Development of the Efficient Biomass Heat Plant and Distribution Network

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Development of the Efficient Biomass Heat Plant and Distribution Network: *The current paper provides an overview of one of the most current national projects in Bulgaria to use biomass in the form of wood waste as a renewable energy source and erecting the energy plant as well as the facilities needed. The current work focuses on description of procedures for estimation of energetic value of wood biomass and provides results in different units.*

Key words: *Wood biomass, Heat distribution network.*

INTRODUCTION

The current project is develop on the basis of preliminary engineering studies for the possibility of burning wood waste in a biomass boiler and extension of the existing heat distribution network with the following main objects in the field of power generation:

- generation and distribution of thermal energy from renewable sources;
- design, construction and operation of facilities used in generation, distribution and supply of energy against payment on the basis of renewable energy sources;
- construction and operation of pipelines for direct supply;
- operating a heating billing system, reporting and collecting payments from consumers of thermal energy;
- district-heating projects in residential and hotel construction, specialized construction work (high-rise and deep building).

BIOMAS PRODUCTION POTENTIAL

The project goal is the sale of thermal energy for heating needs of the consumers by using the energy of renewable energy sources, such as biomass in the form of wood waste, as well as construction of a heat distribution network to the energy consumers.

The project involves the construction of a boiler heating plant for the purposes of generation, distribution and consumption of thermal energy through burning biomass in the form of wood waste, as well as construction of a network.

Biomass will be collected and transported in the area of the Ihtiman municipality within a radius of 20 km of the location of the boiler plant. Biomass will be stored in an open-air storage on the site for a period of 6 months.

The storage will be provided with a wood chipper where larger pieces are turned to chips mechanically. Wood chips will then be transported to closed storage, which ensures uninterrupted operation of the plant at full load for 3 weeks.

The project involves erecting a building to house the boiler plant, delivery and installation of a heating boiler burning biomass with 3.0 MW installed heating capacities, an open-air storage, a fuel conveyer, a feed system, and a system for ash collection and removal. The investment project involves construction of a district heating network, refurbishing and construction of district-heating substations.

The thermal energy generated by the heating plant at the average temperature of 110^0C will be fed to 30 administrative, residential and public buildings within the town of Ihtiman.

The heating plant construction consists of two stages. The first stage will be implemented and design and development of the following sub-facilities:

- boiler premises;
- open warehouse for fuel (wood biomass);
- pump premises;

- delivery and construction of a biomass boiler plant manufactured by Polytechnik Luft und Feuerungstechnik GmbH - Austria.

The second stage of the heating plant construction includes construction of the second stage of the distribution mesh.

The thermal energy production of the second stage of the distribution mesh is with the sales values at the amount of 9,300 MWh.

SUMMARY OF PROJECT RESULTS

The goal of the project is the production and use of thermal energy for heating needs of the consumers by using the energy of renewable energy sources, such as biomass in the form of wood waste.

The allocation of annual biomass project revenues is realized after the whole project completion - shown at the diagram of Figure 1.1.

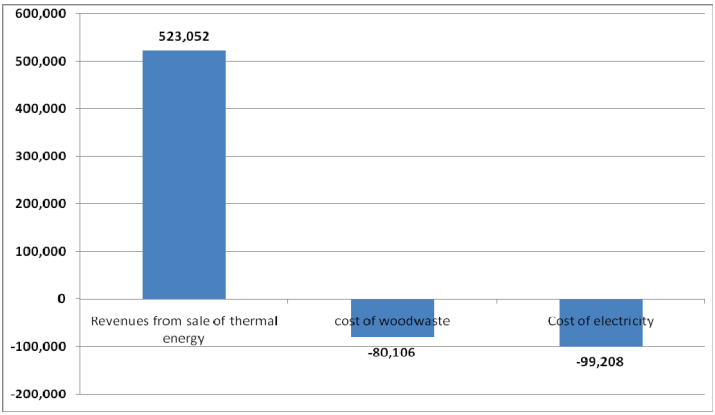

Fig.1.1. Annual Revenues Resulting from Project Implementation

Table 1.2 summarizes the output of the biomass energy project implementation for the overall project implementation period up to 2027 in cash equivalent.

Table 1.2. Total Project Revenues

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2027
Wood Waste	(t/yr.)	-1,626	-3,917	-3,917	-3,917	-3,917	-3,917	-3,917	-3,917	-3,917	-3,917
Electricity	(MWh/yr.)	-803	-1,934	-1,934	-1,934	-1,934	-1,934	-1,934	-1,934	-1,934	-1,934
Thermal Energy Sold to Consumers	(MWh/yr.)	3,861	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300	9,300
Operation and Maintenance Costs	(EUR/yr.)	28,955	28,955	28,955	28,955	28,955	28,955	28,955	28,955	28,955	28,955
Tariffs											
Wood Waste	(EUR/t)	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5	20.5
Electricity	(EUR/MWh)	51.3	51.3	51.3	51.3	51.3	51.3	51.3	51.3	51.3	51.3
Thermal Energy Sold to Consumers	(EUR/MWh)	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2	56.2
Revenues											
	(EUR/yr.)	142,721	343,737	343,737	343,737	343,737	343,737	343,737	343,737	343,737	343,737
	(EUR/yr.)	-28,955	-28,955	-28,955	-28,955	-28,955	-28,955	-28,955	-28,955	-28,955	-28,955
Gross Profit	**(EUR/yr.)**	**113,766**	**314,782**	**314,782**	**314,782**	**314,782**	**314,782**	**314,782**	**314,782**	**314,782**	**314,782**

The expected quantity of thermal energy sold to the heat energy consumers of Ihtiman area is 9,300 MWh/yr., which will lead to annual revenues in the amount of EUR 523,052.

