Solutions for biomass fuel market barriers and raw material availability - IEE/07/777/SI2.499477

Prospects of bioenergy in new industrial sectors – D2.3

VTT-R-01749-10

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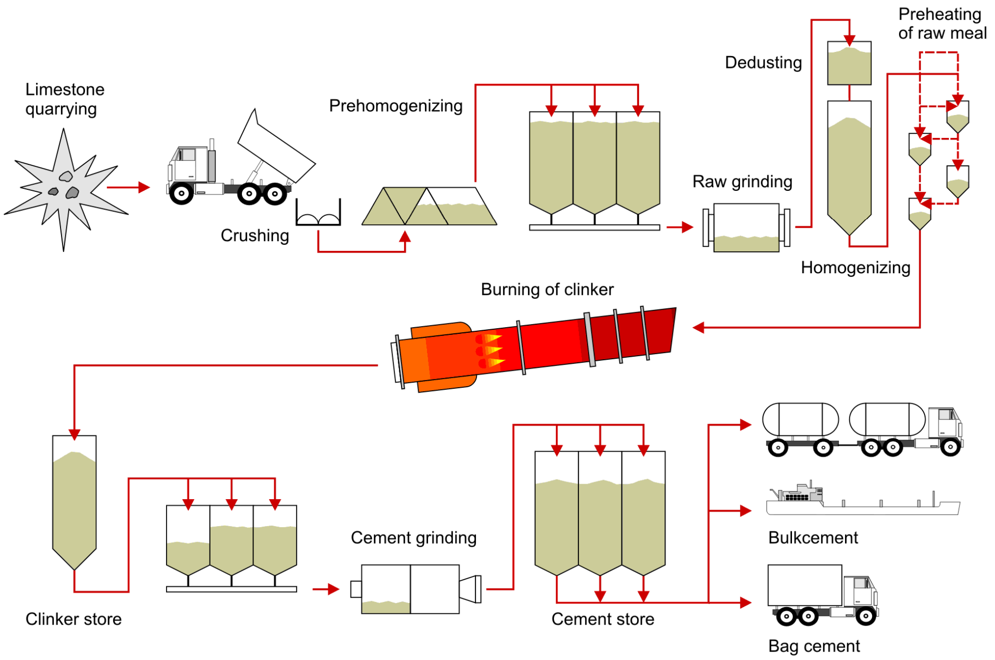

Jyväskylä, February 2010

Intelligent Energy Europe

Content

Content 2

Preface 3

1 Introduction 4

2 New industrial sectors as bioenergy users 5

2.1 General overview 5

2.2 Developments in the food processing and beverage industry 7

2.3 Developments in the ceramic industry 9

2.4 Developments in the cement industry 10

2.5 Developments in other new industrial sectors 12

3 Current potential and use of solid biomass 15

3.1 Advantages of biomass use in new industries 15

3.2 Barriers of biomass use in new industries 15

4 Selected success stories 16

4.1 Food processing and beverage industries: Riso Scotti Energia, Italy 16

4.2 Ceramic industry: Cerâmica Outeiro do Seixo SA, Portugal 17

4.3 Cement industry: ENCI Maastricht, the Netherlands 18

4.4 Other new industrial sectors: PPS Group Inc., Slovakia 20

5 Summary and conclusions 22

References 23

Preface

This publication is part of the EUBIONET III Project (Solutions for biomass fuel market barriers and raw material availability - IEE/07/777/SI2.499477, www.eubionet.net) funded by the European Union's Intelligent Energy Programme. EUBIONETII is coordinated by VTT and other partners are Danish Technological Institute, DTI (Denmark), Energy Centre Bratislava, ECB (Slovakia), Ekodoma (Latvia), Fachagentur Nachwachsende Rohstoffe e.V., FNR (Germany), Swedish University of Agricultural Sciences, SLU (Sweden), Brno University of Technology,UPEI VUT (Czech), Norwegian University of Life Sciences, UMB (Norway), Centre wallon de Recherches agronomiques, CRA-W (Belgium), BLT-HBLuFA Francisco Josephinum, FJ-BLT (Austria), European Biomass Association, AEBIOM (Belgium), Centre for Renewable Energy Sources, CRES (Greece), Utrecht University, UU (Netherlands), University of Florence, UNIFI (Italy), Lithuanian Energy Institute, LEI (Lithuania), Imperial College of Science, Imperial (UK), Centro da Biomassa para a Energia, CBE (Portugal), Energy Restructuring Agency, ApE (Slovenia), Andalusian Energy Agency, AAE (Spain). EUBIONET III project will run 2008 – 2011.

The main objective of the project is to increase the use of biomass based fuels in the EU by finding ways to overcome the market barriers. The purpose is to promote international trade of biomass fuels to help demand and supply meet each other, while at the same time the availability of industrial raw material is to be secured at reasonable price. The EUBIONET III project will in the long run boost sustainable, transparent international biomass fuel trade, secure the most cost efficient and value-adding use of biomass for energy and industry, boost the investments on best practice technologies and new services on biomass heat sector and enhance sustainable and fair international trade of biomass fuels.

The aim of this report is to identify 'new industries' where biomass is used as an 'energy carrier', or has the potential to be used in the future, and to describe which drivers, bottlenecks and opportunities these sectors see for the (increased) use of biomass.

This report is based on the country data provided by each project partner. In each partner country, the most important 'new industries' were recognised and some representatives of current or potential bioenergy users in these industries were interviewed.

Authors, Jyväskylä, February 2010

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1 Introduction

The aim of this report is to identify 'new industries' where biomass is used as an 'energy carrier', or has the potential to be used in the future, and to describe which drivers, bottlenecks and opportunities these sectors see for the (increased) use of biomass.

By 'new industries' we mean industries which are normally not directly associated with bioenergy. Examples of 'new industries' are: metal (e.g. steel, silicon carbide), cement, food processing, and construction (brick producing) industries. The forestry, pulp & paper and the energy sectors are excluded – they are 'traditional' bioenergy users, and will be covered in other part of the EUBIONET III project. Also, the agricultural production sector (including farmers, pig & poultry producers, greenhouse cultivation, and aviculture) are excluded from this report and included in another part of the EUBIONET III project. However, use of biomass in food processing industries (e.g. processing table olives, cocoa, coffee, meat) are included.

By 'energy carrier' we mean that the biomass should be used for energy purposes, e.g. to produce electricity, and/or heat/steam, or to produce biofuels. Examples could be the cement industry (cofiring biomass wastes to produce heat), or the food processing industry (e.g. fermenting their biomass residues to produce heat and electricity). What we are not looking for are industries using biomass to produce biomaterials (e.g. bioplastics) – unless they also use biomass to meet their energy requirements. A borderline case is the production of silicon or iron using wood chips or charcoal as reducing agent. In these examples the role of biomass is twofold: it produces the necessary heat for the process (so it's an energy carrier that we are looking for), but it also is actual part of the chemical reaction (getting the oxygen out of the ore, producing pure iron/silicon).

This report is based on the country data provided by each project partner (see references). In each partner country, the most important 'new industries' were recognised and some representatives of current or potential bioenergy users in these industries were interviewed. As a great part of the information received can be classified as confidential, this report mainly presents summaries and anonymous results. All company-wise data included in this report is published with specified permission of the companies concerned.

