2003 CDM/JI Project Study

Feasibility Study on the Fuel Conversion of the Existing Heat Supply Plants from Coal to Biomass Provided through Willow Afforestation in Republic of Poland

Report

Summary

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1. Overview and Objectives of These Studies

Poland is preparing various systems for their May 2004 entry in the EU. This includes systems that have to do with energy use, in order to satisfy EU mandates. Parallel to this, Poland ratified the Kyoto Protocol in December 2002 and is, therefore, also preparing systems for the mechanisms and certifications handled thereunder. One particular highlight of their commitment to the Kyoto Protocol was Poland's signing of a Memorandum of Understanding (MOU) on Joint Implementation (JI) with the current Dutch government and Canadian government.

As for the energy situation in Poland, 97% of all domestically generated power (138.8 TWh in 2000) comes from coal-fired power generation. Moreover, coal accounts for a large portion of the fuel used to supply heat (steam and hot water).

Given the circumstances, the Polish government turned their attention to the effective use of renewable energy resources as a means for reducing greenhouse gases (GHGs) emissions and thereby hammered out a policy to aggressively promote the introduction of renewable energy resources. Specifically, targets are set to obtain 2.6% of the domestic primary energy from renewable energy resources in 2003, and to increase this figure to 7.5% by 2010 and 14% by 2014[1]. In order to generate power using renewable energy resources, Poland have introduced a system for purchasing "green power" at a price higher than ordinary power rates.

Given the aforementioned situation, a project aimed at reducing GHGs is proposed as a modernization plan for a coal-fired heat supply plant in Plonsk, Poland. The proposal has two plans; one is to remodel the existing heat supply unit for fuel conversion from coal to woody biomass and the other one is to replace one of the existing units with a woody biomass-fired CHP (Combined Heat and Power) unit. A particular note about the proposal is the use of willow trees as woody biomass fuel. A stable supply of this biomass fuel is assumed to come from local afforestation (energy plantations).

With the objective of materializing either the proposed remodeling project or the proposed brand-new CHP project, this feasibility study estimates the project cost and investment effect (revenue, expense and GHGs reduction effect) of these two plans, based on findings of local surveys of the existing heat supply plant. This study also examines what sort of effect any acquired CO_2 credits might have on project feasibility.

Also, we visited concerned authorities of the Polish government for the purpose of exchanging opinions as to whether this project would be qualified as a JI project or not.

[1] "Strategy for the Development of Renewable Energy Sector", Poland

2. Local Facts

2.1 Plonsk City

The city of Plonsk currently owns and operates a heat supply plant that serves the city with hot water and large users such as factories with steam. However, the plant facilities are worn and it is their intention to (1) modernize the facilities and, in the process, (2) convert the fuel from coal to more environmental-friendly fuel in order to reduce not only environmental load but also heat production costs. They are particularly interested in using "plantation-grown willow trees" as woody biomass fuel. They believe that, by adopting willow plantation for their fuel procurement, they can create new business and jobs for farmers in the area around Plonsk.

2.2 PEC Plonsk

PEC Plonsk is the public company for heat supply that serves the city with hot water and factories with process steam. The heat supply plant consists of offices, boiler rooms, coal stockyard, ash storage yard, power receiving facilities, cooling water storage tanks and more. The plant has three indoor coal-fired boiler units for steam supply (in service since 1978) and two indoor coal-fired boiler units for hot water supply (in service since 1978 and 1993, respectively).

PEC Plonsk has 64 employees and sells about 200,000 GJ of heat annually. Their annual sales are about 7.4 million PLN (approx. 222 million JPY)[2], while costs are about 7.5 million PLN (approx. 225 million JPY). Both of these financial figures come from 2002 records, indicating that the heat supply business was in debt that year.

The heat demand supplied by PEC Plonsk has dropped about 30% over the past five years because of energy-saving (improving of insulation performance, etc.) taken by end-users of hot water and a decrease in steam demand by large factories. Most of the demand today is for hot water. However, the rate of demand decrease has slowed and it is believed it will remain at what it is today in the future. As for steam demand, there is very little today and future plans for steam demand have not been decided yet, but PEC Plonsk intends to keep two out of three steam boilers running and find new customers.

