of energy utilised in the transport sector. A small part of this waste is recycled; however, most of it ends up at the incinerator plants, which do not utilise the resulting energy resources in an optimal way. Numerous places only produce heating, and in those plants producing both electricity and heating, the average electrical efficiency level is as low as 17 percent.

This is where gasification plants may turn out to be worthy replacements. According to Thomas Koch, an investment of around DKK 5 billion would suffice in order to build gasification and methanol plants able to produce 500,000 tons of methanol a year based on waste.

Methanol sales would create earnings of DKK 850 million a year and additionally, the plant would be able to produce enough electricity to create further earnings of around 400 million a year. Finally, waste reception earnings would amount to almost

DKK 1 billion, creating total potential earnings of more than DKK 2.2 billion per year. According to Thomas Koch, operational expenses, interest payments and depreciation would come to a total of less than DKK 1 billion per year, resulting in a significant return on investment and plenty of budget buffer for unexpected expenses (see table 1).

A much needed boost

Methanol may be mixed with petrol and utilised in internal combustion engines; however, in practical terms, it is probably more feasible to use pure methanol for vehicles such as busses, taxis etc. Furthermore, methanol is well-suited as fuel for fuel cells, which are much more efficient than internal combustion engines. In this way, methanol, produced through gasification of biomasses or waste and utilised in fuel cells, is the solution that resembles the efficiency of an electric car the most.

Photo: TK Energi

Testing a small trial plant for waste gasification at TK-Energi in Køge. The picture shows a test run on the slag produced by the plant.

– The latest report from the Danish Energy Agency clearly shows that methanol production holds much better perspectives for the future compared to the second-generation biofuels that so many politicians are so fond of. We will obtain a larger reduction of CO_2; we will be able to utilise our waste in a sensible manner; and we will create recyclable slag as a by-product, says Thomas Koch. In his opinion, we mainly ought to go for the methanol solution because of its environmental friendliness; however, he also sees it as an obvious opportunity to give the gasification technology a much needed boost.

– I believe that we have spent almost DKK 1 billion on developing gasification plants, but we have never witnessed a commercial break-through because the necessary framework is missing. Removing taxation on waste, which is used for liquid fuels, gives rise to a number of completely new business opportunities, says the managing director, mentioning as an example a new gasifi-

Earnings:		
Methanol	500,000 tons á DKK 1,700	850,000,000
Electricity	1,000,000 MWh á DKK 400	400,000,000
Waste reception	1,500,000 tons á DKK 650	975,000,000
Total		**2,275,000,000**
Expenses:		
Interest and depreciation		650,000,000
Operation and maintenance		300,000,000
Total		**950,000,000**
Profit		**1,275,000,000**

Table 1. Operating budget for a gasification and methanol plant at a total investment of DKK 5 billion. Calculations are based on a treatment capacity of 170 tons of waste/hour and a thermal effect of 800 MW. Source: TK-Energi.

cation plant in Gjøl, north of Aalborg, where a yearly expense of DKK 2 million for the purchase of hog fuel has been budgeted. If the plant would be able to receive sludge, this fuel expense would be turned into yearly earnings of DKK 17 million.

– Moving DKK 19 million from red into black numbers suddenly makes it a lot easier to obtain a overdraft facility at the bank, says Thomas Koch. In this manner, the plants would become commercially accessible and work well within the free market without depending on plant subsidiaries and other subsidiary programmes.

To be used in practice

To Thomas Koch, one of the keys to success is that those technologies developed by the companies are in fact put to use, and he welcomes the fact that more and more authorities and organisations granting money to research and developments projects share this approach.

– Nowadays, you need to draw up business plans when applying for a grant from Energinet.dk. This is certainly a step in the right direction, says Thomas Koch.

– It is just a bit strange that Energinet.dk has not thought of this when they created a research and development strategy within the area of waste. Here, the taxation rules are not even mentioned although everybody knows that taxation levels decide whether a plant is constructed or not.

– I recon that within the next five years, technology investments will add up to a three-digit million amount. The projects will only be feasible if they are able to convert waste or biomasses with a negative value. It will be of utmost importance that the various authorities and partners involved enter into a profound dialogue regarding goals and resources, says Thomas Koch. He has invited the Danish Energy Agency, the Danish Environmental Protection Agency, Energinet.dk, as well as a representative from the tax authorities, to a meeting aimed at drawing up a common strategy for optimal development and enhancement of those technologies pertaining to energy, environment and waste. ■

Photo: Torben Skøtt/BioPress

Thomas Koch holding a handful of slag stemming from a waste water sludge gasification process. The slag may be utilised in the production of concrete, table tops, filling material for road surfaces, etc.

Reduction of CO_2 four times as large as with methanol

Methanol leads to a reduction in CO_2-levels that is four times that of second-generation bioethanol. This is shown in the report "Alternative fuels in the transport sector", recently published by a cross-ministerial committee. A petrol car is expected to generate a CO_2-emission of 414 kg per GJ of mechanical energy. By substituting petrol with bioethanol, this emission is reduced by around 20 percent; however, by using methanol, a reduction of no less than 85 percent is achieved.

Technology	CO_2 Kg/GJ	SO_2 Kg/GJ	NO_x Kg/GJ	Particles Kg/GJ
Diesel	333	0.01	0.62	0.02
Petrol	414	0.01	0.15	0.00
Second-generation bioethanol, E85	330	0.06	0.44	0.00
Methanol based on biomass	63	0.02	0.14	0.00

Table 2. Emission levels from four different fuel types used in the transport sector in 2025. Source: The report "Alternative fuels in the transport sector" - The Danish Energy Agency, June 2007.

Methanol deriving from waste::

A research challenge

Methanol may be utilised as a complete or partial substitute for petrol; however, its larger perspective is the utilisation in electric cars powered by fuel cells.

Nowadays, methanol, also known as wood alcohol, is primarily used as a solvent or in the production of MTBE, a petrol additive. Furthermore, methanol may be mixed with petrol and is put to use in internal combustion engines, but as soon as methanol makes up more than 5% of the mixture, changing the vehicle fuel supply becomes necessary. Alternatively, methanol may be converted into synthetic petrol in order to utilise it directly in the existing vehicle fleet.

Another solution involves vehicle reconstruction, e.g. for busses and taxis, allowing them to be powered by pure methanol. This process requires an expansion of the tank capacity because methanol only contains half the amount of energy contained in petrol. In return, methanol has a much higher octane rating than petrol, creating efficiency levels similar to those of many diesel engines.

