Biomass Retrofit at Borsod Power Plant
Baseline study

Final draft version

Prepared by:

Vertis Environmental Finance
Keleti Károly utca 11/a
1024 Budapest
Hungary

Tel: +36 1 438 0937
Fax: +36 1 438 0938
info@vertisfinance.com

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1. PROJECT DETAILS

1.1. Project characteristics

1.1.1. Supplier

Company name:	**AES Borsod Energetikai Kft. ("AES Borsod" or "Plant")**
Address:	Ipari u. 7
Zip code + city address:	3704, Kazincbarcika
Postal address:	P.O. Box 440, 3704, Kazincbarcika
Country:	Hungary
Contact person:	Mr. Istvan Ávéd
Job title:	Project director
Telephone number:	+36 48 320 157
Fax number:	+ 36 48 320 157
E-mail:	istvan.aved@aes.com
Bank/Giro number:	UBRT HUHB; 12046102-00149049-00100008
Bank:	Raiffeisen Bank Rt., 2-4 Bajcsy-Zsilinszky u., Miskolc, 3527, Hungary
No. of employees:	165
Company's main activity:	Electricity generation
Tax number:	11070447-2-05
Registration number:	Cg. 05-09-003017
Professional or trade register + city:	Companies Court of Borsod-Abaúj-Zemplén County, Miskolc

1.1.2. Corresponder

Company name:	**Vertis Environmental Finance Kft.**
Address:	Keleti Károly u. 11/a
Zip code + city address:	1024 Budapest
Postal address:	same
Country:	Hungary
Contact person:	Mr. Balázs Kis
Job title:	Analyst
Telephone number:	+36 1 438 0937
Fax number:	+36 1 438 0938
E-mail:	balazs.kis@vertisfinance.com

1.1.3. Project partners

Company name:	**Egererdõ Rt. (“Egererdõ”)**
Position in the project:	Fuel supplier
Visiting address:	Kossuth L. u. 18
Zip code + city:	3300, Eger
Postal address:	same
Country:	Hungary
Contact person:	Mr. László Jung
Job title:	General director
Telephone number:	+36 36 412 325
Fax number:	+36 36 413 207
E-mail:	egererdo@egererdo.hu
No. of employees:	741 (2001. January)
Company’s main activity:	Forest management
CPV number:	0201 (forestry and forest management) 11164511020111410 (Statistics Number)
Registration number:	Cg,.10-10020083
Professional or trade register + city:	Companies Court of Heves County, Eger
Date of registration:	1993. December 31st for the predecessor in title

Company name:	**Észak-Magyarországi Erdõgazdasági Rt. (“Északerdõ”)**
Position in the project:	Fuel supplier
Visiting address:	Deák tér 1
Zip code + city:	3525, Miskolc
Postal address:	P.O. Box 2, 3501, Miskolc
Country:	Hungary
Contact person:	Mr János Cserép
Job title:	General director
Telephone number:	+36 46 501 500
Fax number:	+36 46 501 505
E-mail:	cserepjanos@eszakerdo.hu
No. of employees:	725 (2001 average)
Company’s main activity:	Forest management,
CPV number:	0201 (forestry and forest management)
Registration number:	Cg. 0510000135
Professional or trade register + city:	Companies Court of Borsod-Abaúj-Zemplén County, Miskolc
Date of registration:	1994. February 9th

1.2. Project abstracts

Project title:	**Biomass retrofit at Borsod Power Plant**
Abstract:	The project, one of the largest renewable energy initiatives in Hungary, consists of a refurbishment and fuel switch of the brown-coal fired AES Borsod Power Plant and the establishment of a biomass fuel supply chain. In the current situation the Plant will be unable to operate on brown coal due to economic reasons and environmental obligations entering into force on 1st January 2005. The biomass will be firewood and forestry waste from the Northeast Hungarian region.
Host country:	Hungary
Project starting date:	2004. January 1st (The first boiler will be in operation form the first quarter of 2003 and the second boiler will be in operation from the fourth quarter of 2003)
Construction starting date:	2002. September
Construction finishing date:	2003. December

1.3. Background and justification

Since 1996, the Plant has been owned by AES Inc., one of the world's largest independent power producers. AES already operates four biomass-fired power plants, mostly in the USA.

AES Borsod is located in the Northeast of Hungary, in the valley of the Sajó river, near the city of Kazincbarcika (pop. 34.000). The Plant was originally constructed between 1951-1957 for the supply of power and heat to industrial facilities around Kazincbarcika.