2 New industrial sectors as bioenergy users

Table 1 gives an overview of the industrial categories investigated in EUBIONET III and their presence in different partner countries. The X in brackets means that there is only one company in that industrial sector. In the classification of the industries, so called NACE codes are used. The Statistical Classification of Economic Activities in the European Community (in French: Nomenclature statistique des activités économiques dans la Communauté européenne), commonly referred to as NACE, is a European industry standard classification system.

Table 1. Presence of investigated industries in partner countries.

NACE Code	Austria	Belgium	Czech Rep.	Denmark	Finland	France	Germany	Greece	Italy	Latvia	Lithuania	Netherlands	Norway	Portugal	Slovakia	Slovenia	Spain	Sweden	UK
C10	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
C11	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X
C19	X	X	X		X	X	X		X		(X)	X	X	(X)	(X)	X		X	X
C20	X	X	X		X	X	X		X	X	X	X	X	X	X	X		X	X
C21	X	X	X	X		X	X	X	X		X	X	X	X	X	X		X	X
C23	X	X			X		X		X	X	X		X	X		X		X	
C23.3	X					X	X		X		X		(X)	X	X	X			
C23.5	X		X	X		X	X	X	X		X	X	X	X	X	X	X	X	X
C23.6	X					X	X	X	X	X	X		X	X	X	X		X	
C24	X	X	X		X		X	X	X	X	X	X	X	X	X	X		X	

NACE Industries:
C10 Manufacture of food products
C11 Manufacture of beverages
C19 Manufacture of coke and refined petroleum products
C20 Manufacture of chemicals and chemical products
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
C23 Manufacture of other non-metallic mineral products
C23.3 Manufacture of clay building materials
C23.5.1 + C23.5.2 Manufacture of cement, lime and plaster
C23.6 Manufacture of articles of concrete, cement and plaster
C24 Manufacture of basic metals

2.1 General overview

An overview of the total primary energy use (in PJ) of the investigated industry categories (see Table 1) in each partner country is listed in Table 2. Furthermore, Table 2 shows which and how much biomass is used in these industries. Only the total sums are presented, the split between different industries can be found in country reports.

Table 2. Share of bioenergy in selected industries in partner countries in 2006.

Country	Primary energy use (PJ) in selected industries	Of which biomass	
		PJ	%
Austria	696.2	18.4	2.6
Belgium	542.5	5.8	1.1
Denmark	37.8	0.3	0.8
Finland	162.2	2.5	1.5
France	867.1	?	?
Germany	3 950.0	?	?
Greece	161.0	9.2	5.7
Italy	914.7	0.1	0.0
Latvia	19.3	0.9	4.5
Lithuania	37.4	0.6	1.6
the Netherlands	369.0	1.7	0.5
Norway	148.7	6.3	4.2
Portugal	173.4	20.3	11.7
Slovakia	106.5	0.1	0.1
Slovenia	41.2	0.4	0.9
Spain	599.1	18.3	3.0
Sweden	567.9	2.2	0.8
United Kingdom	?	?	?
Total	9 504.5[1]	87.1[2]	1.9[2]

[1] excluding UK
[2] excluding France, Germany and UK

To get an overview of the advantages/disadvantages and about the future potential of biomass as energy carrier for different new industries, several interviews were carried out by each partner. In each country, a couple of industry categories were selected for this more detailed study. Companies of these selected industries were contacted and interviewed. The selected industries of each country are presented in Table 3.

Table 3. New industries selected for more detailed analysis in each partner country.

NACE Code	Austria	Belgium	Czech Rep.	Denmark	Finland	Germany	Greece	Italy	Latvia	Lithuania	Netherlands	Norway	Portugal	Slovakia	Slovenia	Spain	Sweden	UK
C10		X			X	X		X	X	X						X	X	X
C11					X	X			X		X					X		
C19																		
C20		X				X												
C21				X				X										
C23					X													
C23.3	X									X			X	X				
C23.5	X	X		X			X		X		X	X	X	X		X	X	X
C23.6																		
C23.9										X								
C24	X								X								X	
C25.1			X															

NACE Industries:
C10 Manufacture of food products
C11 Manufacture of beverages
C19 Manufacture of coke and refined petroleum products
C20 Manufacture of chemicals and chemical products
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
C23 Manufacture of other non-metallic mineral products
C23.3 Manufacture of clay building materials
C23.5.1 + C23.5.2 Manufacture of cement, lime and plaster
C23.6 Manufacture of articles of concrete, cement and plaster
C23.9 Manufacture of abrasive products and non-metallic mineral products
C24 Manufacture of basic metals
C25.1 Manufacture of metal structures

In general, those industries which have abundant biomass resources (by-products) themselves, have often already built a bioenergy project, if it was profitable. However, the current economic crisis has postponed many investments as the companies are waiting for better times. At the moment, investing on bioenergy projects is not a topic for many of the interviewed companies.

Bioenergy plans are considered interesting by industries to reduce GHG emissions, to receive green certificates, to use by-products and to improve their brand image. Still, bioenergy has not yet been as widely taken into account as fossil fuels when it comes up to finding a solution to produce energy. Some industries are not yet convinced, many of the industrial bioenergy projects currently in service are quite new, and thus the existing experiences are not long enough, which leads to difficulties in estimating the projects' relevance.

In some countries (e.g. Belgium), energy audits have been carried out to help industrial companies build energy plans. In many cases audits have shown that biomass could be used to produce either heat (biogas, wood), or combined heat and power, CHP (biogas, fats, oils, wood gasification). CHP projects lead to the largest energy consumption reductions while biomass heat production leads to the largest CO_2 emissions reduction.

As another example, if we look at the development over time in all industries in Norway, it can be noticed that the share of energy from biomass feedstocks has been fairly stable at 10 – 12%. There has been a rather large positive development especially in the Norwegian cement industry, where the use of alternative fuels increased from 5% in 1992 to around 50% in 2006. Also in the food industry there has been an increase in the use of bioenergy, but the share is still rather low. In the industrial sector with the by far largest total energy use, manufacture of basic metals, there is virtually no use of bioenergy at all.

In chapter 2.2, bioenergy developments in some selected industrial branches are presented.

2.2 Developments in the food processing and beverage industry

The main energy consumers in the food processing industry are the production process itself and the storage of products. In the beverage industry, heat energy in the form of hot and warm water and steam is needed for example for beer brewing and cleaning of bottles. Buildings, offices etc. have a much smaller share of energy consumption in these industries.

In many countries, food industry and breweries already have invested in biogas production from their process by-products. However, high investment costs and quite complicated technologies limit the companies' willingness to invest in bioenergy systems. Also, some companies have outsourced their energy production as it is not their main line of business, even though their energy use is quite substantial.

For many producers, it is more favourable to use the residues and by-products as agricultural fertiliser or sell it as animal feed. The decisive factor seems to be the price. Environmental aspects are an additional plus, but the cost effectiveness is decisive for the realisation of bioenergy projects. For example, one interviewed brewery stated, that the processing and dehydrating of the wet draff would be so costly, that it is more profitable to sell it as animal feed.