Methanol cannot be put to direct use in diesel engines; however, it may play a part in biodiesel production or be converted to DME, an environmentally friendly alternative to diesel. DME may also be produced directly from gas, and that is probably the most obvious solution if the goal is to produce fuel for diesel-powered vehicles. ▶

More money for demonstration plants

By passing the new law of EUDP, the development of new energy technologies are given a notable boost, making it markedly easier to obtain financial support for the construction of demonstration plants. With an annual budget of around DKK 400 million, this programme is particularly aimed at enhancing and developing the business potential of such new technologies.

By Torben Skøtt

– We have gone into labour, but the baby has not yet been born. This is how Torkil Bentzen described the new EUDP programme during an informational meeting about energy research on August 15th in Skærbæk. Flemming Hansen, Danish minister of transport and energy, recently appointed Torkil Bentzen chairman of the executive committee, which in future will be responsible for ensuring that the subsidiary millions are in fact spent on projects with a good business potential for Denmark. The other committee members are still to be nominated; however, the idea is to select people with a business-related background.

Torkil Bentzen has a broad background from both the industry and energy sectors, and until spring 2007, he was chairman of the Danish Energy Industry Federation, part of the Confederation of Danish Industries. Now he will be heading a committee, which has indeed been selected by the minister of transport and energy, but is not subject to his authority. This will be a very independent organisation, which is, however, expected to take the executed energy politics into careful consideration, as expressed by Torkil Bentzen.

EUDP will be part of the Danish Energy Agency. The sekretariat manager has yet to be appointed; however, this will happen within the next couple of month in order to be ready for the first tendering round in 2008.

Up to DKK 400 million/year

EUDP substitutes the energy research programme EFP, but will have more substantial financial resources at its disposal than EFP had. The Danish Finance Bill 2007 includes DKK 186 million for this project, of which DKK 76 million stem from those resources originally allocated to the EFP programme. In 2008, the amount increases to just over DKK 200 million; in 2009, some

Photo: Torben Skøtt/BioPress

Left: Lise Nielson from Energinet.dk shows Torkil Bentzen how nowadays, electronic applications may be forwarded directly to the ForskEL programme administrators.

Photo: Torben Skøtt/BioPress

Right: Lars Nikolaisen and Peter Daugbjerg Jensen from the Danish Technological Institute enjoying good food at the informational meeting in Skærbæk.

The large perspective is, however, electric cars with fuel cells, powered by methanol. Here, the efficiency level obtained is significantly higher than those found in the cars driving around today, and as methanol fulfils all requirements regarding energy density, pollution and distribution - as opposed to e.g. hydrogen - many people call this the fuel of the future.

Methanol may be produced by using gas and various catalysts. Whereas countries such as Iran and Saudi Arabia, where gas prices are as low as they can get, mainly use natural gas in the production, countries such as China and South Africa convert coal into gas and then into methanol.

Waste calls for innovation

Utilisation of biomasses or waste in methanol production has not yet become a major feature in any country, but technically seen, nothing stands in the way of making it work. The challenge consists in constructing a gasification plant that is able to produce clean gasses at high pressure.

According to Thomas Koch from TK-Energi, a so-called entrained flow vaporizer would be the obvious choice. It is able to handle all fuel types and produces gasses with a very low tar content. The technique has been tested using coal as fuel, i.e. the development needs primarily consist in adjusting the vaporizer to the use of waste, and establishing the pre-treatment plants needed.

– Whereas the challenge lies within pre-treatment and vaporizer design, converting gas to methanol is a well-known technique, explains Thomas Koch. He recons that it would cost between DKK 50 million and DKK 100 million to develop and establish a 10 MW plant with an ability of producing close to two million litres of methanol per year. *TS*

Programme	2007	2008	2009	2010
EUDP[1]	186	208	289	394
The Strategic Research Council[2]	108	94	170	299
ForskEL and ELFORSK[2]	155	155	155	155
Danish National Advanced Technology Foundation[3]	55	71	87	103
EU	49	49	49	49
I alt	**553**	**577**	**750**	**1.000**

List of public financial resources for energy research from 2007 to 2010 in DKK. Several of these figures are based on estimates, but it is certain that the next four years will see a doubling of the resources, arriving at a total of DKK 1 billion in 2010.

Notes:
1. *In 2007, DKK 76 million stem from the EFP programme.*
2. *Assumes a technical extrapolation of resources, which has not yet been passed.*
3. *It is estimated that 20% of the resources from the Danish National Advanced Technology Foundation will be assigned to energy technology*

DKK 300 million have been earmarked for the project; and in 2010, the amount rises to just under DKK 400 million. Similarly, the Danish Strategic Research Council will have more resources at its disposal in order to create a reasonable balance between basic research and those demonstration and development projects taking the technologies to a commercial level.

In particular, Torkil Bentzen is expecting the new executive committee to look for long-term projects, which have the potential to create a significant number of jobs and export earnings. In fact, the executive committee will solely decide on the projects to support; however, they must meet an already established demand of spending DKK 50 million per year for the next four years on development of second-generation biofuels.

Industry to be included

– One of our requirements is for the project to have a business potential and therefore, the selected projects must involve one or more enterprises. On one hand, we need to ensure project viability; however, on the other hand, we cannot support technologies that would be able to manage without receiving any public subsidiaries. We need to focus on the fine line between these two issues and identify those projects that would never have been carried out in practice, had it not been for our financial support, Torkil Bentzen explained during the meeting on energy research programmes. He believes in being at the forefront of things, drawing a parallel to the wind mill industry.

– Experience from the wind mill industry has shown that an energy crisis can give rise to new jobs and earnings for Denmark. We were kind of forced into it, and many people put up a brave fight, but today, we have to admit that because someone took the initiative, we were able to establish an industry that has become number one in the world.

– We are perfectly able to do the same within other areas, but we need to focus on fast developing technologies. I can assure you that in many places across Europe, plenty of politicians are lending a hand to industrial players in their efforts to get going. We need to find out what areas suit us best and in which areas we are able to make a difference, said Torkil Bentzen. He is looking forward to the new executive committee embarking on its tasks in order to be able to start working on those new projects longed for by the business community. ■

Torkil Bentzen:

Globalisation resources are not earmarked for ethanol

DKK 200 million from the Globalisation Foundation have been reserved for second-generation biofuels but not earmarked for certain technologies. The goals, not the technologies, decide who gets the money.