3. Project Description

3.1 Heat Supply Unit Remodeling Plans

3.1.1 Survey of the Existing Heat Supply Plant

The heat supply plant is located in the industrial zone of Plonsk and has a 29,171m^2 site. When it started operation in 1978, PEC Plonsk serves the city with

[2] PLN: Polish zloty. Monetary figures in this report are converted at 1 PLN = 30 JPY

hot water and process steam with nearby factories. The rated capacity of the plant was 11.6 MWth (WR-10) for hot water supply and 36 MWth (OR-16 [12 MWth] x 3) for steam supply in 1978. Then, in 1993, they added another hot water supply boiler of 26 MWth (WRp-23) because of an increase in hot water demand.

Hot water supply is 23 MWth in winter when faced with maximum demand and 2 MWth in summer when demand is the lowest. From October to April, the plant runs at the efficiency of 80% or more, while from May to September at the efficiency of 60 - 65%, indicating a considerable difference in plant efficiency across the year.

The hot water supply system is a closed circulatory system. Hot water is going out of the plant at about 130 degrees centigrade to heat exchangers located on 44 substations in the city. After heat exchange, water is coming into the plant at about 70 degrees centigrade.

The boiler fuel is domestically mined coal at present. The coal is brought in by freight cars from the mines in the south about 400 km away from Plonsk and stored in the coal stockyard at the plant.

3.1.2 Remodeling Plan: Coal >> Woody Biomass (Plan 1)

In order to reduce coal consumption as much as possible, the WR-10 boiler is selected as the boiler that will be remodeled for fuel conversion from coal to biomass-fuel, because of its high availability factor.

Designs for remodeling are based on the rated output of 11.6 MWth, which is the same output as WR-10, after the fuel conversion. Designs are worked out to use existing equipment - boiler and auxiliary facilities such as fuel supply system, flue gas treatment system and ash treatment system - as much as possible in order to reduce costs. As a result, it is determined that the flue gas treatment system does not require remodeling and the boiler will be remodeled only to compensate the change in fuel and an increase in fuel consumption rate. The main specifications after remodeling are listed in Table 1.

Table 1 Main specifications after remodeling for biomass-fuel

Item		Specification
Heat output	MWth	11.6
Boiler efficiency	%	75
Fuel consumption	ton/h	4.7

3.1.3 Brand-new CHP Plan (Plan 2)

The brand-new CHP is designed as follows.

Location for CHP Installation

Out of the existing five heat supply units, the OR-16 boiler for steam supply that

is located in the middle of three OR-16 boilers is seriously damaged and cannot be operated at present. A brand-new CHP boiler, therefore, is installed the place where the middle one among three OR-16 boilers is right now, after the middle OR-16 will be removed.

System Heating Capacity

As with Plan 1, heat output capacity would cover the 11.6 MWth, which is the same output as WR-10 that has the high availability factor.

It would also be built to handle heat demand changes from zero to 11.6 MWth and the extraction steam from the steam turbine for power generation would be used as heat source for hot water supply.

Power generation Capacity

Since there is spatial constraint for the brand-new CHP boiler, the CHP boiler would also have capacity limitation. But it would be necessary to cover heat output of 11.6 MWth. Therefore, in consideration of boiler capacity and heat capacity, power generation capacity is settled on 3 MW, which would optimize total efficiency of the CHP unit. The CHP is designed to be able to dispatch 3 MW throughout the year, regardless of changes in heat demand.

The main specifications of the new CHP are listed in Table 2.

Table 2 Main specifications of brand-new CHP

Item		Specification
Power output	MW	3.0
Heating output	MWth	11.6
Rated efficiency (total)	%	67.4
Fuel consumption	ton/h	6.6

3.2 Heating Plant Operation Plans

In order to compare the effect (fuel consumption, heat supply, power generation, power received, etc.) of the aforementioned two plans, it is assumed to supply the same heat demand as indicated in the 2002 operation records obtained from PEC Plonsk. Simulation results are summarized in Table 3.