After the construction of the biomass boiler plant using wood waste as a fuel, the wood waste consumption will amount to 3,917 t/yr. and the wood waste costs will amount to EUR 80,106. The total result of biomass energy project will be an increase in the electricity consumption for own needs by 1,934 MWh/yr., which will lead to increase of the electricity costs to the total value of EUR 99,208.

The expected annual gross profit as a result of the implementation of this project amounts to EUR 314,782.

The annual combustion of 3,917 tons of wood waste shall replace the usage of 1,053 tons of light fuel oil. This substitution results in annual CO_2 emissions reduction to the amount of 2,920 tons. As a result of the substitution of light fuel oil combustion with wood waste, for the period 2008 - 2012 the CO_2 emissions reduction amounts to 12,894 tons.

However, from 2008 until 2012, the CO_2 emissions will increase by 7,758 tons due to electricity usage for the needs of the biomass boiler plant and with 7 tons due to transportation of the waste to the boiler plant.

The total effect from the biomass energy project will result in CO_2 emissions reduction with 5,116 tons for the period 2008 - 2012. The CO_2 emissions reduction for the period 2008 - 2012 is presented in Table 1.3.

Table 1.3. Carbon Dioxide Emissions Reduction

Emission characteristics		2008	2009	2010	2011	2012	**Total**
Light Fuel Oil Savings	(t/yr.)	437	1,053	1,053	1,053	1,053	**4,649**
Light Fuel Oil Savings	(GJ/yr.)	17,277	41,611	41,611	41,611	41,611	**183,723**
Carbon Emission Factors for Light Fuel Oil	(tCO_2/GJ)	0.0702	0.0702	0.0702	0.0702	0.0702	
CO_2 Emissions Reduction from Light Fuel Oil Savings	(tCO_2/yr.)	1,213	2,920	2,920	2,920	2,920	**12,894**
Electricity Savings	(MWh/yr.)	-803	-1,934	-1,934	-1,934	-1,934	**-8,539**
Carbon Emission Factors for Electricity	(tCO_2/MWh)	1.059	0.947	0.908	0.884	0.833	
CO_2 Emissions Reduction from Electricity Savings	(tCO_2/yr.)	-850	-1831	-1756	-1710	-1611	**-7,758**
Light Fuel Oil for Transportation	(t/yr.)	0.6	1.4	1.4	1.4	1.4	**6.3**
Carbon Emission Factors for Transportation	(tCO_2/t)	3.14	3.14	3.14	3.14	3.14	
CO_2 Emissions Reduction from Transportation	(tCO_2/yr.)	-1.9	-4.5	-4.5	-4.5	-4.5	**-20**
Carbon Emission Reduction	**(tCO_2/yr.)**	**360**	**1,084**	**1,160**	**1,206**	**1,305**	**5,116**

RISK AND SENSITIVITY ANALYSES

In order to test the robustness of the financial results of the project, several sensitivity scenarios that have the potential to threaten the financial viability of the project were developed. The cases included project cost overrun, start-up delay, net operating cash decrease due to wrong implementation or bad exploitation of the system, and finally the worst case scenario, which is a combination of all three scenarios.

The analysis shows that cost deviations from the base case during the project construction and operation can lead to significant deterioration of project financial results. Under the worst case scenario, which combines the analysed risks, the project financials are the following: the payback period is 8.2 years, the IRR is 8.3%, and the NPV is negative and amounts to EUR –192,022.

ASSESSMENT OF IMPACT OF PROJECT ON ENERGY BALANCE

The installed hot water boiler plant burning biomass is with total thermal output of the boiler – 3.0 MW and will generate thermal energy to the amount of 9,300 MWh/yr.

According to the published energy balance, the total annual final energy consumption in the country is 8,520 K tons of crude oil equivalent, 639 K tons of which are attributed to

biomass.

The estimated produced thermal energy from the biomass boiler plant is 800 tons of crude oil equivalents, i.e. 0.0387% of the total annual final energy consumption and 0.125% of the total biomass consumption.

CONCLUSIONS

The project described involves the construction of a boiler heating plant for the purposes of generation, distribution and consumption of thermal energy through burning biomass in the form of wood waste, as well as construction of a network.

The project involves erecting a building to house the boiler plant, delivery and installation of a heating boiler burning biomass with 3.0 MW installed heating capacities, an open-air storage, a fuel conveyer, a feed system, and a system for ash collection and removal. The investment project involves construction of a district heating network, refurbishing and construction of district-heating substations.

The thermal energy production of the distribution mesh is with the estimated sales values at the amount of 9,300 MWh.

As a major conclusion, the risk analysis shows that under the worst case scenario the investments would have the payback period of 8.2 years.

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