As we all know, the Danish government has reserved DKK 200 million from the Globalisation Foundation for the development of second-generation biofuels. Often, this decision has been presented as if the money would be earmarked for enzyme-based plants, and some have even said that only a certain type of projects would be considered.

The new chairman of the EUDP programme, Torkil Bentzen, does not appreciate this approach. During an informational meeting about energy research on August 15th, he was asked whether the DKK 200 million have been reserved for certain technologies, which he denied.

Photo: Torben Skott/BioPress

– Second-generation biofuels are fuels that may be produced based on waste, and if various technologies will take us to the same goal, all such technologies will be able to participate in the selection process, Torkil Bentzen said during the annual informational meeting about energy research.

– No, this is not how we have defined the programme. Second-generation biofuels are fuels that may be produced based on waste, and if various technologies will take us to the same goal, all such technologies will be able to participate in the selection process, said Torkil Bentzen.

In the agreement on usage of the Globalisation Foundation - featured on the Ministry of Finance webpage, amongst other places – second-generation technologies are defined as technologies allowing a more extensive biofuel production; however, the table of resource assignment uses the term bioethanol. *TS*

The electric car beats the bio car
– but we still need to develop biofuels

Developing biofuels such as ethanol and biodiesel is just a transition phenomena. Seen from an environmental point of view, electric cars are a much better choice because of their high efficiency levels; however, we need to keep on developing biofuels for the sake of their business potential. This is the conclusion reached by a cross-ministerial task group in a recently published report.

Photo: Tesla Motors

Electric cars are not necessarily boring! Featuring 248 hp and a design resembling a full-blooded sports car, the new Tesla Roadster strips away the myth that electric cars are small, slow city cars. The maximum speed is 210 km/h, and 0 - 100 km/h is done in four seconds. A centre-mounted AC-engine powers the car, and the 6,831 lithium-ion batteries hidden under the bonnet create enough power to drive 400 kilometres.

By Torben Skøtt

Our biomass resources will yield more by utilising them in electricity and heating production, and in the long run, electric cars are the best alternative to vehicles powered by petrol or diesel. An electric engine has a markedly higher efficiency level than an internal combustion engine, and significant local environmental advantages are obtained, namely less noise and cleaner air. At the same time, electric cars can function as electric storage units, making it possible to fit larger amounts of renewable energy into the energy system.

Nevertheless, we need to keep on developing new technologies for the production of biofuels. This is the conclusion reached by a cross-ministerial task group in a report on alternative fuels in the transport sector. The main argument supporting this conclusion is related to the large business perspectives contained in such new technologies, but also the fact that the transport sector relies almost 100% on crude oil plays a significant role. No less than 60% of the Danish oil consumption is used in the transport sector, and many years are likely to pass before electricity becomes a realistic alternative to petrol and diesel.

In cooperation with the company COWI, the task group behind this report has evaluated the potential of various technologies in terms of environment, economy and CO_2-reduction. On the contrary, the report does not include attempts to estimate global environmental consequences of such technologies, bearing in mind that ethanol production, in particular, has given rise to a vast amount of criticism.

The report was discussed in a hearing until August 6th and currently, the task group is examining all the hearing outcomes in order to finalise the final version sometime this autumn.

Technologies to be invested in:

- Second-generation bioethanol and establishment of full scale test plants.
- Biofuels such as DME and methanol based on thermal biomass gasification.
- Co-production of electricity, heating and transport fuels.
- Electric cars powered by batteries or fuel cells.
- Systems allowing electric cars to function as storage for wind power and other types of renewable energy.

An expensive solution

According to the report, first-generation biofuels, namely ethanol and biodiesel, are now the most realistic alternatives to petrol and diesel; however, seen from a socio-economic point of view, they make up an expensive solution. Biodiesel is doing better than ethanol in this respect, and based on an economic viewpoint, natural gas should be considered as well. Biogas, in many ways similar to natural gas, has not been included in the report because the task group recons that biogas is better suited for CHPs. Biodiesel, based on animal fat, is not included in the report neither because available resources in this area are limited.

The report states that second-generation biofuels are expected to be able to compete with first-generation biofuels sometime after 2010. At that time, the raw materials needed for second-generation production will be much easier to obtain than for the first-generation technologies, hereby creating a more extensive production of second-generation biofuels and perhaps even easing off the pressure on food prices.

In the long term, however, it is difficult to identify a worthy competitor to

the electric car, which – not least because of its high engine efficiency level – comes with a range of environmental advantages. The batteries required are still a weak point in need of considerable improvements, and it will probably be several decades before a major breakthrough takes place.

In this manner, cars fitted with electricity-producing fuel cells might turn out to be an obvious solution, particularly in the transition phase. The fuel used in such cars could be hydrogen produced by wind mills, as an example, or methanol produced through gasification of biomasses. Whereas the latter solution resembles the efficiency level of electric cars the most, the hydrogen car is not particularly efficient, mainly due to conversion losses during the processes of hydrogen production and electricity conversion.

Denmark in a strong position

Since the beginning of the 1990s, there has been an increased focus on development of alternatives to petrol and diesel, and in recent years, Denmark has invested large sums of money in the development of second-generation biofuels. In 2006, this research area received a total of DKK 100 million in subsidiaries from various programmes. The organisations involved spent a similar amount and also carried out extensive research and development efforts that were not financially supported.

According to the report on alternative fuels, Denmark is enjoying a very strong position within almost all second-generation biofuel parameters. We thus possess a unique basis for obtaining a leading international position. This is why no less than

DKK 200 million from the Globalisation Foundation have been earmarked for developing this research area during the period 2007 - 2010. The goal is to allow Danish research results to create a growth potential within the Danish business community similar to that of the wind power industry.

Developing new enzymes for bioethanol production purposes is one of the areas, in which the Danish companies Novozymes and Danisco have managed to conquer 80% of the world market, and Denmark also offers a solid knowledge base in the area of biomass

treatment. Throughout that last 10-15 years, the CHP sector and the agricultural industry have been able to develop a technique that makes it possible to handle large amounts of biomasses, and today we are world leaders when it comes to straw utilisation in the energy sector.

From gas to diesel

Denmark needs to keep on focusing on its strong positions, the report published by the cross-ministerial task group concludes, but apart from that we should, amongst other things, invest in biomass gasification processes involving gas conversion into liquid fuels. Today, we already possess a considerable knowledge about conversion of natural gas into liquid fuels, which may function as the base for a commercial development of technologies able to convert biomasses to methanol and DME, for example, which is utilised in diesel engines.