Table 3 Energy balance in project implementation

			Record in 2002		PLAN1		PLAN2		
			WR-10	WRp-23	WR-10	WRp-23	WR-10	WRp-23	CHP
Unit Capacity									
	Heat	MWth	11.6	23.0	11.6	18.0*	11.6	18.0*	11.6
	Electricity	MWe	—	—	—	—	—	—	3.0
Energy supply									
	Heat	TJ/yr	132.9	115.5	183.8	64.6	3.0	48.2	197.2
	Electricity	GWh/yr	—	—	—	—	—	—	24.4
Power consumption									
	Electricity	GWh/yr	1.4	0.9	2.0	0.9	0.03	0.9	4.0
Fuel consumption									
	Coal	TJ/yr	189.0	147.0	—	82.2	4.3	61.3	—
		1,000 ton/yr	9.0	7.0	—	3.9	0.2	2.9	—
	Willow	TJ	—	—	273.1	—	—	—	542.8
		1,000 ton/yr	—	—	23.1	—	—	—	46.0

(* Output after environmental remodeling of the boiler planned for around 2006 changes from 23 MWth to 18 MWth.)

3.3 Biomass Fuel Procurement Plan

3.3.1 Willow plantation in Poland

Some of universities in Poland are currently researching diverse uses of willow trees, such as a material for furniture and medicines. For this purpose, test-plantation is underway in some places. Also, research has already been launched into using willow trees as biomass fuel.

3.3.2 Fuel Properties

In this project, it is assumed that harvested willow, whose moisture content is 46% just after harvested, is stored and dried naturally on plantation. As a result, the moisture content is expected to become down to 35%. Thereafter the dried willow is transported to PEC Plonsk. For the willow in these calculations, a calorific value of 11.8 GJ/ton (35% moisture content) is adopted.

3.3.3 Required Acreage of Willow Plantations

The willow plantation acreage needed to supply the biomass fuel requirement for implementing the projects in Table 3 is given in Table 4.

Table 4 Required plantation acreage

	Required acreage
PLAN 1	Approx. 705ha
PLAN 2	Approx. 1,398ha

(118.98 ton/ha harvested every 3 years at 3-year harvest cycles.)

4. Studies relating to GHG Emissions

4.1 Baseline

The “baseline” is established as the continuance of heat supply by burning coal with the existing heat supply units. Since heat demand changes every year because of the weather and temperature fluctuation, and coal consumption changes as well. The “baseline” emission of each year is to be set according to the heat demand change of each year.

More specifically, the CO_2 emission factor resulting from the heat supply in the base year (provisionally set as 2002 in this report) and the average CO_2 emission factor calculated from all power sources in Polish national power grid are fixed, and CO_2 emissions are calculated according to the heat demand and power consumption of each year.

The “baseline” emission from the power generated in Plan 2 is calculated on an assumption that, if this project is not implemented, the amount of power that would have been generated by this project would be supplied by the existing power sources connected to the Polish national power grid.

4.2 Setting of Project Boundary

The boundary of this project is limited to the main facilities of PEC Plonsk that emit GHGs as a result of “fuel combustion” and “power consumption for the operation of the heat supply facilities”.

4.3 Duration of the Project Activity and Crediting Period

4.3.1 Duration of the Project Activity

Taking into consideration the lifetime of the equipment, the project activity period of this project is set as 20 years.

4.3.2 Crediting Period

The crediting period of this project is the five years from 2008 - 2012, or the first commitment period of the Kyoto Protocol.

4.4 Monitoring Data and Data Collection Methodology

The following 4 types of data are to be monitored: (1) coal consumption, (2) hot water supply calorific value, (3) electric power purchased from the national grid, and (4) power generation from the new CHP (for Plan 2).

The coal consumption is to be monitored and recorded every hour by weighing the loaded amount of the coal on a scale. The calorific value of the hot water supplied is to be calculated by monitoring and recording the amount and temperature of the hot water every hour. The electric power purchased from the national grid is to be recorded directly from bills for 3 months power purchase amount. The amount of power generated from the new CHP is to be monitored and recorded every day using a wattmeter set up at the end of the generator.

4.5 GHG Reduction Effect

4.5.1 Calculation of GHG Emissions from Activities

Baseline Emissions

Baseline emissions are calculated from the CO_2 emissions resulting from coal burning, the power consumption at the plant that is purchased from the national grid, and the power generation on the national grid (same amount that is to be generated by the CHP). In this report, 2002 achievement values are used for those data. The amount of the heat supply of each year from this project is assumed to be the same as that in 2002. Results are given in Table 5.