The Plant is connected to the national electricity system by a 120kV cable. The Plant is also connected by a 35kV direct cable and by steam pipes to BorsodChem Rt. (Borsod Chemical Works, "BorsodChem"), which is one of the largest chemical plants in Hungary and currently produces mainly PVC products.

Major refurbishments were done at the boilers between 1978-1988 and a new flue gas cleaning system was also installed. The Plant was formerly the exclusive heat supplier and is still supplying heat to the district heating system of Kazincbarcika, where 63% of the households are connected to the district heating system. This system supplies heat to the equivalent of 6,000 flats.

The power purchase agreement with MVM Rt. (the Hungarian national power company, "MVM") expired in 2001 and the heat purchase agreement with the city expires at the end of 2002. Demand for the Plant's heat production was strongly reduced when BorsodChem completed its in-house power plant for its process heating and power needs.

In Hungary most of the power plants operating on fossil fuels sell both heat and power. In general, sale of heat allows these plants to sell electricity at a lower price. Because the Plant's heat purchase agreement has expired and the city of Kazincbarcika has entered into a contract with another heat supplier, and the biggest industrial consumer has built up an own energy system, in its current condition AES Borsod cannot sell heat and cannot produce electricity at a competitive price.

Because the Plant also cannot operate in its current state after 1st January 2005 due to tighter SO_2 emissions limit values, the Plant must either be closed, improve its flue gas cleaning system, or else switch fuels. The improvement of the flue gas cleaning system and a switch to another fossil fuel is

not a viable option due to the mentioned economic considerations and yet closure is also not the most desirable choice, because the Plant is in relatively good condition. For the continuation of operation, in 2001 the management of the Plant committed itself to the refurbishment the plant and to produce electricity from biomass.

Since then AES Borsod has entered into a memorandum of understanding with two of the three local forest management companies, Egererdõ, Északerdõ, under which they will supply 220,000 tonnes of firewood for the Plant within the framework of their approved forest management plan. AES Borsod is advanced in negotiations with Ipolyerdõ about 50,000 tonnes of firewood from Ipolyerdõ. Also negotiations are under way with companies removing stumps from the forests about a possible supply of 50,000 to 80,000 tonnes of wood chips from stumps.

A large percentage of the wood that will be supplied to the Plant under these arrangements are currently used for domestic heating and by wallboard manufacturers. However, wood derived from thinning usually does not meet the quality requirements of the joinery industry and demand in the existing small-scale wallboard industry is much less than the available amount of wood in the region. Therefore the forest management companies have significant extra capacity of firewood from logging and forest thinning, ready for sale. The planned AES Borsod project establishes significant demand for firewood and forestry waste, creating a balance between demand and supply.

Északerdõ has committed to deliver 120,000 tonnes and Egererdõ has committed to deliver 100,000 tonnes of firewood and forestry wastes to AES Borsod per annum. Északerdõ manages 103,000 hectares of forest in Borsod-Abaúj-Zemplén County and Egererdõ manages 72,000 hectares of forest mainly in the Bükk and Mátra mountains. Ipolyerdõ[1], a nearby forest management company manages 67,000 hectares of forest in North Hungary and committed to supply 50,000 tonnes of wood.

Pursuant to the negotiations with the local forest management companies and stump processing companies concerning fuel supply, the Plant could operate at 80% load capacity produce a minimum 260 GWh electricity (net) annually. In case of increased available fuel supply, the annual electricity production could increase up to 320 GWh (net).

As part of the technical preparations for the project, and to pre-negotiate aspects of the obligatory renewable power purchase agreement with MVM and MEH[2], AES Borsod has been mixing sawdust with coal in its boilers since 1 May 2002. Approximately 4,600 tonnes of sawdust are added per month to produce electricity from renewable sources using the current combustion system. This represents the first time a power plant in the Hungarian grid has sold renewable energy to MVM under the green power laws. Of the total amount of sawdust that is currently burned at AES Borsod (this representing 55,000 tonnes on an annualised basis), approximately one-third would be otherwise landfilled.[3]

AES Borsod is currently investigating the possibility of energy crop cultivation on the spoil-bank of its coalmine to further increase the fuel supply.

[1] Due to no MoU has signed and to the relatively low amount of available wood Ipolyerdõ is not considered a project partner at the moment.
[2] Magyar Energia Hivatal (Hungarian Energy Office)
[3] There are substantial avoided methane emissions as a result, but because these are difficult to verify precisely.