Methanol production can be based on biomasses and waste. First of all, the material has to be gasified, and the resulting gasses are then converted into methanol by means of a catalyst. The methanol may be mixed with petrol or diesel, or completely substitute these, for use in internal combustion engines. Nowadays, a maximum of 3% methanol is allowed in normal petrol, but some engines on the market are able to cope with petrol/methanol-mixtures containing up to 85% methanol.

The most interesting usage, though, is as fuel for a fuel cell delivering power to an electric engine. Despite the conversion loss within the fuel cell, a higher efficiency level is obtained overall, compared to using methanol directly in an internal combustion engine. Fuel cells are still very expensive, but as a vast amount of money is being invested into research and development within this area, one might expect cars fitted with fuel cells and powered by methanol to become an interesting solution in line with electric cars running on batteries.

The report "Alternative fuels in the transport sector" may be downloaded at www.ens.dk.

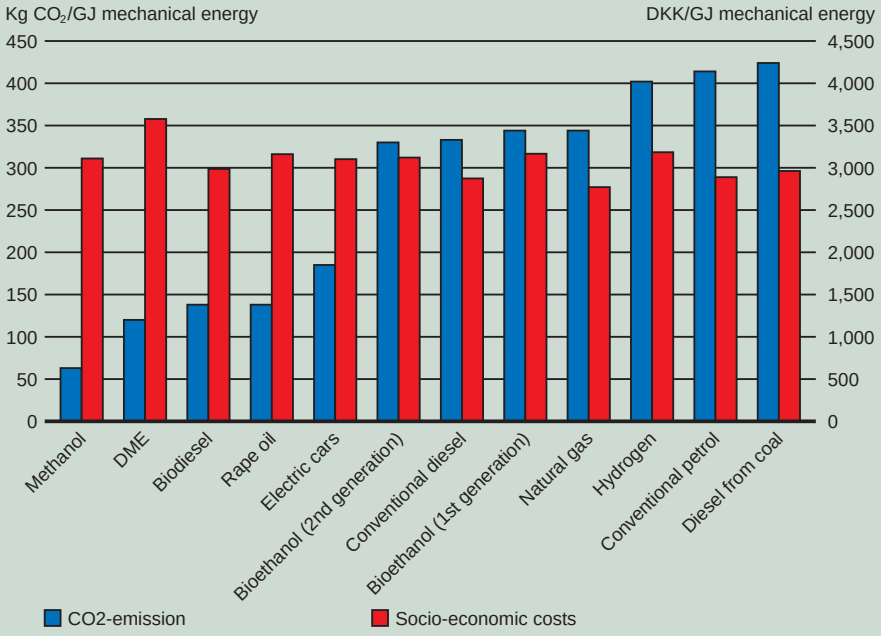

Figure 1. CO_2-emission and socio-economic costs related to various fuel types in 2025. Source: "Alternative fuels in the transport sector", the Danish Energy Agency, 2007.

Scientific work with many details

Is research into something as basic as fuel pellets actually possible? Yes, it is, and it is a clever thing to do. Obtaining more profound information about the more basic theories about pellets production facilitates the utilisation of a much larger part of those biomass resources available around the world.

By Torben Skøtt

Photo: Torben Skøtt/BioPress

Jens Kai Holm (left) and Ulrik Henriksen (right) at one of the test installations used for wood pellets trials.

- This project on biopellets is something completely different to what we usually do, says civil engineer Dr. Ulrik Henriksen from the Institute of Mechanics, Energy and Construction at the Danish University of Technology. Together with biophysicist

Dr. Jens Kai Holm, he has been heading a research project that, so far, has resulted in the publication of two scientific articles in the recognised periodical "Energy & Fuels", published by the American Chemical Society.

– Normally, we do research on completely new biotechnical technologies, but this time we have chosen to work with a more than 100 years old technology, says Ulrik Henriksen, and continues:

– The reason for this is that we have never been completely sure about the theory behind pellets pressing, and this information shortage has created quite a few problems, for instance, if a producer has started producing wood pellets based on hardwood tree instead of softwood tree. Today, we are able to explain the process parameters, and based on this knowledge, companies can design their press units in a way that is optimally suited to the type of biomass in question.

One of the companies in need of more such information is Køge Biopillefabrik, established by Energi E2 in 2003 with a view to deliver wood pellets and straw pellets to the plants Avedøreværket and Amagerværket, respectively. The factory ran into trouble from the very beginning and very often, the technicians did not understand the problems encountered.

Pellets are the future

When wood pellets entered the market, the choice of raw materials was extensive. Furniture factories were almost lining up in order to get rid of their bursting stock of sawdust and wood chips, allowing pellets producers to be critical.

Photo: Torben Skøtt/BioPress

Nowadays, not only sawdust and wood chips from the furniture industry are used for fuel pellets. This picture is from Køge Biopillefabrik, where residual products from the company Junckers Industrier are used alongside fresh wood directly from the forest and straw from the agricultural industry.

Photo: Jens Kai Holm, MEK – DTU

Rotating pellets press taken apart for inspection purposes.

This is all history. Nowadays, the furniture industry is unable to meet demands for sawdust and wood chips, forcing pellets producers to look for other suppliers. It is no longer unusual to make use of logs, which are chopped into wood chips, split in a hammer mill and dried before being pressed into wood pellets.

– The producers are constantly on the look-out for new types of raw materials and I have no doubt that this trend is going to continue in the years to come, says Jens Kai Holm. He is convinced that pellets make up the optimal solution when it comes to taking advantage of the vast biomass resources available across the world - simply because pellets are so much easier to handle and transport across large distances than straw bales, as an example.

Biomass pellets also carry other advantages. It is a lot easier to control the combustion process in a wood pellets stove than in a wood-burning stove, and this fact may have a positive effect on environmental strains as well. The latest study carried out by the National Environmental Research Institute of Denmark shows that the particle emission from a modern wood-burning stove is around ten times that of a wood pellets stove.

Large CHPs might also be able to benefit from using pellets; they are handled more or less like coal, and only small reconstruction efforts are needed to be able to use biopellets in a coal-fired CHP.

Teething problems

In principle, a pellets press works by pressing sawdust - typically wood or straw material - through a tube; however, all types of biomasses may in fact be turned into pellets.