In Finland, one cheese manufacturer has invested in a new solid biomass boiler in 2005. In this case, the dairy plant does not have high amounts of own by-products that could be used as fuel. Small amounts of energy originate from the dairy's own waste water process. The organic content is extracted from the waste water and cofired with the wood fuels. Fuels, sawdust and bark, are purchased from a local wood processing plant. Fuels are burnt in a small fluidised bed boiler. The main reasons for the fuel switch for this factory were the low price of biomass, “green values” which is seen as added value for cheese manufacturing, and the possibility to sell the excess heat to the city district heating network. Fuel used in this factory is produced locally, it comes from the co-operative’s own forest.

The representative of the dairy mentioned that one of the disadvantages of using biomass as fuel is the high investment costs. Also the location of the plant is important. In urban areas, especially in southern Finland, it is more difficult to secure the supply of biomass for the long term. Often the factories of the food industry are located in places where it is impossible to base fuel supply on biomass alone, due to the limited availability of biomass fuels within reasonable distance. In these cases, energy supply is often outsourced.

The Federation of German Food and Drink Industries states that the energy costs have increased in recent years and are a high burden for companies and private households. As the most important solution, the Federation presents the improvement of energy efficiency and promotes the initiative of energy efficiency networks, where small and middle-sized companies identify potentials for energy efficiency improvement. The Federation also declares the use of renewable energies as the second pillar of a sustainable energy management, as significant amounts of by-products and residues, which offer a high energetic potential, are produced during the manufacturing of food products and beverages.

However, a leading principle is and remains the use of biomass for the application with the highest profit. In other words, if biomass streams can be sold more profitably for other uses (e.g. as animal feed or fertilizer), they are not used for energy purposes.

Figure 1. Images from a rice industry plant. Source: UNIFI/Riso Scotti

In the interviews, the companies mentioned several advantages of bioenergy systems. Most often, bioenergy was considered as an attractive way to discard any organic waste products. Also independence of fossil fuels, reduced greenhouse gas emissions and greener image were seen important.

Some companies deemed bioenergy to be a financially attractive option, however much more often the high investment and biomass procurement costs were mentioned as major barriers. In addition, insufficient or non-existing biomass supply infrastructure and problems with the security or supply limit the willingness to invest in bioenergy. Some companies also mentioned competition for the biomass resources with other applications (animal fodder, as raw material in other processes, etc.) and regulations regarding e.g. emission limits and biomass classification.

In an explorative study, Budding and Blok (2009) investigated the financial feasibility of using more biomass from the food-processing sector for anaerobic digestion. Their main conclusions were that utilization of biomass by-products can only be feasible if:

- A subsidy is available for the renewable energy produced
- Sufficient biomass material is available within the close vicinity of the digester
- The biomass waste streams are available at negative costs (i.e. otherwise a fee has to be paid for their processing)
- There is a heat demand close to the digester, or (preferably) the biogas can be used directly in the near vicinity
- The digestate can be used as fertilizer

From the literature and interviews, it became clear that in a few cases, already biomass streams (e.g. spent coffee ground, rejected food products, animal fats, manure) and waste water are used to produce either process steam (in boilers) or biogas (through digesters). Some companies have started to build pilot plants, which typically produce a few hundred TJ of biogas per year. However, given the limitations mentioned above, many companies in the food processing industry are reluctant to invest on a large scale in bioenergy production.

Among the new industrial sectors, the food processing and beverage industries are among the most promising regarding the introduction of bioenergy systems. The low cost of raw material (residues from the processes of primary agricultural products) creates favourable conditions for exploitation of residues for energy production (often heat). In these cases, residues are used in the place of production and there is no need for transportation, reducing the cost of produced energy.

2.3 Developments in the ceramic industry

The modern brick manufacturing process uses much less energy than the traditional one. Thermal energy is needed for brick drying and firing. The modern process is very sensitive, and the brick manufacturers say that the use of biomass fuels would make it more difficult to control the firing process, as there are no commercially available technologies for that. First development priority of many brick manufacturers has been increased energy efficiency. In the process, a lot of waste heat is produced. In first instance, this heat is used for brick drying. However, manufacturers are also interested to use biomass, when it is possible without disturbing the process.

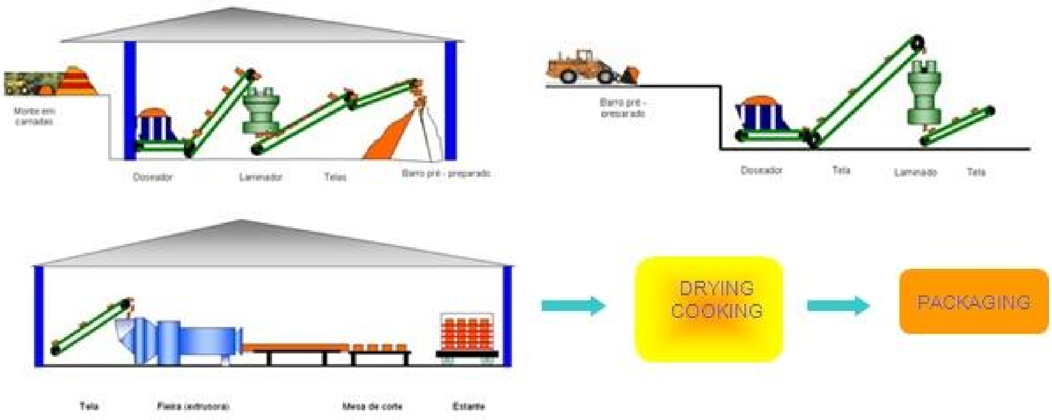

Figure 2. Process diagram of the bricks production. Source: CBE/Ceramics of Outeiro do Seixo.

Another barrier to increased biomass use is that the investment costs of biomass technology are high especially if the number of operating hours is relatively low. If the existing fossil fuel boiler plant is still reasonably new, the costs of replacing the boiler with a biomass boiler are seen too high.

In the brick industry, the main use of sawdust is not for energy production but to create the brick porosity. The biomass is mixed with clay to cause small hollow spaces after burning. These hollow spaces are responsible for a good porosity and insulation. In addition to competing applications, also regulations, high biomass procurement costs and insufficient or non-existing biomass supply infrastructure have been mentioned as barriers to increased share of bioenergy in the sector.

On the other hand, there are several reasons for the interest of brick manufacturers in increasing bioenergy use in their processes: green values are seen very positive for brick's image. The lifecycle of bricks is very long. The EU Emissions Trading Scheme covers CO_2 emissions from high-emitting installations in the power and heat generation industry and in selected energy-intensive industrial, including factories making cement and bricks. Also for this reason, the options to replace fossil fuels with renewables in the production process are welcomed by the brick industry.

The independence of fossil fuels and the reduction of greenhouse gas emissions, as well as the possibility to generate profit in the emissions allowances market are the main motivations to increase the biomass use for energy production in this sector. In some cases bioenergy is also financially attractive option.