1.4. Intervention

Project goals (long term strategic goals)
The strategic objectives of the project are to:

- Create a precedent for large-scale renewable energy based power production in Hungary
- Conserve and establish employment opportunities in Borsod-Abaúj-Zemplén County
- Establish the first Joint Implementation project in Hungary and thereby pave the way for further climate action related investments for Hungary and AES.

Purpose of the project
The key purpose of the project is to keep the AES Borsod Power Plant in operation in an economically and environmentally feasible way for at least 25 more years. More broadly, the project will pioneer the introduction of large-scale renewable energy production in Hungary and will achieve significant GHG emissions reductions in a cost-effective manner.

Results of the project
The results of the project are:

- A minimum of 260 GWh net annual green energy production.
- Avoidance of an average 150,000 tonnes of CO_2 as well as approximately 3,000 tonnes of SO_2 reductions annually[4]. Due to the reduction of SO_2 and particulate emissions the air quality of the Borsod area will be significantly increased.
- Conservation of at least 150 jobs in the power plant and creation of up to 300 jobs in connection with the forest management activities.

Activities
To achieve the results AES Borsod will finish the project planning in terms of financial contracting and technology and fuel supplier contracting. AES Borsod will refurbish and operate two turbulent fluidised bed boilers, adjust the existing auxiliary equipments and establish an on-site wood chipping plant and a woodchip storage facility. Two of the forest management companies have committed themselves to deliver sufficient biomass to the Plant.

Actors
The actors excluding AES Borsod are the forest management companies Északerdõ, Egererdõ and Ipolyerdõ. Other actors include stump processing companies, as well as subcontractors involved in logging and transporting of the biomass. In the short term, MVM will be the purchaser of the produced electricity although as the electricity market liberalizes large power consumers, electricity distributors, and other players in a potential green certificate market could be considered actors.

[4] From replacement of off-site electricity generation at other power plant.

2. SYSTEM BOUNDARIES AND SOURCES & EMISSIONS COVERED

2.1. Description of GHG emission sources of the project

Direct on-site emissions
The on-site GHG emissions are fuel combustion related emissions resulting from:
- Burning biomass in the boilers
- Operating machinery for every-day operations including transportation of sand, wood, and ash at the power plant
- Burning natural gas used to start up the boilers.

Direct off-site emissions
The off-site sources of the CO_2 emissions in the project derive primarily from processes involved in supplying biomass fuel to the Plant:
- Logging: Includes fuel combustion-related emissions from operation of chainsaws used for logging and cutting, and special forestry machines used for dragging logs and stumps.
- Transshipment: The transshipment equipment is used for taking logs from storage sites to trucks and taking logs from trucks to trains. These emissions also result from fuel combustion.
- Transportation: Transportation of the biomass is done by both truck and trains resulting fuel combustion type emissions.
- Transportation of sand and ash: The emissions also result from fuel combustion in connection with the sand and ash transportation to and from the plant.

Indirect on-site emissions
The only known and accounted indirect source of on-site emissions is the chipping equipment, which will consume a significant amount of electricity. The GHG emissions effect of the chipping equipment is accounted in the calculations as on-site electricity consumption.

Indirect off-site emission sources
Indirect off-site emissions influenced in some way by the project relate to coal mining activities and the wallboard manufacturers that buy wood and wood waste from the forest management companies.

It is highly likely that as the result of the current project the coal mining activity of nearby Lyukóbánya will be significantly reduced and that in the longer term the mine will be closed and recultivated (the mine's other consumer, the Tiszapalkonya power plant, will end operations). This will cause a significant reduction of GHG emissions from energy used to extract the coal. However, because the project baseline is closure these emissions benefits are not included here.