You would think that the sawdust would just exit at the other end of the tube and very often, the first pellets are in fact very loose, resembling sawdust more than pellets. Getting the process going can involve a certain amount of teething problems; initially, there is no backing to assist in pressing the sawdust into pellets. This problem is often solved by adding a binding agent to the pellets or by using maize, which tends to stick, Jens Kai Holm explains.

Once the process has started, everything runs a lot smoother. Those pellets making their way out of the press create a natural backing, in turn making it easier to build up the pressure needed to establish a stabile pellets production.

Several parameters

The fact that pulverised wood, straw or other types of biomass can be made to stick together to form a pellet is down to a combination of mechanical and chemical mechanisms.

The single particles contained in the powder have uneven surfaces, meaning that the powder tends to get lumpy when exposed to mechanical pressure.

The circumstances behind the chemical mechanisms are not yet completely clear; however, amongst other things, the lignin, one of the main components of biomass, changes its characteristics based on the pressure, temperature and water content in question. Just as lignin helps to keep the powder particles together, a suitable biomass moisture content can also be advantageous.

Photo: Torben Skøtt/BioPress

Rotating pellets press at Køge Biopillefabrik. A large part of the trials carried out at the Institute of Mechanics, Energy and Construction involved a similar, although smaller, press.

Photo: Jens Kai Holm, MEK – DTU

This is what finished wood pellets look like.

Various parameters decide the extent to which the process will start working easily or not. Several of these parameters also influence the force levels present within the pellets press.

Something apparently very simple then turns out to be a complicated interaction between a range of factors; that makes it easier to understand why pellets producers get into trouble at times. Too long press passages make the force exercised onto the pellets too strong; energy consumption and tear levels increase; and there is a risk of the pellets getting stuck in the passages. On the other hand, too short passages create the risk of a too low pressure, resulting in nothing but sawdust at the other end.

Based on tests carried out at the institute, researchers working at the Institute of Mechanics, Energy and Construction at the Danish University of Technology have come up with a list of formulae that describe in detail the process taking place in a pellets press. In this way, the producers will find it easier to design efficient pellets presses with an ability to handle many different types of biomass.

– The good thing is that this new knowledge is relevant to other areas than pellets production. I would have liked to know all this back then, when we constructed out pyrolysis plants, and I realise that these theories are applicable to many different areas, says Ulrik Henriksen.

The project, supported by the EFP programme and DONG Energy, is carried out in cooperation with ReAddit, Danish Technological Institute and Dong Energy.

Chimney filters can save billions

Photo: Torben Skøtt/BioPress

According to a recent survey carried out by the National Environmental Research Institute of Denmark and the Danish Environmental Protection Agency, chimney filters are able to remove 96% of all particles stemming from wood firing. This solution would cost the consumers a total of DKK 4.5 billion; however, our society would save more than DKK 16 billion by reducing particle pollution significantly.

By Torben Skøtt

Just a few years ago, research into air pollution was mainly about traffic issues, but ever since a survey on air quality in a residential area close to Roskilde was published by the National Environmental Research Institute of Denmark in 2004, the interest in pollution stemming from wood firing has increased considerably. The survey, carried out in an area, where half of the households were using a wood-burning stove or a wood-fired boiler, showed that the level of particle pollution was similar to that of one of the busiest roads at rush hour; H. C. Andersens Boulevard in central Copenhagen.

Later, the National Environmental Research Institute of Denmark published a series of reports and articles on this topic, concluding, amongst other things, that around half of the particle pollution in Denmark can be assigned to the use of wood firing.

The wood fuels cannot be blamed for this problem; the big sinners are the individual installations, in particular older boilers and wood-burning stoves, causing problems and creating a bad image for the idea behind wood firing.

It is not completely clear just how dangerous the smoke particles stemming from wood-firing stoves are, but based on quite an extensive knowledge on health risks related to particles stemming from traffic, there is no reason to believe that particles from wood-firing stoves are less dangerous than traffic particles.

Photo: Torben Skøtt/BioPress

The masonry stove is a low-tech but effective method of reducing particle emission.

Apart from particles, certain contents of dioxin and PAH are found in wood smoke. Both substances are carcinogenic and emerge, amongst other reasons, from incomplete incineration and burning of waste that contains chlorine combinations.

Solutions

Recently, the Danish Environmental Protection Agency completed a large project involving an overview of the problems as well as some of the technical solutions needed in order to reduce pollution to an acceptable level. At the same time, a new declaration on wood-firing stoves is in the making and DKK 10 million have been earmarked for the years 2008 and 2009 to be used for testing a range of technologies believed to be able to reduce pollution stemming from wood-firing stoves and boilers. Wood firing pollution is caused by a complicated interaction between a variety of factors such as fuel, firing technique, the individual stove or boiler, the chimney, as well as the location of the chimney in relation to its surroundings. Consumers are able to do quite a lot to reduce pollution by using their wood firing equipment sensibly and by following the advice published, amongst other places, at www.fyrfornuftigt.dk.

Just applying a better firing technique will not do the job, though. In order to create a significant reduction of particle emission deriving from wood firing, we need to improve the stoves and boilers. As many solutions still only exist on the drawing board or as prototypes, this is yet another obvious task for researchers and developers alike.

Chimney filters

Norway is one of the countries at the forefront of developments within the area of electrostatic filters that are fitted onto chimney tops. According to the National Environmental Research Institute of Denmark, if all wood firing installations in Denmark were fitted with such filters, the particle emission level would be reduced by no less than 96%.

The price of a filter for a household is expected to be around DKK 4,000 - 5,000. Furthermore, the filter will require a bit of electricity and cause a certain level of expenses for installation and maintenance. During a period of ten years, each household will face a total cost of around DKK 10,000.

Previously, the Danish Institute of Agricultural Sciences have carried out trials involving electrostatic filters for straw and wood chip-fired plants within the agricultural industry. These trials showed that such filters are able to reduce particle emission by 97% - 99% and furthermore, they are able to retain those alkali metals released during straw burning procedures. The price of such a filter is expected to be around DKK 60,000.

Photo: Torben Skøtt/BioPress

Installing an automatic stoker for wood pellets is one of the cheapest methods of reducing particle emission.

