COMBUSTION OF BIOMASS IN FOSSIL POWER PLANTS IN THE CZECH REPUBLIC

[*]Jiří Beneš, [**]Zbyněk Martínek,
Department of Electric Power Engineering and Ecology, Faculty of Electrical Engineering,
University of West Bohemia in Pilsen, Univerzitní 26, 306 14 Plzeň, Czech Republic
[*]tel. +420 471 114 177, E-mail: jbenes@kee.zcu.cz
[**]tel. +420 377 634 376, E-mail: martinek@kee.zcu.cz

SUMMARY

This paper deals with the issue of combustion of biomass in the existing fossil fuel power stations in the Czech Republic. The first parts are focused on ecological and social advantages resulting from development of renewable sources in energetic. In the next part, the influence of the state support on the combustion of biomass for generation of electric power is considered. The calculation in the last part of this paper demonstrates economic efficiency of biomass combustion in midsized source of power.

Keywords: *advantages of using biomass, bio fuel, combustion, emission allowances (EUA), European Energy Exchange (EEE), fossil fuels, solar radiation*

1. INDRODUCTION

Combustion of biomass in fossil fuel power stations is a trend which has recently become popular among the experts.

Generally, it is possible to say, that energy accumulated in plant material is very ecological. Solar radiation causes photosynthesis with chlorophyll in the green leaves of the cultivated plants and energy starts to transform into the form of solid carbonic matters. During combustion of these materials (biomass) is desorbed only such amount of energy, that was put with the sunshine before.

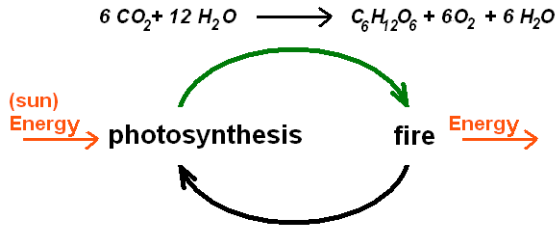

Fig.1 Energy scheme of photosynthesis

Combustion of biomass has many advantages in comparison with other forms of solar power conversion (e.g. photovoltaic, solar collectors). First, the way of using energy is based on the already proven process, without significant need for new technological equipment. Second, the price for biomass is quite acceptable and guaranteed.

Another reason for use of biomass as a power source is the fact, that it can be used just at the moment, when the demand for energy evolves.

2. FOSSIL FUELS

2.1. Reserves of fossil fuels

Using of the renewable sources is the one of alternatives for our society, how to manage limited fuels. It is no secret, that the reserves of the mostly used fuel, the soft coal, have been decreased in our surroundings during last decades. Nowadays it is expected that they should be exploited in next few several decades.

Coal	200 – 250 years
Oil	40 – 50 years
Natural gas	60 – 70 years

Tab.1 Forecast of the fuel reserves in the world

2.2. Technical possibilities of combustion in the power stations

The power plants generating the electricity on the basis of combustion of solid fuels represent the largest portion of the whole energy system. They have been gradually improved since industrial revolution. Nowadays, no subsequent development of technology and dramatic and fundamental increase of their efficiency are expected in the near future.

Fossil power stations are usually equipped with pulverising (granulation), fluid or grating boilers, depending on the importance of the heat as the primary output and depending on the kind of fuel. In

this respect, the grating and fluid boilers seem to be most suitable for combustion of biomass.

Technical facilities fuelling biomass has efficiency 80 – 91%.

Solid fuel	A^d %	Fluid in the solid %
Brown coal	3 ÷ 33	20 ÷ 55
Bituminous coal	3,7 ÷ 17	10 ÷ 40
Biomass –wood	2 ÷ 3	70 ÷ 85
Biomass -filings	< 1	70 ÷ 85
Biomass -grass	4,2 ÷ 5,8	70 ÷ 75
Biomass -straw	3,5 ÷ 6,5	70 ÷ 82
Biomass –bran	3 ÷ 5	70 ÷ 80

Tab.2 Ash and fluid contents in the solid

In comparison with other fossil fuels, biomass comprises bigger volume of fluid materials; on the other hand, the amount of non–combustible and brimstone materials is nearly zero.