The wallboard manufacturers are now using wood as raw material. It is conceivable that these companies, which now rely on the forest management companies for their wood supply, will have to

resource their wood waste from suppliers that are further away, thus increasing transport-related GHG emissions. However, this amount will be non significant.[5]

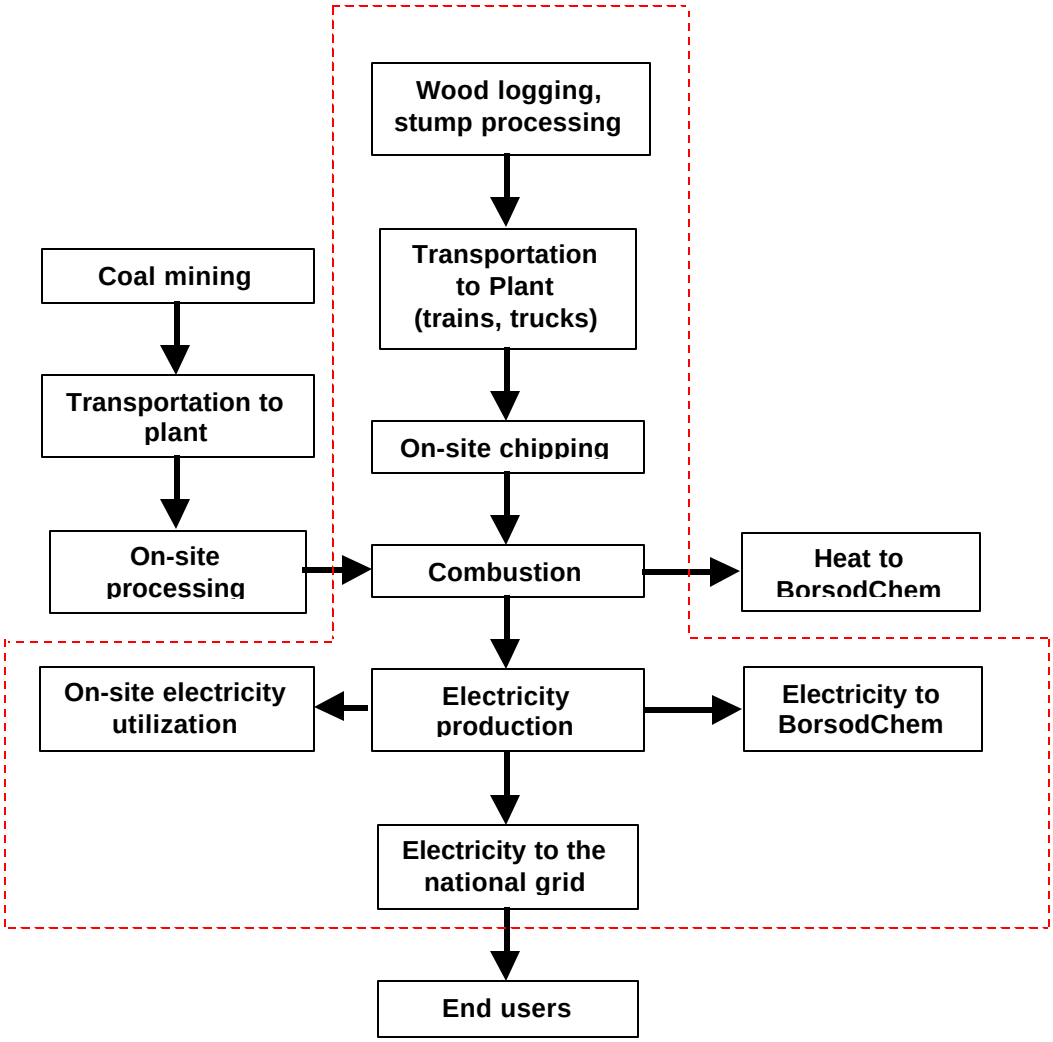
The likely utilization of sawdust from sawmills in some amount will also result in emissions reductions due to avoided deposition and anaerobic digestion. Because precise details about sawdust supply are unavailable, this factor is not calculated in the emissions reductions for this project.

[5] Assuming 80,000 tonnes of annual raw material transportation, 30,000 tonnes shortage for the wallboard manufacturers due to the wood purchase of AES Borsod and 100km increase in transportation distance.

2.2. Flow chart of the project

2.2.1. Flow chart

The following chart represents the complete flow chart of the project. Project boundaries are marked with dashed red line.



The wood supplied from the neighboring forest management companies is from thinnings and loggings performed in full compliance with forestry regulations. The Hungarian forest management system is one of the oldest and most sophisticated in Europe and has strong provisions for sustainable forestry. Under its laws, each forest management company must design plan describing for thinning and logging activities for approval by the regional forest management authority. This is a precondition for supplying wood to commercial customers. The thinning process ensures the health of the forest ecosystem and promotes natural regrowth.

Standard chainsaws will be used for logging, lopping and cutting of logs. The logged wood will be mainly hard wood (oak, beech, acacia, hornbeam and ash-tree) and tree stumps. From the forest, the

logged wood will be dragged using special machinery and will be collected on small storage sites near weather-safe roads.