	Reduction TSP/GJ	Investment DKK	Cost DKK/kg TSP
Masonry stove	900	35,000	78.41
Modern stove	460	12,000	52.17
Wood pellets stove	1,040	20,000	51.70
Electrostatic filter	1,045	10,000	38.59
Afterburner in an old stove	770	2,000	20.78
New wood boiler with storage tank	1,850	60,000	10.81
New wood pellets boiler	1,965	50,000	8.48
Wood pellets burner fitted	1,900	20,000	4.68

Table 2.Shows the reduction potential of various technologies in relation to a reference scenario. Furthermore, the expected price for each investment, as well as the cost in comparison to the potential particle emission (TSP) reduction, is included. Source: "Wood-burning stoves and small boilers - particle emission and reduction initiatives", the Danish Environmental Protection Agency, 2007.

Afterburner

Another way of reducing particles, released from older stoves, is to establish a type of extra fire chamber within the stove, in which the gasses are burned by means of adding pre-heated air from the fire chamber.

Several foreign producers offer afterburning technologies, but it is still unsure whether or not these technologies would fit to Danish stoves. Additionally, the cost difference between applying afterburning technologies and investing in a new stove is still to be defined.

One unit, developed at Norway's University of Technology and Science, has been tested in cooperation with the municipality of Trondheim, Norway, by installing 100 units into old stoves and open fireplaces. The participating families reported a higher heat utilisation efficiency, a better chimney draught, as well as less soot and ashes.

The Danish Environmental Protection Agency is hoping to be able to carry out a range of field experiments during the heating season 2008/2009, using different types of filters and afterburners. The agency does highlight the fact, however, that none of the technologies available today can be considered complete.

The simple solutions

Finally, a variety of simple and tested solutions are available, which would be able to reduce particle emission considerably. It is well-known that wood pellets create a much lower emission than firewood and that particle emission from a masonry stove is significantly lower than that of a wood-burning stove (see table 2).

In its most recent project, the Danish Environmental Protection Agency analysed three scenarios, each reducing particle emission levels by means of different initiatives (table 3); one scenario involving a declaration listing certain requirements with regards to particle emission and two scenarios involving the fitting of filters on all or a demarcated part of the chimneys, respectively. All three scenarios lead to a socio-economic profit; however, the scenario involving filters on all chimneys is clearly the economically best option, featuring a socio-economic profit of almost DKK 12 billion.

The report "Wood-burning stoves and small boilers - particle emission and reduction initiatives" can be downloaded at www.mst.dk. ■

Scenario	Cost	Net saving
Declaration	384 mio.	2,989 mio.
Partial filters	1,364 mio.	6,399 mio.
100 % filters	4,538 mio.	11,857 mio.

Table 3. Costs (covered by the consumers) and net savings induced by each of the three scenarios. Source: "Wood-burning stoves and small boilers - particle emission and reduction initiatives", the Danish Environmental Research Institute, 2007.

Other countries focusing on pollution from smaller systems

The debate on pollution from wood-burning stoves and smaller boiler systems is not only taking place in Denmark. Other countries, in particular Switzerland, Sweden and Norway, are also focusing on this area, supporting research into catalysts, afterburners and electro filters, amongst other things.

By Anders Evald

Photo: Torben Skøtt/BioPress

The pollution from wood firing is not only connected to the chosen technology. Even the best boiler has a disproportionately big escape of harmful substances if you like here burn wet three.

For Task 32, a task group working within the International Energy Agency, emissions originating from biomass incineration has become a new area of focus. Interestingly, many countries are now looking at the smallest systems, e.g. wood-burning stoves and boilers for single household heating. Several studies have shown that such systems are the biggest sinners when it comes to emission of harmful substances, and based on these conclusions, a range of comprehensive research and development projects on small-scale systems have now been initiated in Sweden and Austria, amongst other places.

Because the high emission levels are related to consumer behaviour and a technology featuring some very basic limitations, the problems pertaining to small-scale systems give rise to quite a few headaches. Technological developments, e.g. catalysts for wood-burning stoves; fitting of afterburners on existing stoves; small electro filters or additives, will not solve the problem on their own. Initiatives such as information campaigns about correct wood firing procedures; requirements regarding accumulation tanks on boilers, or exchange of wood-burning stoves for pellets stoves, are needed as well.

Emission factors

Thomas Nussbaumer from Switzerland has carried out a study on emission factors in anything from heating systems to biomass units in different countries. Large country-to-country differences in results and measuring methods exist. A detailed report on this topic is available at www.ieabcc.nl.

In connection with the latest task group meeting in Jyväskylä, Finland, a seminar on ultra-fine-grade particles stemming from biomass incineration was held. Whereas coarse particles are relatively easy to handle in treatment plants for combustion gasses, the very small particles make up a big problem; partly because of their health-related importance and partly because it is complicated to reduce their plant emission levels.

Anders Evald, a civil engineer, works for FORCE Technology and acts as the Danish representative in the task group Task 32, which belongs to the IEA Bioenergy Agreement. ■

International company wants to utilise Danish

An international company is looking to utilise Danish knowledge in the field of bioethanol in order to increase the output from their first-generation plants.

Recently, the Danish technology company BioGasol entered into a cooperation agreement with the international company Tate & Lyle, one of the leading food ingredient producers worldwide. The goal of the cooperation is to develop a process that allows fibre-containing residual products from existing bioethanol plants to be turned into more ethanol and forage. Basically, it is all about obtaining more from existing first-generation plants and creating a better protein residue that is more suitable as animal forage.

The conversion of fibre-containing residual products from existing ethanol plants requires new solutions with regards to pre-treatment and fermentation, and this is where the knowledge and patented technologies held by BioGasol play an important role. On the other hand, Tate & Lyle are able to contribute with know-how on industrial production processes in order to facilitate an integration of Biogasol technologies into existing processing plants in practice. *TS*

Supergrass

Researchers are constantly on the look-out for new energy crops, and in Sweden, a new grass crop has been identified: szarvasi-1 or supergrass as the farmers call it.

The grass type has been refined throughout the last 15 years by a group of researchers located in Hungary, and Swedish researchers have been participating in the project since 2003. In Hungary, the dry matter yield has reached a level of 20 tons/hectare, and the Swedes are hoping to obtain a minimum of 12 tons/hectare.

TS

International cooperation

Denmark takes part in various task groups through the International Energy Agency. The task group Task 32, part of the IEA Bioenergy Agreement, focuses on biomass incineration, including co-incineration of biomasses and fossil fuels.

By Anders Evald

Task 32 is a good example of a fruitful international cooperation, featuring outspokenness rarely found within a group of representatives from different nations, representing different professional and industrial interests. There is a very free tone within the group and the participants help each other wherever possible.