Solid fuel	Chemical elements in the solid %				
	C	O	H	N	S
Brown coal	68,3	21,2	5,8	1,6	2,35
Bituminous coal	85,9	5,9	4,8	1,7	1,2
Biomass –wood	50,5	43,5	5,8	0,1	0,0
Biomass -filings	60,0	41,0	7,7	0,1	0,1
Biomass -grass	47,6	44,4	6,9	0,9	0,2
Biomass -straw	51,7	41,2	5,8	0,6	0,1
Biomass –bran	40,1	51,1	5,5	2,8	0,3

Tab.3 Chemical elements in the solid

Combustion of bio fuel is relatively clean and so contributes to the reduction of air pollution in our environment.

3. INFLUENCE OF THE STATE SUPPORT ON BIOMASS COMBUSTION

The price of biomass is higher in contrary to other fossil fuels. The state support is therefore inevitable. The state can support production of "green" energy from biomass mainly with the following ways:

A) Endowment for "green" energy production

According to the Czech laws, the level (amount) of the state support depends on the manner by which is biomass combusted. For purpose of the table below, these defined terms are respected: for common combustion of coal and biomass (symbol S), for parallel combustion of coal and biomass (symbol P) and for pure combustion of biomass (symbol O).

The Czech law also defines the categories of biomass for purpose of calculation of support:- grown biomass (index 1), brown biomass (index 2) and white biomass (index 3).

The minimal redemption price for electric power produced from biomass has been guaranteed and fixed for at least next 15 years.

2006	Endowment	Advantaged price
Category S1	Green bonus	1.180 CZK/MWh
Category S2	Green bonus	850 CZK/MWh
Category S3	Green bonus	540 CZK/MWh
Category P1	Green bonus	1.430 CZK/MWh
Category P2	Green bonus	1.100 CZK/MWh
Category P3	Green bonus	790 CZK/MWh
Category O1	Redemption	2.930 or 1.960 CZK/MWh
Category O2	price or	2.600 or 1.630 CZK/MWh
Category O3	Green bonus	2.290 or 1.320 CZK/MWh

*) 1 EUR = about 30 CZK

Tab.4 Endowment of power production from biomass

This policy has been relatively effective in the Czech Republic over past two years. The figure below shows how much of the electric power was produced from biomass in the Czech Republic in last years.

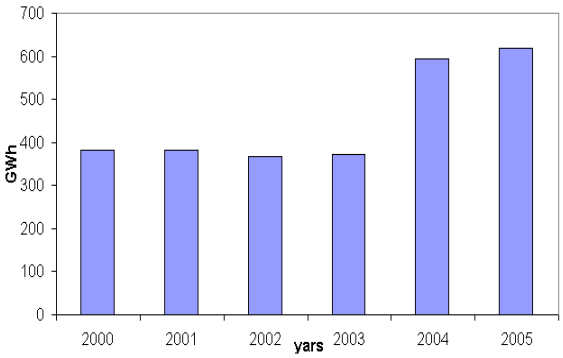

Fig. 2 Gross production of electric energy from biomass in the Czech Republic

B) Control of the CO_2 emission output

Biomass is environmental friendly fuel which does not cause increase of CO_2emissions. For producers of electric power, it is advantageous to combust biomass in existing power plants and to sell

emission allowances (EUA), which were given to them and which have not been used, at the exchange.

Figure below shows prices of EUA at the European Energy Exchange (EEE) in Leipzig.

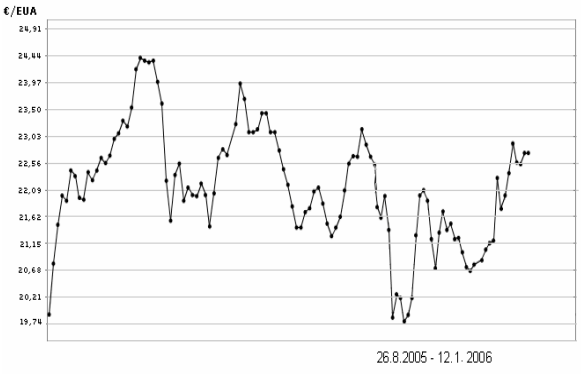

Fig. 3 Course of prices of EUA at the EEE

4. ECONOMIC EFFICIENCY OF BIOMASS COMBUSTION

In final part of this article, we present the demonstration of model calculation of economic efficiency in midsized power plant, which combust bio fuel (brown biomass) and coal in common.