Table 5 Baseline emissions in Plan 1 and Plan 2

CO_2 emissions from coal burning **(A)**	31,150 [t-CO_2/yr]
CO_2 emissions from power consumption **(B)**	2,315 [t-CO_2/yr]
CO_2 reductions by generated power from CHP to the grid **(C)**	24,047 [t-CO_2/yr]
Baseline emissions of Plan 1 (D=A+B)	**33,465 [t-CO_2/yr]**
Baseline emissions of Plan 2 (E=A+B+C)	**57,512 [t-CO_2/yr]**

GHG Emission and Reduction through the Project Activity

The emission of GHGs and the reduction through the activity are given in Tables 6 and 7, respectively.

Table 6 Emission and reduction from PLAN 1 implementation

CO_2 emissions from coal burning **(F)**	7,622 [t-CO_2//yr]
CO_2 emissions from power consumption **(G)**	2,936 [t-CO_2//yr]
Emission from PLAN 1 implementation (H=F+G)	**10,558 [t-CO_2/yr]**
Reduction from PLAN 1 implementation (=D-H)	**22,907 [t-CO_2/yr]**

Table 7 Emission and reduction from PLAN 2 implementation

CO_2 emissions from coal burning **(I)**	6,082 [t-CO_2/yr]
CO_2 emissions from site power consumption **(J)**	4,929 [t-CO_2/yr]
Emission from PLAN 2 implementation (K=I+J)	**11,011 [t-CO_2/yr]**
Reduction from PLAN 2 implementation (=E-K)	**46,501 [t-CO_2/yr]**

5. Contribution of the Project to Sustainable Development

As Poland is about to join the EU (planned in May 2004), the expansion of renewable energy sources in Poland is an urgent issue. Hence, it has a very forward-looking approach to the proposal of introducing wood biomass fuel. This project is not only 'increase the share of renewable energy sources', but, by converting the currently used 'coal' to 'biomass', it can also reduce the emission of pollutants (SO_2, NO_2, Ash, etc.) generated from the combustion with the existing facilities. Therefore, it is expected to contribute protection of air pollution to Plonsk City, and by this token to Poland

nationwide.

If a brand-new CHP is introduced to the plant, not only the decrepit equipment that was built 30 or more years ago is to be completely renewed, but also improvement in plant efficiency can be expected as existing mono-generation system will be replaced with the latest CHP system. In Poland, other heat supply plants, which are as old as the plant owned by PEC Plonsk, are in full service. Accordingly, it is expected that the scheme of this project can be applied to other plants.

6. Project Profitability

6.1 Required Expense and Revenue

6.1.1 Estimation of Initial Investment

Initial investment is estimated at 4.6 million PLN for Plan 1 and 33.0 million PLN for Plan 2.

6.1.2 Project Cost and Project Revenue

The revenue and expense (one-year) as PEC Plonsk when the energy supply project proposed in this study will be implemented is given in Table 8. However, this does not include revenue from CO_2 credits.

Table 8 Estimated annual revenue and expense

[Million PLN]

Items	Current	PLAN1	PLAN2
Business revenue	7.31	7.31	13.41
Business expense	7.33	7.85	13.19
Annual balance	-0.02	-0.54	0.22

6.2 Cost Effect of GHG Reduction

Cost Effect of Plan 1

=22,907 t-CO_2/yr ÷(4.6 million PLN×30JPY/PLN)=166 t-CO_2/yr/million JPY

Cost Effect of Plan 2

=46,501 t-CO_2/yr ÷(33.0 million PLN×30JPY/PLN)=47 t-CO_2/yr/million JPY

6.3 Other Indices for Assessment

Based on the results of the preceding section, Plan 2 seems more feasible than Plan 1 in consideration of the absolute reduction in GHGs and the annual revenue and expense (excluding revenue from CO_2 credits). Therefore, Plan 2 was studied further.

6.3.1 Economic Feasibility of Plan 2

The internal rate of return for the first 20 years after the project launches would be 3.72%, therefore initial investment would be recovered in 14 years. (This case excludes revenue from CO_2 credits).