The task group is dominated by European countries, including Sweden, Norway, Finland, England, The Netherlands, Belgium, Germany and Switzerland. Other participants include Canada and at times also the USA and Australia.

The Canadians are quickly becoming more and more aware of the ways that their gigantic biomass resources may be utilised; however, they are working against tough odds, including very low electricity prices and limited possibilities of distributing the heating in common distribution plants.

Five years ago, the task group published the book "Handbook of Biomass Combustion and Co-firing". This book has now been revised and a new edition will be available as of November 2007. At the same time, the book has been translated into Chinese – perhaps a symbol of the fact that the current European interest in and dominance of biofuel research will not last forever.

On the website www.ieabcc.nl, the task group members have compiled a range of presentations, articles and reports, and a newsletter about the work of the task group is regularly distributed by the author of this article. If you want to join the distribution list, please write to aev@force.dk.

Biogas ought to be a top priority

Photo: Torben Skøtt/BioPress

When it comes to reduction of CO_2 and substitution of fossil fuels, biogas ought to be a top priority compared to other types of bioenergy. This is the conclusion reached by two researchers from the Danish University of Technology, who have drawn up a life cycle analysis for the company Xergi A/S, a supplier of energy and environment-related plants.

If Denmark really wants to make an effort to reduce the emission of greenhouse gasses, then we need to produce as much biogas as possible. The reason is that not only are biogasses a replacement of fossil fuels and thus a contributor towards CO_2-emission reduction, but also that manure gives off large greenhouse gas volumes, unless it is degassed before being distributed on the fields.

This conclusion was reached in a life cycle analysis carried out by Katrine Anker Thyø and Henrik Wenzel from the Danish University of Technology for Xergi A/S. The analysis compares biogas from livestock manure, biogas produced on the basis of maize ensilage, two different types of biodiesel, and the utilisation of willow energy.

According to this report, biogas stemming from livestock manure stands out by leading to a significantly higher greenhouse emission reduction than other types of bioenergy and thus, it is able to replace fossil fuels at a higher level.

Today, only 5% of livestock manure is used for energy production, i.e. the potential is considerable. Taking this process one step further by including energy crops into the production, biogas once again does very well. In this way, maize ensilage for biogas production and willow usage in CHPs is more advantageous for the environment than if the same acreage was used for crops utilised in the production of ethanol and biodiesel.

100,000 km. on one hectare of maize

The life cycle analysis also showed that a normal family car is able to go around 100,000 km. on biogas originating from one hectare of maize.

Biogas for transport purposes is not included as a solution in the report on alternative fuels in the transport sector, recently drawn up by a cross-ministerial committee. The report talks about natural gas, presented as the cheapest alternative to petrol and diesel seen from a socio-economic point of view.

Whereas biogas has not been considered because it requires pre-cleansing and upgrading procedures, natural gas is ready for immediate use within the transport sector. The committee behind the report thus concludes that it is better to substitute natural gas for biogas in CHPs and utilise the natural gas saved through this substitution for transport purposes.

According to a report published by the Danish Board of Technology, livestock manure is able to meet 20% of the fuel needs within the Danish transport sector. Apart from that, significant gas volumes, which can be produced by growing energy crops such as maize, add yet another advantage. *TS*

Energy 2007

Today, subsidiaries within the area of Danish energy research are granted through five different programmes administered by the Danish Energy Agency, Energinet.dk, the Danish Energy Association, The Strategic Research Council Programme Committee for Energy and Environment, as well as the Danish National Advanced Technology Foundation.

During recent years, goal-oriented work has been carried out in order to expand and improve the cooperation between the various programmes, offering the users a clear overview of the programmes and their relevance to a particular project. Amongst other things, this cooperation has led to joint informational meetings, coordination of annual subsidiary offers and recently, a joint report on Danish energy research 2007 was published.

Featuring the title "Energy 2007", the report provides its readers with a clear impression of the interaction between various subsidiary programmes, also on an international level. The report features special programme presentation sections; a comprehensive list of granted, current and completed projects; and articles on several of the largest projects.

The annual report on Danish energy research, "Energy 2007" is available at www.miljovenligelproduktion2007.dk

TS

Energy research projects on the Internet

If you would like to obtain an overview of the vast number of energy research projects in the area of bioenergy, the database at RISØ provides for a good place to begin.

At www.danskeenergiprojekter.dk, you can gain access to a comprehensive list of current and completed energy research projects in Denmark. Administered by RISØ National Laboratory, the website includes projects supported by the Danish Energy Agency, Energinet.dk, the Danish Energy Association, as well as the Danish Strategic Research Council Programme Committee for Energy and Environment. The database was established in 1996 and is updated regularly.

An alternative way of obtaining information about energy research projects is the internet portal www.energiforskning.dk. This is a joint portal for Danish, EU and Nordic research programmes. The latter has recently launched a completely new website about bioenergy at www.nordicenergy.net/bioenergy.

In order to gain an overview of the latest projects, visit www.miljovenligelproduktion2007.dk. This website includes the new, Danish joint annual report, and it is very easy to use in order to find information about specific projects. Finally, you might want to visit our website at www.biopress.dk, featuring a total of 21 editions of FiB (Bioenergy Research) published since April 2004. The publications exist in Danish and English.

TS

Biogas plants must speed up

The companies Novozymes and Xergi, the largest producer of biogas plants in Denmark, are now embarking on a project dealing with the development of new micro-organisms that are able to speed up the biogas process.

Nowadays, biogas plants are only able to utilise around half of the gas potential in livestock manure. The companies Novozymes and Xergi find that dissatisfactory, and they have now teamed up in order to speed up the gas production.

Whereas Novozymes will contribute their knowledge on micro-organisms, Xergi is going to carry out tests on how the new organisms will contribute to an optimisation of biogas production processes in practice.

Initially, Novozymes Biologicals are going to carry out a range of experiments at their laboratory facilities in Virginia, USA. Afterwards, Xergi will initiate the more practical experiments, probably in the new test plant at the Danish Institute of Agricultural Sciences in Foulum. Such experiments will clarify whether the micro-organisms may be added directly to the reactor tank, or whether a separate pre-treatment step must be introduced. *TS*

Waste incineration plant optimisation

Title:	6538 - Support system for waste incinerator operators
Proj. man.:	Weel & Sandvig Energi & Procesinnovation Aps, Mogens Weel Hansen, ✆ +45 2671 0046
Grant:	PSO – DKK 961,000

Tool development for op. improvements through reconstruction to illustrate importance of waste composition, furnace temperature, dynamics.