2.4 Developments in the cement industry

Production of cement is relatively energy intensive and emits a large quantity of CO_2. Energy use is about 3500 kJ/kg clinker and emission is about 1 ton CO_2 per ton Portland clinker, of which about 40% is from the fuel and about 60% from calcination of limestone. Thus, the fuel demand of a large cement factory is enormous.

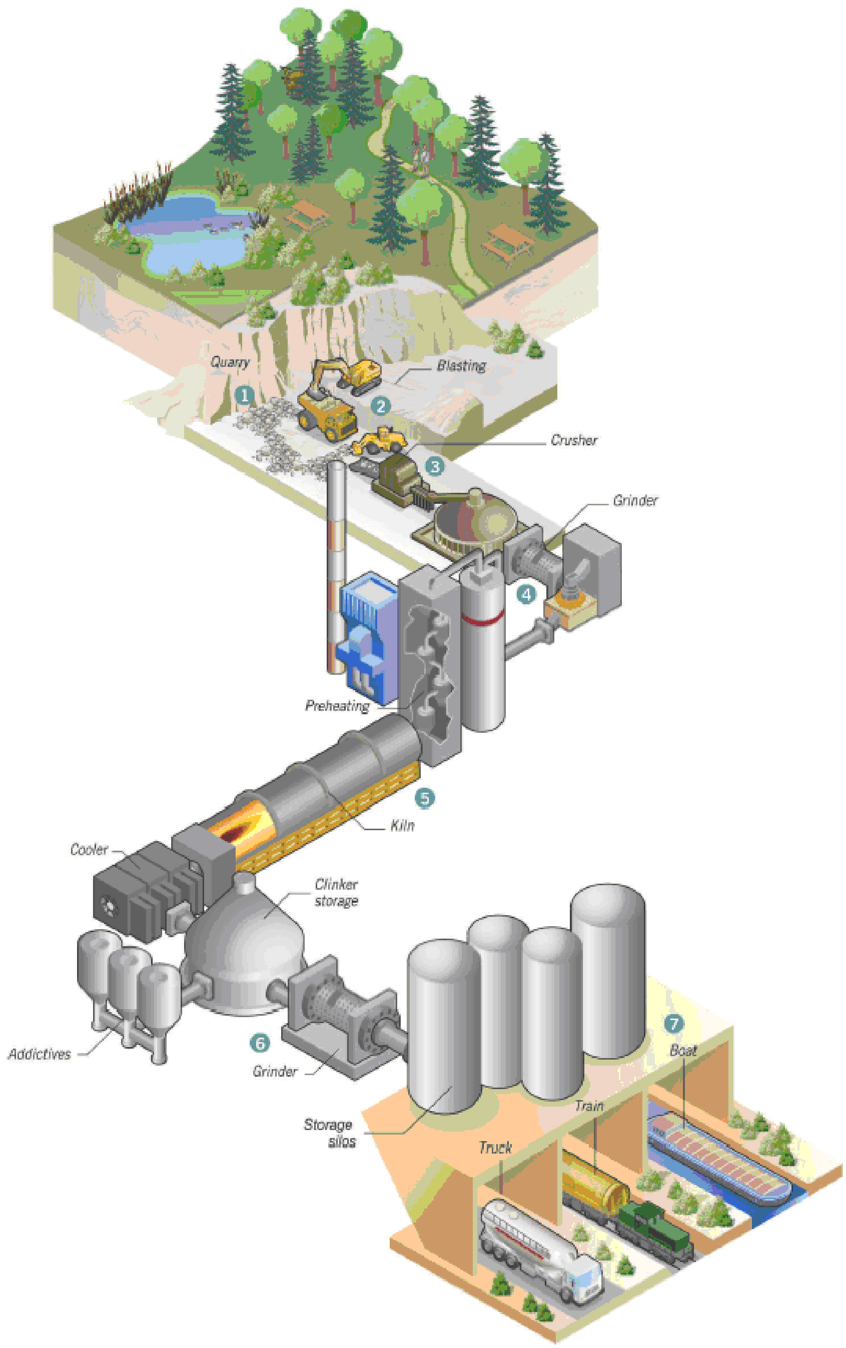

Figure 3. Process diagram of the cement production. Source: FJ-BLT

Generally for most producers coal is the major energy source in production, even though some cement factories already use biomass in proportions which in some cases reach up to 50%. The kilns are suited for using a range of different fuels, but it would be difficult to supply such high amounts of biomass that the share of biomass in the total energy mix would be considerable. On the other hand, cement industry can easily use even wet and low-calorific value fuels in small portions. For example municipal waste, sewage sludge, animal meal, waste wood, paper sludge and crushed tires are used in different cement factories in different European countries.

In Belgium, biomass is already used in cocombustion to produce cement and lime and these sectors plan to increase biomass use. But in their case, an outside biomass supply is needed. This extern supply implies additional costs to buy biomass and transport it. Consequently, these sectors consider biomass availability as a potential barrier and in this context competition with other sectors using biomass as raw material is present. Several biomass types and qualities also co-exist in the same time but supply traders are currently rare. Quality could be a problem depending on final users. For example, unlike cement, lime production can only use high quality biofuels.

For example in Finland, the cement factories have in recent years invested in new fuel receiving equipment which enables the use of biomass fuels. Different biomass feedstocks have been tested and the results have been promising. Technically it would be possible to use even more biomass, but the price of the available biomass has been too high. However, since the high temperature of the cement kiln makes it possible to use low quality fuels, the cement factories can use fuels that do not serve in e.g. power plants. Because of the high temperature, it is also possible to use waste materials that in lower temperatures would not be safe to use (such as sewage sludge or MBM).

Necessary investments to start the use of biomass are generally fairly high. The pay-back period may be long, therefore it is essential, that the biomass supply with reasonable costs is secured for long-term.

Also the location of the industrial site at issue is important. In many countries, biomass is more easily available in forested areas. Competition on the available biomass resources is bigger close to cities where also the municipal energy production may already absorb all available biomass fuels.

In the Netherlands, the only cement factory utilizing biomass has been strongly increasing its use of biomass waste streams from 0% in 1996 to 44% in 2007, leading to an overall greenhouse gas emission reduction of 28% compared to 1990. Sewage sludge is the principal biomass source, other biomass feedstocks being still significant quantities of bone meal, paper sludge and plastic-paper derived fuel.

There are, however, some barriers for increased use of biomass which are common to most countries. To some extent there is competition over the resources and the infrastructure is not yet developed well enough. Further, the costs of biomass are relatively high and so are the necessary investment costs to adjust the instalment to biomass fuels.

The cement industry is currently suffering from a considerable decrease of production mainly due to the current world economic crisis. The current situation has led to the closure of large construction companies, which is likely to cause difficulties also for cement industry.

2.5 Developments in other new industrial sectors

In addition to the above mentioned industrial sectors, also several others were covered in the interviews of companies. However, for these industries, the number of companies was not high enough for generalised conclusions. Below, some individual observations are presented regarding the possibilities of bioenergy in other new industrial sectors.

The German Chemical Industry Association emphasises the issue of energy efficiency and warns of the conflict between food production and climate protection. Nevertheless, the chemical industry is also focusing on the use of renewable raw materials. In the view of the increasing oil and gas prices, interest is growing in crops as an energy source and basis for raw materials. Research on the field of biofuels is also active.