4.1 Precondition

Heating plant has cogeneration unit and grate boiler without desulphurization unit. Fossil fuel is brown coal supplied by the company MUS, a. s, with characteristic 163 ps3, biomass are wood chips.

Specific heat consumption for supply of electric power	12 GJ/MWh
Price of energy in coal (with transport)	55 CZK/GJ
Price of energy in biomass (with transport)	110 CZK/GJ
Relative content of sulphur	0,8 %.
Calorific capacity of coal	11,4 GJ/t
Calorific capacity of biomass-crushed wood	11 GJ/t

4.2 Results of operational calculation:

Emission of CO_2 from coal	1,32 t/MWh
Emission of SO_2 from coal (95% SO_2 in waste gases)	13,3 kg/MWh
Emission of ash - coal (Ad=29%)	305 kg/MWh
Emission of ash - biomass (Ad=2%)	21 kg/MWh

4.3 Economic effect for supply of electric power:

Proceeds from selling EUA (21€/EUA)	831,6 CZK/MWh
Tariff for storage of ash (300 CZK/t)	85,2 CZK/MWh
Tariff for output of SO_2 (1000 CZK/t)	13,3 CZK/MWh
Fuel expenses for supply of electric power from coal:	660 CZK/MWh
Fuel expenses for supply of electric power from biomass:	-1.320 CZK/MWh
"Green bonus" in category S2	850 CZK/MWh
Profit before tax **Tax** **Net profit**	**1.120,1 CZK/MWh** **-268,9 CZK/MWh** **851,2 CZK/MWh**

*) 1 € = about 30 CZK

**) Without impact of possible new capital costs and without impact on own consumption of electric power in heating plant.

5. CONCLUSION

The use of biomass as a renewable source of energy is the easiest and the cheapest solution under present conditions. Current technological units of both fossil fuel power stations and heating plants can be used in this way without considerable problems. Moreover, this solution can be considered in some cases as economic advantageous. For all these things it is possible to expect that the trend of producing of electric power from biomass will be relevant in future as well.

This paper was written as a part of the MPO ČR project Ev. N. 2A-2TP1/051/2007.

REFERENCES

[1] Pastorek Z., Kára J.: Biomasa, FCC PUBLIC, Praha, 2004

[2] www.i-ekis.cz

[3] Bufka A: Obnovitelné zdroje energie a energeticky využívané odpady v roce 2004 ,MPO, Praha 2004

[4] ERO Price Decision No. 10/2005 of 18 November 2005 Price determination for electricity and related services and minimum redemption prices and specified conditions applicable to electricity supplied by producers of electricity from combined heat & power plant and to electricity supplied by generators of electricity from renewable sources

[5] MPO (Ministry of Industry and Trade of the

Czech Republic) www.mpo.cz
[6] ERU (The Energy Regulatory Office) www.eru.cz
[7] www.biom.cz
[8] Energy company CEZ, a. s., www.cez.cz

BIOGRAPHY

Ing. Jiří Beneš graduated at Faculty of Electrical Engineering, West Bohemia University in Pilsen in 2003. Now he is an external post graduate (Ph.D.) student. Thesis title is "Appraisal of system of centralized heating supply with regard to upcoming of planned building of new gas end electric network in households and enterprises". He is employed by ČEZ Group.

Doc. Ing. Zbyněk Martínek, CSc. was born on 22.4.1955. He finished his university study in 1983 (M.Sc.Eng.) in specialization Electric Power Engineering, Institute of Technology Pilsen. Professional practice: 1983-1984 Scholarship Holder, Institute of Technology in Pilsen, 1984-1986 Teacher I, II, Institute of Technology in Pilsen, 1986 Lecturer-Science Study, 1989 Senior Lecturer, Institute of Technology in Pilsen, 1990 Ph.D. (CSc.) in Power Engineering, University of West Bohemia in Pilsen, 1997 Associate Professor, 1997 till now Associate Professor at University of West Bohemia in Pilsen, Department of Electric Power Engineering and Ecology.