From these storage sites the logs and forestry wastes will be transported either by high capacity trucks directly to the Plant, or in case of longer distances the wood will be first transported by trucks to the transshipment site, transferred to trains, and transported to the Plant.

At the Plant the logs will be immediately chipped and loaded to the daily bins or to the chip storage facility to minimize energy consumption and transshipment. However an on-site log storage site will be formed to provide a buffer against the risk of fuel supply interruption.

Stump processing companies also use special machines to extract stumps out from the ground and then either chipping off-site or transporting in whole to the Plant where it is chipped. Although no MoU has been signed yet it seems to be highly likely that AES Borsod will utilize stumps.

Wood transportation to the Plant will happen continuously on workdays. At the Plant the storage facility will act as a buffer containing wood chips for a ten-day period and the log storage site will contain wood logs for another three weeks.

After combustion the steam will be utilized for electricity production and it is conceivable that a certain amount of steam will be generated on coal basis in the old boilers and sold to BorsodChem as security backup heating (this is expected to be less than 300 TJ annually).

The heat distribution system dating from the expired district heating contract will not be demolished, but it is unlikely that AES Borsod will sell heat to the city of Kazincbarcika. The produced electricity will be sold to the national power distributor out of which a significant amount of the electricity will be transported directly to the BorsodChem plant by direct cable connection.

2.2.2. System boundaries

As 60%-80% of the total amount of the wood produced by the forest management companies will be utilized by the Plant, wood logging and transportation will be highly influenced by the project and are placed inside the project boundaries, as are any stump processing and energy crop cultivation-connected activities. Emissions related to transfer of electricity to the grid are also placed inside the project boundaries, giving full coverage for project-related emissions. The electricity supplied to the grid and the electricity supplied to the BorsodChem plant could in theory be differentiated, because electricity is supplied to BorsodChem through a more efficient direct cable connection than the electricity of the overall grid. This could be defined as reduction in the natural grid electricity consumption, although for giving conservative estimations the electricity supplied to BorsodChem is not differentiated at the baseline calculation.

It is conceivable that the plant will remain utilizing a small amount of coal and will supply steam to BorsodChem. Although the coal and the wood combustion lines cross, coal utilization can be traced through the production process. Based on heat physical calculations, it can be proven that the heat from coal combustion is not used for renewable electricity generation. The coal tracing system is currently operational, as it is a mandatory element of the Plant's agreement with MVM and the Hungarian Energy Office as a means of validating green electricity generation for the current mixed

fuel combustion arrangement. Therefore any coal-connected GHG emissions for heat supply to BorsodChem are placed outside the project boundaries.

2.2.3. Replacements

In the current project two of the ten existing boilers will be refurbished providing 45 MW_{th} capacity. One of the existing three steam turbine is going to be refurbish providing 27 MW_{el} capacity. In case of higher load one of the non-refurbished efficient steam turbines are going to used. At the relevant blocks the entire combustion technology will be refurbished as part of the project. The two refurbished 100 tonnes/hour capacity boilers will use turbulent fluidised bed firing and the fuel supply system will be adjusted as necessary. The current project involves:

- On-site installation of the biomass chipping, storage and supply system,
- A fuel switch in 2 of the 10 existing boilers,
- Refurbishment of 1 of the existing 3 steam turbines,
- Installation of a new air input fan system,
- Installation of a new controlling system,
- Renovation and re-engineering of the electric precipitators, and
- Refurbishment of a cooling tower for the elimination of heat contamination of the Sajó river.

Some of the daily coal storage facilities will be adjusted to accommodate the wood ash and sand used for maintaining the fluid bed.

3. CURRENT SITUATION

3.1. Current situation of the AES Borsod Power Plant

At present, AES Borsod Power Plant combusts approximately 700,000 tonnes of brown coal annually, all of which is mined at the nearby Lyukóbánya mine (14 km from the power plant). The coal is transported to the power plant both by cable railway and also by tracks. The coal mined at Lyukóbánya is also utilized at the AES Tiszapalkonya Power Plant (200 MW installed capacity). Currently AES Borsod still supplies heat to the city of Kazincbarcika and to BorsodChem.