In an energy intensive industry as chemical industry, the costs for energy are crucial. However, it may be difficult to estimate the difference between the prices for energy through biomass and gas, because the prices for wood and gas vary strongly, but a rough estimate has been made in Germany that the biomass energy costs approx. 25 - 50% of the costs of energy produced with gas. In this case, the produced electricity is additionally granted with the feed-in tariff under the German Renewable Energy Sources Act (EEG).

In the pharmaceutical industry, biomass could be used e.g. in hot water production for the heating system. This would lead to a larger independence of fossil fuels and greener production – like in other industries as well. Also the main barriers are more or less the same: problems with the security of biomass supply and insufficient or even non-existing infrastructure for biomass supply. In addition, the impossibility to find a reliable biomass provider and high investment costs for biomass conversion installations were mentioned as reasons for not using bioenergy.

The Finnish oil refining industry has invested heavily in biofuels and other environmentally-friendly products. Neste Oil has developed a technology (NExtBLT) to produce high quality biodiesel, equivalent to good-quality fossil diesel from tri-glycerides (vegetable oils and animal fats). The first large-scale, 170 000 ton (approximately 7 PJ) per year biodiesel plant, based on the above mentioned technology entered into production in Porvoo in 2007. A second similar plant at Porvoo was ready at the end of 2009. This may boost the production volume and profitability of this sector in the near future.

Neste Oil and the forest industry company Stora Enso have established the joint venture NSE Biofuels with the purpose of building an industrial pilot plant at the Stora Enso Varkaus mills. The plant was ready in June 2009. The idea is to produce raw biodiesel from woody biomass at the trial plant, and then process it into commercial fuel at the Neste Oil Porvoo refinery. Another forest industry company, UPM, has announced that it will focus strongly on second generation biodiesel and that it intends to become a remarkable second-generation biofuel producer.

In 2007, the St1 oil company (St1 Biofuels Oy) introduced the production of fuel-ethanol from food industry waste, scrap and by-product flows based on its Ethanolix concept (Figure 4). Biowaste from food processing plants as well as food industry by-products that contain sugar, starch or low concentrations of ethanol can be used to make bioethanol. The types of waste and side streams that can be processed contain i.e. potato processing waste, bakery waste and side streams, dairy industry waste and side streams and brewery waste.

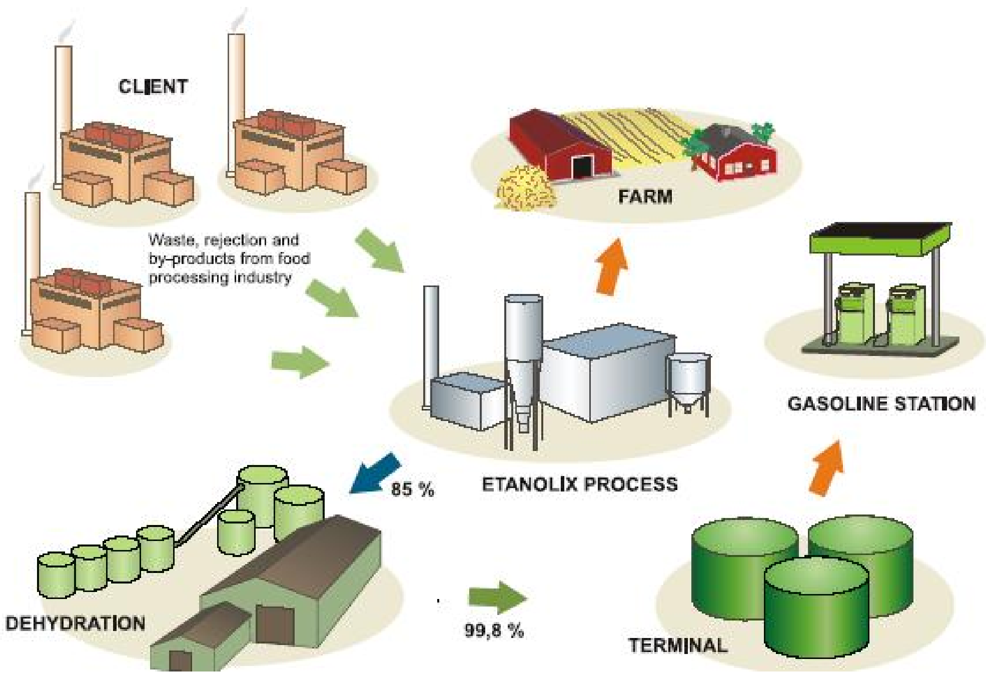

Figure 4. Etanolix concept for food industry side streams and waste. Source: VTT/St1.

As a very energy intensive sector, the basic metal industry is one of the main energy consumers in many countries. For example in Norway, manufacturing of basic metals uses about 13% of the total energy consumption in the country. Due to the high energy use, the importance of fuel energy density increases. Because the energy density of biomass is low compared to other conventional fuels like coal and gas, the potential contribution of biomass in the total energy consumption is only modest.

3 Current potential and use of solid biomass

3.1 Advantages of biomass use in new industries

In general, bioenergy plans were considered interesting by industries to reduce greenhouse gas emissions, to receive green certificates, to use by-products and to improve their brand image. Also the independence from fossil fuels was mentioned as an advantage of biomass use. In some cases bioenergy was considered financially attractive, but this was not the case for the majority – at least not without some kind of financial incentives.

3.2 Barriers of biomass use in new industries

As barriers for increased biomass use, the high biomass procurement costs and the high investment costs for biomass conversion installations were most often mentioned. The pay-back time is considered too long and the profitability is not guaranteed.

The current economic crisis was mentioned many times in the interviews. Bioenergy projects are big investments, and during the current recession period these investments are postponed as they do not belong to the main line of business.

In several countries the biomass supply infrastructure is insufficient or even non-existing. The availability of the feedstock and the security of supply are not guaranteed. The unsteady quality of biomass was also mentioned as a barrier; on the other hand, in cement industry this is not a major concern.

Bioenergy technologies are more complex than those for traditional fuels. In many countries it may be difficult to find qualified people or it needs time to train some.

Regarding legislation, several kinds of biomass are considered as waste and using them lead to a more restrictive legislation (e.g. emissions standards). Also other administrative and legislative barriers exist.

For CHP based on wood, a technological gap was mentioned for small-sized power installations using wood: there are no mature technologies available for power between 3 kW and 300 kW.

4 Selected success stories

4.1 Food processing and beverage industries: Riso Scotti Energia, Italy

Founded in 1860, Riso Scotti was one of the first Italian rice factories to produce and sell packaged rice, thus guaranteeing the constant high quality and hygiene of the product. Today, the most prestigious varieties of rice are harvested from the Scotti farms, whose rice fields extend over hundreds of hectares, in the heart of the Po Valley, and are then prepared and packaged in the modern plant of Pavia. Riso Scotti S.p.A. nowadays controls a group of high-tech companies covering the entire process from rice cultivation and milling, to rice based products R&D, production and distribution.

Riso Scotti Energia is one of this high-tech companies group; it produces energy from biomass both from dedicated energy crops and agricultural residues, mainly from the rice factories of the group. The cogeneration plant went into operation in year 2003; heat is used for the rice production process while electricity is sold to the public network.