6.3.2 Sensitivity Analysis for Rate of Return Improvement of Plan 2

Reduction of Initial Investment

(Willow price: 10 PLN/GJ, Power price: 250 PLN/MWh)

According to the present estimate, if initial investment can be reduced by 30%, the internal rate of return would be 8.09% and the initial investment would, therefore, be recovered in 10 years.

Willow Purchase Price (Power price: 250 PLN/MWh)

If willows cost becomes 8 PLN/GJ (20% reduction), the internal rate of return would be 7.54%. If initial investment is reduced by 30% in addition to this, the internal rate of return would be 12.69%.

Green Power Selling Price

When price of green power is 280 PLN/MWh and price of willow is 10 PLN/GJ, the internal rate of return would be 6.37%. In addition to this, if initial investment is reduced by 30% and willow price is reduced to 8 PLN/GJ, the internal rate of return would be 15.43%.

CO_2 Credits

Considering profits from the CO_2 credits, the internal rate of return becomes 4.82% at 18 PLN/t-CO_2 (5 USD/t-CO_2)[3], 5.88% at 35 PLN/t-CO_2 (10 USD/t-CO_2) and 8.29% at 70 PLN/t-CO_2 (20 USD/t-CO_2). In order for the internal rate of return to exceed 15% with the assumed CO_2 credit price of 40 PLN/t-CO_2, which is lower than latest future price of CO_2 credit on the EU domestic market or 61 PLN/t-CO_2 (source: Point Carbon-27.Feb.2004), it becomes clear that simultaneous combination of reduction of initial investment, increase of "Green Power" sales rate, and decrease of willow price is inevitable in addition to considering the CO_2 credit price.

7. Status of Preparation for JI Projects in Poland

7.1 Possibility of the Project to be Approved as JI Project in Poland

In an effort to reduce GHGs in EU, plans are to allow EU countries to trade emission credits (EU-ETS) within EU starting from 2005. The EU-ETS applies to "Combustion installations with a rated thermal input exceeding 20MW". Upper limit of emission ("allowance") is set for above-mentioned installations. The "Operators" that attain the target can sell remaining "allowance" on the market, while the "Operators" that do not attain the target must either purchase credits to make up for the insufficiency or pay a penalty. It was said at the moment that "Combustion installations" that were subject to the EU-ETS could not be applicable to JI projects

[3] Monetary figures in this report are converted at 1 USD = 3.6 PLN

and that the CO_2 credits produced by the installations subject to EU-ETS could not be transferred to countries outside EU. According to the information heard from Poland's Ministry of Environment, however, EU candidate countries are also opposed to the scheme because it limits their ability to implement JI projects in their countries, and therefore EU is preparing for a draft amendment. At the time of this study, it was heard that this draft amendment would allow CO_2 credits produced by the installations subject to EU-ETS be converted into ERU, or CO_2 credits from JI, and that these ERU could be transferred to countries outside EU.

Polish Ministry of Environment and the National Fund for Environmental Protection and Water Management, which is in charge of treating initial JI project application in Poland, are considering the EU debate on the aforementioned matter and suggested that though the facilities of this project is to be subject to EU-ETS since the PEC Plonsk has combustion installations that uses more than 20 MW of fuel, the project could also be qualified as a JI project. However, they also suggested that the quantity of ERU that could be acquired should be negotiated between Polish government and the participant(s).

7.2 JI Policy of Poland

Though Polish JI policy Guidance is still being discussed within the Ministry of Environment, information regarding necessary JI procedures was obtained during the second survey. A JI project applied is screened and approved by an independent organization appointed by the Polish government. Moreover, Project Design Document (PDD) must be submitted to the National Fund for Environmental Protection and Water Management for checking the contents of the project. After that, the Ministry of Environment checks the same document by for approval. Then, the Ministry of Environment negotiates the allocation of CO_2 credits with the JI project participant(s). It is required that the following information is described in PDD.

- Official letter from the host country and all other participants
- Additionality assessment
- Baseline study
- Monitoring plan
- Analysis of Environmental impacts
- Description of Project
- Stakeholder comments

In addition, the PDD is open for public comments for 30 days through the secretariat of the United Nations Framework Convention on Climate Change (UNFCCC).