3.2. Current situation of the Hungarian power system

In year 2000 the total domestic electricity production in Hungary was 32,062 GWh and imported electricity totaled 3,440 GWh. In 2000 41.6% of the total domestic electricity production was generated at the Paks nuclear power plant and 57.3% was generated in thermal power plants. Most Hungarian thermal power plants fire coal and hydrocarbons, which represent 29% and 32% respectively of the domestic electricity generation. The three Hungarian hydropower plants generated 137 GWh in 2000, representing just 0,4% of the total domestic production. The

Hungarian power sector was responsible for the emission of 21,612,000 tonnes CO_2 in 2000, of which 55% came from coal- and lignite-fired plants and 45% from hydrocarbon-fired plants.

It is likely that in the coming years the share of total emissions from coal-fired power plants will decrease slightly, since coal remains the major source of the domestic fossil fuel production. Hydrocarbon-fired power plants will tend to utilize much more natural gas in the future, switching from fuel oil. Significant increase in renewable based electricity production is assumed as the new electricity law sets obligatory power purchase for renewable based energy producers and as Hungary's implements other measures to achieve the ambitious renewable energy targets.

4. KEY FACTORS INFLUENCING THE BASELINE AND THE PROJECT

4.1. Legal factors

- The Government Decree on Air Quality Protection 21/2001. (II.14.), which sets tighter non-GHG emissions limit values from 2005 January 1st and apply to point sources exceeding 140 kW thermal input capacity.

- The Hungarian Electricity Law (2001/CXV.), which enters into force from 2003 January 1st sets obligatory power purchase for renewable energy generators at a fixed price (as does the current law on electricity). This price will be reviewed periodically until 2008. The law also calls for a system of green certificates, but delays the launch of this market for several years until the EU or international markets for green certificates becomes operational. One of the law's basic principles is to ensure a predictable and sufficiently high price for generators of renewable energy.

- The Forestry Law (1996/LIV.) and other forestry connected rules regulate logging and other forest management activities. Hungary has one of the oldest and most sophisticated forest management systems in the world, including substantial protections for forest conservation and sustainable forest management. Regulations obligates forest management companies to replant all forest they cut out, ensuring there is no net loss in forest area. The logging practices of all three forest management companies are acceptable to the regional Forest Management Authority.

4.2. Economic factors

- The city of Kazincbarcika and BorsodChem have both elected to derive their heat supply from sources other than the AES Borsod, and are already establishing the necessary infrastructure to do so. Therefore, it is not expected that AES Borsod will supply heat to the city of Kazincbarcika and any steam the Plant supplies to BorsodChem will probably be peak and/or backup heat capacity depending on the request from BorsodChem.

- The current electricity law obligates the national electricity distributor to purchase electricity from renewable sources (in fact this arrangement is already in place between MVM and AES Borsod for the sawdust now being fired). The eventual system of green certificates will also provide financial incentives for renewable energy developers in Hungary, and AES Borsod will already be an established, large-scale producer. EU accession will give the Plant access to an even larger market for green certificates. Given the relatively low infrastructure cost of retrofitting an existing plant (as opposed to constructing a new one), the Plant will achieve relatively high returns on its investment.

4.3. Political

- Hungary's increasing commitment to environmental issues in general and renewable energy in particular is partly due to its advanced stages of preparation for EU accession. This process will continue to have a positive effect on green energy policies.
- Hungary has already made a strategic decision in energy policy (1999/1107. Government Decision) that will increase the share of primary energy utilization of renewables to 5-6% from the present level of under 1,6%.
- The Borsod area is considered by the government to be a priority area for foreign investment given Eastern Hungary's relatively underdeveloped economy.

4.4. Socio-demographic

- Hungary is almost certain to experience an increase of the standards of living and a corresponding annual 4-5% increase in electricity consumption.
- By averting a total shutdown of the Plant, the project will save at least 150 jobs directly. This will have a positive impact on the local economy that depends on the purchasing power of Plant employees. Also, the significant increase in demand for wood will create up to 300 jobs at the forest management companies and their subcontractors.
- The health benefits for citizens of the Borsod area from shutdown are obvious—dramatically improved air quality and lower risk for pollution-related respiratory and cancerous diseases. However, these benefits are also valid for the baseline scenario as well. Since the power generation capacity from AES Borsod will displace capacity elsewhere in the MVM network, the project will reduce emissions of air pollutants elsewhere in Hungary. Thus the project will have significant health benefits for Hungary as a whole since it offsets "grey" power with "green power."