Riso Scotti's production process is a large state of the art high-tech plant which concentrates the most modern and efficient solutions in the food industry. The entire process minimises the production of wastes; all the by-products of the rice manufacturing process present a further utilisation:

- rice husks and straw as biofuel for the cogeneration plant;
- rice chaff, which is composed by the fatty external layers of the raw rice grain, are the raw material for rice oil production;
- the white rice broken grains are used to produce puffed rice grains.

The by-products amount is nearly 40% (in mass) of the input raw material. Through a strict quality and efficiency control of every production phase and a totally new production lay out, Riso Scotti is able to run a "zero waste" operation.

The plant burns nearly 80~90 000 tons of biomass per year. The input biomass comes from the rice production process (rice husks and straw); this biomass is integrated by wood chip fuel from dedicated energy crops (white poplar) and by other agro-industry residues and wastes.

The plant power unit is composed by two impulse steam turbines; one of 5.6 MW electric nominal power at 8200 rpm, the other of 2.0 MW electric nominal power at 7450 rpm; thus the total nominal electric plant power is 7.6 MW.

The main plant components/areas are the following:

- storage area; the area where the biofuel is stored and pre-processed;
- plant feeder;
- boiler and steam generator;
- fumes treatment and filtering;
- steam turbines;
- automatic monitoring and control.

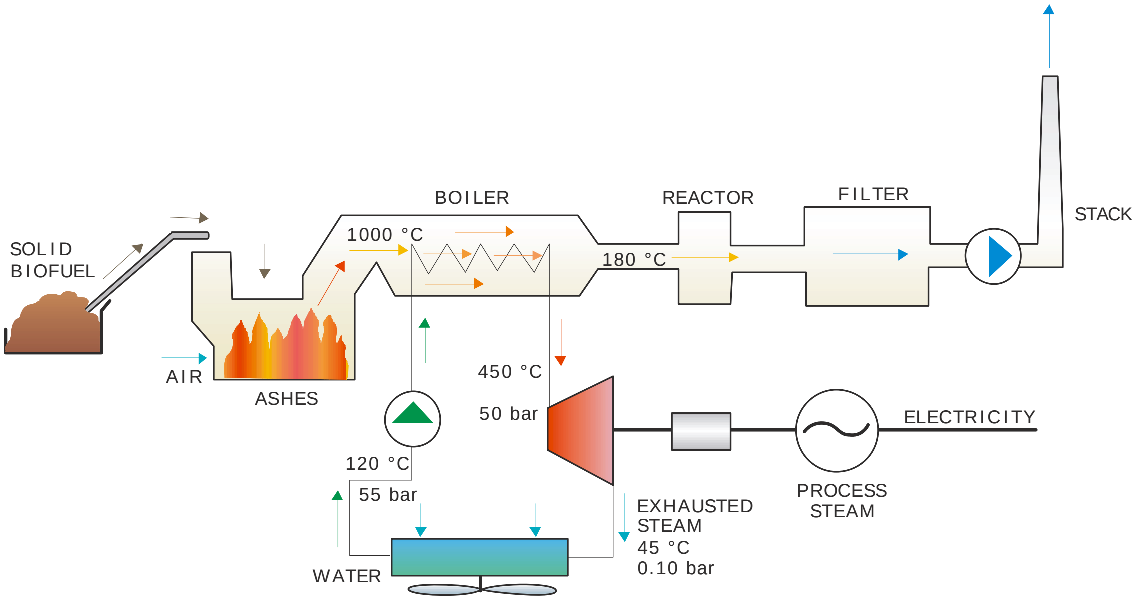

Figure 5. Plant scheme. Source: UNIFI/Riso Scotti

The cogeneration plant produces nearly 45 GWh electricity per year; this electricity is sent to the public grid under the CIP6 incentive system. Moreover, nearly 10 t/h of steam are extracted from the steam turbine and used for the rice manufacturing process.

For this plant, a fossil fuel saving of nearly 30 000 t/y has been evaluated, thus avoiding CO_2 emissions of about 130 000 t/y.

4.2 Ceramic industry: Cerâmica Outeiro do Seixo SA, Portugal

The Ceramics of Outeiro do Seixo is dedicated to the production of red clay for bricks for construction, as well as the marketing of tiles. This industrial unit is located in the central region of Portugal, in an area with abundant raw materials for this type of industry.

The Ceramics of Outeiro do Seixo tries to ensure maximum protection for the environment, performing preventing measures at the source and management of natural resources, where possible it uses cleaner technologies, and establishes appropriate waste management to implement the waste policy targets.

In this context, in April 2007, the company initiated the project of replacing part of the fossil fuels, needed to produce energy for the manufacturing process, by biomass. The motivation for the use of biomass was mainly to reduce the dependence on fossil fuels by using biomass resources from the region or nearby regions. The primary objective of the introduction of biomass for production of heat (firing zone) was the reduction of CO_2 emissions, and the profit generated by the sale of allowances that result from burning of biomass (zero emission) rather than fossil fuels.

In these industries, the greatest consumption of energy and the gas emissions occur in the drying and cooking stages of the production process. The drying phase aims to reduce the amount of water in the products before entering the furnace. After shaping the brick it is dried in chambers at temperatures ranging usually between 30 and 70 °C. The drying time is variable and may fluctuate around 16 hours.

After drying the bricks are baked in kilns where they are continuously subjected to temperatures ranging between 800 and 1000 °C (cooking). The furnace is composed of several areas such as the Ante-Fire, the cooking and cooling. The objective of these steps is the gradual increase of temperature to the firing zone and the decrease afterwards. The firing time is variable, around 24 hours.

The main factor of innovation in this project was to adapt the existing equipment that worked only with petroleum coke and implemented some changes in order to use only biomass or co-firing biomass with petroleum coke. Because only a few changes for the existing system for solid fuels were made, the investment costs were not very significant.

Figure 6. The premises of Ceramics of Outeiro do Seixo. Source: CBE/Ceramics of Outeiro do Seixo.

The biomass used as fuel is pine bark, sawdust and cork powder. These fuels come from resources from the region or nearby regions. In 2008 biomass was responsible for approximately 30% of energy produced. The total energy consumption was about 106 TJ in 2008.

The energy is used in the kiln, to produce the heat needed to cook the ceramic products. The burning system is by gravity, i.e. the fuel is transported by pipeline and injected together with air in the furnace roof (the area of burning) and falls by gravity, so that its combustion is complete before reaching its base. The furnace has a height of 2 m.

The Ceramics of Outeiro do Seixo aims to increase the consumption of biomass. However, it is naturally necessary that the cost of biomass remain competitive with fossil fuels.

4.3 Cement industry: ENCI Maastricht, the Netherlands

ENCI Maastricht is the largest cement factory in the Netherlands. In 2007, ENCI Maastricht produced almost 1.4 million tonnes of cement, and about 900 000 tonnes clinker (which are largely used internally for cement production). It has been strongly increasing its use of biomass waste streams from 0% in 1996 to 44% in 2007, leading to an overall greenhouse gas emission reduction of 28% compared to 1990. Sewage sludge is the principal biomass source, other biomass feedstocks being still significant quantities of bone meal, paper sludge and plastic-paper derived fuel.