Incineration plants/aerosols & chemical reactions

Title:	6517 - Laboratory investigations of aerosol formation and chemical reactions in the flue gases from biomass and waste incineration plants
Proj. man.:	Dep. of Chemical Engineering Hans Livbjerg, ✆ +45 4525 5535
Grant:	PSO – DKK 3,018,000

Alkaline comb. influence on aerosol formation, incl. boiler coating. Some additives reduce aerosol formation, limiting coating.

Straw infeed and fuel optimisation

Title:	3338 - Improved straw infeed and fuel optimisation
Proj. man.:	Dong Energy A/S, Charles Nielsen, ✆ +45 7622 2406
Grant:	PSO – DKK 978,639

4 online straw crane moist. meter syst. acquired, mounted. Constant fired straw effect control concept developed, implemented, not tested. After proj. 4100, proj. 3322 & 3338 voided.

LT_CFB gasifier/500 kW tests

Title:	4833 - LT_CFB gasifier/500 kW tests
Proj. man.:	DFBT, Peder Stoholm, ✆ +45 4677 5907
Grant:	PSO – DKK 5,088,000

Gasifier process model. 4 long-term tests. Success criteria: fuel flexibility, op. stability, economic feasibility, ash melting avoidance, reduced coke loss, efficient ash/nutrient retention.

Solid biofuels/QA systems

Title:	4115 - Pre-normative work on sampling and testing of solid biofuels for the de-velopment of quality assurance systems
Proj. man.:	Dong Energy A/S, Charles Nielsen, ✆ +45 7622 2406
Grant:	PSO – DKK 4,589,000

EU-project "BIONORM"/Danish initiative on wood chip moisture determination. Method with low/known volatile component discharge. Methods for reliable on-site/on-line moisture measurements.

Volatiles conversion in combustion

Title:	6518 - Mechanisms for conversion of volatiles in biomass and waste combustion
Proj. man.:	Department of Chemical Engineering Peter Glarborg, ✆ +45 4525 5535
Grant:	PSO – DKK 3,038,000

Chemistry of SO_2 and HCl emissions, aerosol/coating formation, corrosion in biomass combustion. Models of reactor tests from literature on HCN/NH_3 conversion.

Deposition/corrosion in straw-fired boilers

Title:	6513 - Relations between combustion, deposition, flue gas temperature and corrosion in straw-fired boilers
Proj. man.:	Dong Energy A/S, Søren Aakjær Jensen, ✆ +45 4480 6000
Grant:	PSO – DKK 2,915,000

Chloride/potassium = treatm. prob. Additives for flux prob. Add to biomass w. lower chloride/potassium cont.; get 100% KCl-convers.; processable resid.

Corrosion investigations at CHP

Title:	6510 - Corrosion investigations at the Maribo-Sakskøbing combined heat and power plant
Proj. man.:	Dong Energy A/S, Lars Storm Pedersen, ✆ +45 4480 6660
Grant:	PSO – DKK 2,011,000

2006 follow-up meas. on biomass-fired CHP in Maribo-Sakskøbing, commissioned in 2000. No signs of corrosion in superheaters but initial material loss in input channels and on grate.

Improved straw infeed

Title:	3322 - Improved straw infeed
Proj. man.:	Dong Energy A/S, Charles Nielsen, ✆ +45 7622 2406
Grant:	PSO – DKK 631,515

Design changes to Enstedværket's biomass boiler straw scarifier; feeding channel temp. regulation, screw conveyor control tests. Weighing cells, length meas. equipment on feeding belts (4 straw lines).

Deposit removal in bio-fueled boilers

Title:	3144 - Optimisation of deposit removal in bio-fueled boilers
Proj. man.:	Dong Energy A/S, Charles Nielsen, ✆ +45 7622 2406
Grant:	PSO – DKK 1,025,000

Examination of 1 Swedish, 11 Danish biomass-fired boiler plants; focus on coatings on boiler surfaces. Coatings appear on all plants; precautions necessary.

FiB – Bioenergy Research is published with support from Denmark's Energy Research Programme. The newsletter, which is free of charge, is published six times a year both in a Danish and an English version. Both versions can be downloaded from the Internet at the following homepage: www.biopress.dk

The Danish version of the newsletter is also available in a printed version. Further copies of the Danish version can be ordered from BioPress, via the following e-mail address: biopress@ biopress.dk, or telephone nr +45 8617 8507.

Editor responsible:
Torben Skøtt

ISSN: 1604-6358

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

Photo on the front page:
Torben Skøtt/BioPress and TK Energi.

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

More electricity from waste

Photo: Torben Skøtt/Biopress

Energinet.dk are now placing more focus on waste through a new strategy, which, amongst other things, is intended to secure a much higher electricity production level from the various waste sections. The goal is to double electricity efficiency levels at the incineration plants and establish more flexible plants that are better able to adjust the electricity production to actual consumption levels.

To a great extent, waste is a renewable resource similar to biomass and other types of renewable energy. Both the Danish Energy Agency and Energinet.dk are expecting around 80% of our waste to be classified as renewable energy; however, whereas we have typically focused on effective utilisation of biomasses, as an example, waste has not yet received the same level of attention.

– The incineration plants primarily earn their money from recipient fees and historically seen, energy sales have never really been of any importance, explains research coordinator Steen Vestervang from Energinet.dk, where a new waste strategy was recently drawn up.

– Our goal is to double electricity efficiency levels at the waste treatment plants from the current level of 17%. Additionally, we want to develop a new technology that will make it easier for the plants to deliver the system output needed in order to keep the electricity supply network balanced, says Steen Vestervang.

If electricity efficiency levels at the waste incineration plants are in fact increased to an average of 30%, the plants will be able to produce 3.1 TW/h of electricity per year, thereby covering 9% of the Danish electricity consumption by means of waste. In order to reach this goal, the steam temperature and the pressure within the plants will be increased, and waste will to a greater extent be utilised in large plants with high electricity efficiency levels.

Steen Vestervang stresses that the new strategy drawn up by Energinet.dk only covers a small part of the waste treatment area:

– We are focusing on those items, which, seen from a social point of view, cannot be utilised for anything else but energy production. This is our task, i.e. neither do we consider recyclable items, nor taxation regulations, nor any other terms and conditions, says Steen Vestervang.

TS