4.5. Environmental

- As the current project is considered as a fuel switch[6] by the North Hungarian Environmental Inspectorate, a detailed Environmental Impact Assessment was not requested. The plant is authorized to work under its current Environmental Permits with the compliance of the new emissions limit values set by the North Hungarian Environmental Inspectorate.
- Just as the project will have a positive effect on the ecosystem as a whole, due to the reduction in non-GHG emissions.

4.6. Technical

- The potential ERU yield of this project depends mostly on the amount of biomass fuel supply the Plant is able to secure. Current estimates are conservative, and imply a 80% utilization of the Plant's (new) capacity. As more of the Plant's capacity is utilized, the number of ERUs produced by the project grows accordingly.

[6] The project is only considered a fuel switch from a technical standpoint. In the context of the emissions benefits the baseline is shutdown.

- Currently AES is utilizing sawdust in its existing boilers beside coal. The future situation of sawdust purchase, and possible regulatory changes regarding sawdust deposition, are unclear. Because AES will attempt to secure as large a wood supply as possible, it is likely that the Plant will continue to purchase sawdust from sawmills on an ongoing basis. Inasmuch as a significant share of this sawdust would ended up being landfilled, continued utilization of sawdust in the project will have an emissions abatement benefit of some magnitude. However, due to the lack of a current long-term contract with the sawmills, the future amount of sawdust is not accounted in the baseline calculation. This means that the realized emission reductions may be significantly larger than currently estimated.
- It is probable that AES Borsod will utilize stumps from forests in the annual amount of 50,000 tonnes (thereby enabling an increase in power production and a corresponding increase in ERUs). It is likely that the amount of stumps supply can rise to 80,000 tonnes annually.
- It is highly likely that the equipment used for logging and transportation will change over time, due gradual replacement of the equipment and vehicle fleet with more efficient, modern models. Therefore the carbon intensity of the biomass supply will gradually decline.
- The potential in-house energy crop cultivation of AES Borsod on its spoil-bank depends on economical and technical feasibility testing which is still underway.

5. CALCULATION OF THE BASELINE EMISSIONS

Because a fuel switch to another fossil fuel is not an economically viable option, and because the Plant will be unable to comply with tighter SO_2 emission limits after 2005 January 1st, the baseline is the closure of the Plant. The project, therefore, is defined as the installation of new electricity generating capacity through conversion of coal-fired boilers to accommodate biomass.

The AES Borsod Plant will operate on full load if possible, depending on the available amount of combustible biomass. MVM is obligated to buy as much green power as the Plant will produce, up to a maximum of 50 MW_{el}. The baseline electricity production is that which MVM produces elsewhere under business-as-usual circumstances, and which it will buy instead from AES Borsod if the project occurs. Therefore, the electricity produced at AES Borsod reduces off-site emissions at other power plants.

The minimum amount of electricity generated by the project (and therefore the amount of electricity generation displaced elsewhere in the grid—see line 17 below) is to be at least 260 GWh net, which in turn gives the minimum amount of GHG emissions reduction.

Default emissions factors on electricity[7] were used for the baseline calculations. Because the project boundaries include the distribution of electricity via the grid, losses in the grid were also accounted in the baseline.

The following table below shows the standard baseline emission factors for grid electricity, the estimated annual energy generation and the baseline emissions.

		Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	*Average in 2008-2012*
	Electricity production											
17	Electricity produced	MWh	259 800	259 800	259 800	259 800	259 800	259 800	259 800	259 800	259 800	*259 800*
21	Losses in grid	%	15	15	15	15	15	15	14	14	14	*14*
22	Emissions factor in grid	tCO_2/MWh	0,753	0,740	0,727	0,714	0,701	0,687	0,674	0,661	0,648	
16	CO_2 eq. emissions from generation	tonnes	166 285	163 414	160 543	157 673	154 802	151 710	150 590	147 686	144 781	*149 914*

[7] Source: Ministry of Economic Affairs of the Netherlands, Operating Guideline for Baseline Studies, Validation, Monitoring and Verification of Joint Implementation Projects; Volume 2a: Baseline Studies, monitoring and Reporting. Version 2.0 (page 33.)

6. ESTIMATION OF PROJECT EMISSIONS

The only output of the project is electricity fed into the grid. The gross amount of electricity generated will be a minimum of 260 GWh with the utilization of 320,000 tonnes of wood.