Cement is produced in two steps: first, clinker is produced from raw materials by heating limestone with small quantities of other materials (such as clay) to 1450°C in a kiln. Then, in the second step the resulting hard substance, called 'clinker', is ground into a fine powder. The raw materials are delivered in bulk, crushed and homogenised, preheated and then fed into a rotary kiln which reaches flame temperatures of up to 2000°C. The inclination of the kiln allows the materials to slowly reach the other end, where it is quickly cooled to 100 - 200°C. Hot flue gases from the kiln are used for preheating of the homogenised raw material before it enters to the kiln. Carbonates of limestone react with the heat by forming calcium oxide CaO (also called burnt lime) and carbon dioxide CO_2. The high temperature of the kiln melts the CaO powder. New compounds – silicates, aluminates and ferrites of calcium are formed. When mixing the ready cement powder with water, the hardening happens thanks to these compounds. The final product of this phase is called "clinker". After cooling, these solid grains are then stored in silos.

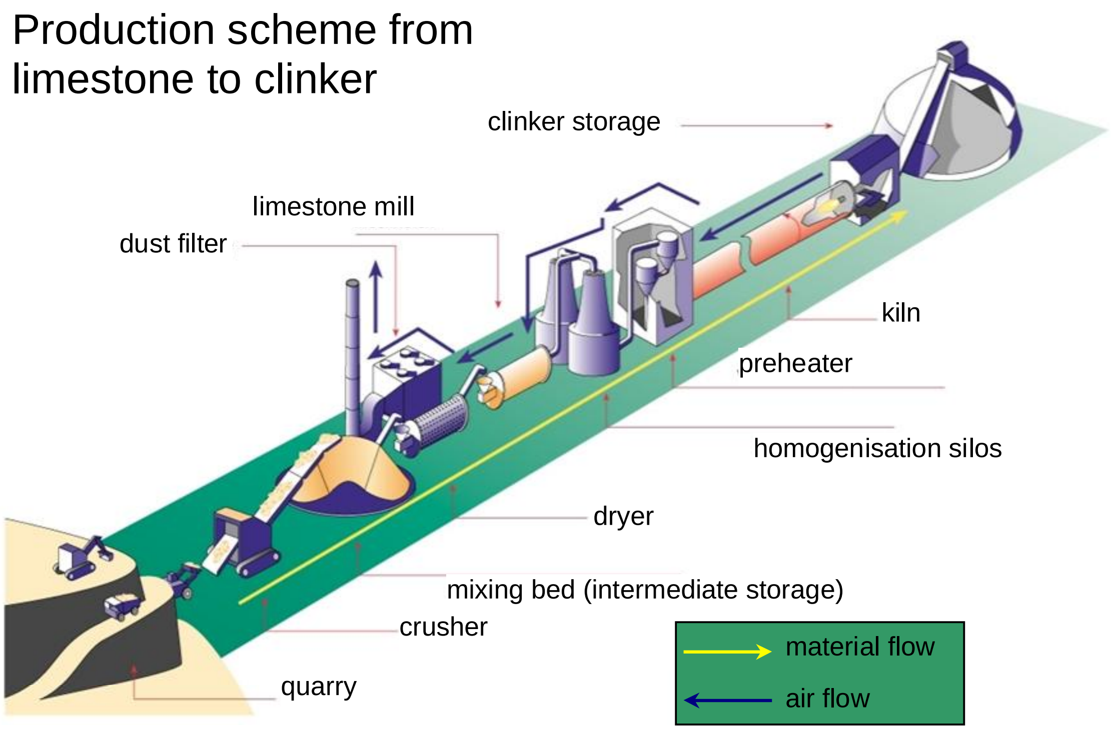

Figure 7. Overview of the cement manufacturing process at the ENCI Maastricht plant. Source: UU/ENCI Maastricht

Producing cement is very energy-intensive process, and ENCI Maastricht alone consumes annually about 3.1 PJ of primary energy, which is little less than 1% of the total primary energy demand of the Netherlands.

ENCI uses a mix of fossil fuels, biomass fuels and other alternative fuels. In 2007, this contribution was 14% fossil fuels, 44% biomass and 42% other alternative fuels (e.g. anode dust or glycolbottom). The fuel is used for the cement production process, where it produces the required heat to reduce $CaCO_3$ to CaO.

ENCI uses a variety of biomass fuels, which are either 100% organic material (such as sewage or paper sludge and animal meal) or sources mixed with fossil-derived materials (such as paper and plastics-derived fuels, PPDF). The various biomass streams are all sourced externally, i.e. no biomass is used from internal production.

In order to be able to process dried sewage sludge in its kiln, the sewage sludge has to be grinded first. Therefore, ENCI Maastricht has invested into two mills to crush the sewage sludge. First trials with sewage sludge started in 1996. Since then, sewage sludge consumption has steadily increased from less than 1 tonne per hour (tph) in 1997. In 2007, the annual sewage sludge consumption had reached 11 tph.

The high ash content (30-40%), which causes problems for power plants, is used to replace natural raw materials for the clinker formation. The mercury and chlorine contents and the impact of the sludge's P_2O_5 on early strength levels limits the sewage sludge utilization.

The production of cement is a rather energy-intensive process. The total annual CO_2-emission of the Netherlands amounts to approximately 212 million tonnes CO_2 equivalents. ENCI is responsible for roughly 0.3% of this emission.

It is important to recognize that CO_2 emissions during the clinker/cement production process are from two different sources. The first is caused by the chemical reaction where limestone ($CaCO_3$) is transformed in the kiln under intense heat into calcium oxide (CaO) and carbon dioxide (CO_2). More than 60% of the total CO_2-emission during the production of cement is caused by this process. It is important to point out that this emission is fixed, and cannot be lowered.

4.4 Other new industrial sectors: PPS Group Inc., Slovakia

PPS Group Inc. is a company of over 50 years tradition in the engineering industry and has aggregated a wide experience in this field. The company currently employs more than 1 500 people and enjoys strong growth. Turnover was 54.4 millions of euros in 2007. The main strategic program is focused on the production of heavy metal constructions (such as arms, booms, frames) for agriculture, construction, mining and other machinery, on fixture production and on assembly of final products.

In 2003 the company adopted a concept of energy management development. An extraordinary price increase of purchase prices for natural gas in 2005, forced the Steering Group and management of PPS to begin concerning seriously the possibility of heat production from alternative fuel sources in the second half of 2005. Professional energy analytics carried out a series of measures aimed at reducing energy costs. The conclusion was clear. The largest savings rate brings the fuel base change. Replacement of expensive natural gas by biomass has been identified as a crucial measure in the direction of further power engineering of the company.

Figure 8. Mechanical industry plant of PPS Group Inc. at Detva, Slovakia. Source: ECB/PPS Group

Heating plant of the company was originally built for coal. In the early nineties it was fully converted to the use of natural gas. Heating, hot water and heat energy for technology are provided with two gas boilers with a total installed capacity of 20 MW. Distribution system is operated at 120/90 °C thermal gradient at a maximum pressure of 0.95 MPa.

The new biomass boiler VESKOM-B with a capacity of 8 MW was added to the existing system. The former premises of the coal boiler were used as a location of the new boiler. Hence, during installation there was no need for boiler machinery reconstruction.

Construction work began in the summer of 2006. First formal ignition of the boiler took place on 22 December 2006. Trial operation of the boiler at projected performance and quality parameters started on 2 January 2007.

The biomass boiler is an essential heating source for the factory. Gas boilers operate only in the winter mode. In summer only the biomass boiler is used, with a wide range power regulation. During wintertime the biomass boiler is operated as water preheating to gas boilers and the gas boilers additionally heat the water to the desired temperature.

The VESKOM-B boiler is a basic energy source of the company. The total annual heating need at almost 100 000 GJ will be replaced by biomass up to 80%. This requires more than 10 000 tons of wood biomass.

Local biomass resources will be used as fuel. Boiler is designed for burning wood biomass of different sizes (unique pieces to the length 1000 mm), with high humidity. It uses the wood chips, sawdust, shavings, bark, scrap, etc. Fuel pollution or ash impurities, frequently presented are not an obstacle for the boiler. This feature enables the boiler to use maximum of local resources, as it is independent on high-quality chips.

5 Summary and conclusions

In many countries, especially in Scandinavia, bioenergy use is already quite well established in the chemical and mechanical forest industry. These industries are able to use their own by-products in their energy production, which makes the investments on bioenergy economically viable.

On the other hand, several other industrial sectors require lots of energy in their processes, but the share of bioenergy is negligible. These industries might form a great opportunity for increased biomass use in energy production, provided that the bioenergy projects are competitive compared with traditional energy solutions. In this report these industrial sectors are called 'new industries'. Currently the share of bioenergy in the studied industrial sectors ranges between 0.5 – 11.7% of the total energy consumption, the biggest share being in Portugal.

Bioenergy plans are considered interesting by industries to reduce GHG emissions, to receive green certificates, to use by-products and to improve their brand image. Still, bioenergy has not yet been as widely taken into account as fossil fuels when it comes up to finding a solution to produce energy. Some industries are not yet convinced, as many of the industrial bioenergy projects currently in service are quite new, and thus the experiences are not long enough, which leads to difficulties in estimating the projects' relevance.

In some industrial sectors, such as the food and beverage industries, all or part of the by-products can be used in bioenergy production. In these industries, the share of bioenergy is somewhat bigger, but there is room for improvement. However, high investment costs and quite complicated technologies limit the companies' willingness to invest in bioenergy systems. In addition, in many cases, other uses of the by-products e.g. as fertilizer or animal feed are more profitable.

One possible solution for those industries which require high quality fuels could be replacing coal with torrefied wood. Torrefaction is a mild pre-treatment of biomass at a temperature between 200-300 °C, which improves the fuel quality for combustion and gasification applications. In combination with pelletisation, torrefaction also aids the logistics issues that exist for untreated biomass. Torrefaction of biomass is an effective method to improve the grindability of biomass to enable more efficient co-firing in existing power stations.

The largest potential for increased bioenergy use would be in the cement industry, where the requirements for fuel quality are not so strict. In the cement industry, however, the energy consumption is so enormous, that even a small percentage of biomass in the fuel mix would mean such big amounts that the security of fuel supply may become a major obstacle.

Concluding, in general, the new industries are interested in bioenergy and willing to make their image greener, but the practical problems such as lack of infrastructure, insecurity of biomass supply and high fuel prices tend to limit the realisation of the investments. In many countries there is also lack of skilled people and knowledge on the new technologies.

The most unused biomass potential can be found in fruit and herbaceous biomass fractions (Junginger et al. 2010). As the insecurity of fuel supply has been a major bottleneck, there is a need for further research to find out if the fruit and herbaceous potential could be a solution for the new industries.

In the interviews carried out, several companies expressed their interest in bioenergy systems. Many of them had already plans for new projects, but they have been postponed due to the current recession.

References

Alakangas, E., Veijonen, K. & Flyktman, M., WP2 – Biomass fuel trade in Europe. Country report: Finland, EUBIONET III, 2009, 25 p.

Almeida, T., WP2 – Biomass fuel trade in Europe. Country report: Portugal, EUBIONET III, 2009, 23 p.

Blumberga, D. & Ozolina, L., WP2 – Biomass fuel trade in Europe. Country report: Latvia, EUBIONET III, 2009, 20 p.

Budding, B., & Blok, P., Nog meer energie uit voedingsmiddelen,Analyse praktische haalbaarheid biomassa vergisting van reststromen voedings- en genotsmiddelen industrie. Report by Rebel Advisory for FNLI/SenterNovem, March 2009.

Eleftheriadis, I., WP2 – Biomass fuel trade in Europe. Country report: Greece, EUBIONET III, 2009, 19 p.

Erlickytė-Marčiukaitienė, R. & Marčiukaitis, M., WP2 – Biomass fuel trade in Europe. Country report: Lithuania, EUBIONET III, 2009, 36 p.

Fáber, A., WP2 – Biomass fuel trade in Europe. Country report: Slovakia, EUBIONET III, 2009, 17 p.

Hinge, J., WP2 – Biomass fuel trade in Europe. Country report: Denmark, EUBIONET III, 2009, 26 p.

Junginger, M., WP2 – Biomass fuel trade in Europe. Country report: The Netherlands, EUBIONET III, 2009, 19 p.

Junginger, M., van Dam, J., Alakangas, E., Virkkunen, M., Vesterinen, P. & Veijonen, K., Solutions to overcome barriers in bioenergy markets in Europe – D2.2. EUBIONET III, 2010, 56 p.

Kropac, J., WP2 – Biomass fuel trade in Europe. Country report: Czech Republic, EUBIONET III, 2009, 9 p.

Martikainen, A., WP2 – Biomass fuel trade in Europe. Country report: Germany, EUBIONET III, 2009, 37 p.

Nibbi, L., WP2 – Biomass fuel trade in Europe. Country report: Italy, EUBIONET III, 2009, 17 p.

Olsson, O., Hillring, B: & Cardoso, M., WP2 – Biomass fuel trade in Europe. Country report: Sweden, EUBIONET III, 2009, 22 p.

Panoutsou, C. & Perry, M., WP2 – Biomass fuel trade in Europe. Country report: United Kingdom, EUBIONET III, 2009, 17 p.

Pieret, N., WP2 – Biomass fuel trade in Europe. Country report: Belgium, EUBIONET III, 2009, 17 p.

Rathbauer, J. & Sulzbacher, L., WP2 – Biomass fuel trade in Europe. Country report: Austria, EUBIONET III, 2009, 20 p.

Robles Fernández, S., Manso Ramírez, a. & Ramírez Fernández A., WP2 – Biomass fuel trade in Europe. Country report: Spain, EUBIONET III, 2009, 24 p.

Rørstad, P. K. & Solberg, B:, WP2 – Biomass fuel trade in Europe. Country report: Norway, EUBIONET III, 2009, 21 p.

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EUBIONET III – Fact sheet 18, XXX, Slovenia. ApE, X p.