The Hungarian law on electricity sets obligatory power purchase, therefore the demand for its produced electricity is constant. The technology refurbishment provides capability for a gross maximum of 365 GWh electricity production (320 GWh net). In the project emissions calculation, the electricity production equivalent of 320,000 tonnes of biomass supply was estimated as a conservative minimum amount.

The CO_2 emissions from combustion in the boilers is not calculated, as the CO_2 emissions from burning wood is less than or equal to than the CO_2 sequestered during the life of the trees (due to the carbon sequestered in soil) and can be observed during the aerobic degradation of biomass in the forests.

The emissions sources of the project are listed and described under section 2.1. and the detailed calculation of direct off-site emissions is attached in Annex A. Off-site emissions calculations are given relative to emissions factors for biomass delivery. Due to the lack of detailed information available on the fossil fuel utilization related to stump processing, the biomass delivery-connected emissions factor estimate is defined as medium precision level.

On-site direct emissions from heavy machinery used to transport sand, ash and logs are estimated to be 240 tonnes of CO_2 eq. annually[8]. On-site direct emissions from starting boilers with natural gas were also accounted. Emissions connected to sand and ash transportation is accounted as other direct off-site emissions.

Other GHG emissions are not calculated, as they will comprise less than the one percent of the overall project emissions. The project boundaries exclude boiler refurbishment-connected emissions, as these are outside the control and the measuring capacity of the project developer.

[8] Assuming 3,500 annual working hours and 25 litres of gasoline consumption per hour.

Project emissions

	Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	*Average in 2008-2012*	Level of precision
Biomass utilization												
1 Biomass utilized	tonne	320 000	320 000	320 000	320 000	320 000	320 000	320 000	320 000	320 000	*320 000*	H[1]
2 NCV of biomass	GJ/tonne	12,2	12,2	12,2	12,2	12,2	12,2	12,2	12,2	12,2	*12,2*	H[2]
3 CO_2 eq. emissions factor for biomass delivery	tCO_2/tonne	0,01904	0,01904	0,01904	0,01904	0,01904	0,01904	0,01904	0,01904	0,01904	*0*	M[3]
4 CO_2 eq. emissions	tonnes	6 094	6 094	6 094	6 094	6 094	6 094	6 094	6 094	6 094	*6 094*	
Electricity production												
14 On-site fuel use for electricity production	TJ	3 904	3 904	3 904	3 904	3 904	3 904	3 904	3 904	3 904	*3 904*	H
15 CO_2 eq. emissions factor	kton/TJ	0	0	0	0	0	0	0	0	0	*0*	
16 CO_2 eq. emissions	kton	0	0	0	0	0	0	0	0	0	*0*	
17 Electricity produced	MWh	293 000	293 000	293 000	293 000	293 000	293 000	293 000	293 000	293 000	*293 000*	H
18 Efficiency of electricity production	%	27,0	27,0	27,0	27,0	27,0	27,0	27,0	27,0	27,0	*27,0*	
19 Electricity from grid	MWh	0	0	0	0	0	0	0	0	0	*0*	H
20 On-site total electricity use	MWh	33 200	33 200	33 200	33 200	33 200	33 200	33 200	33 200	33 200	*33 200*	H
21 Losses in grid	%	15	15	15	15	15	15	14	14	14	*14*	
Other direct on-site emissions												
37 Heavy machinery used on-site	tCO_2	240	240	240	240	240	240	240	240	240	*240*	H
38 Natural gas start-up firing	tCO_2	57	57	57	57	57	57	57	57	57	*57*	H[4]
Other direct off-site emissions												
39 Sand and ash transportation	tCO_2	32	32	32	32	32	32	32	32	32	*32*	H[5]

[1] Contracted minimum amount. The amount of biomass utilized and therefore the amount of produced electricity can be increased by 30%.

[2] The weighted average value.

[3] Detailed calculation available under Annex A. containing processing and transportation connected emissions.

[4] Equal to 5 annual start ups each consuming 6000m^3 of natural gas (1 start-up is expected)

[5] Ash: 550 tonnes utilized annually and 100km transportation distance, sand: 3200 tonnes produced annually and 30km transportation dictance by 8 tonnes capacity tracks.

7. CREDITING TIME

Start date of the project: 2004. January 1st
Lifetime of the project: 25 years
Crediting time of the project: 5 years (between 2008 and 2012)

8. CALCULATION OF THE EMISSION REDUCTIONS

The following table shows the emissions reduction calculated. For each row the conservative end were accounted with the indicated level of precision.

		Unit	2004	2005	2006	2007	2008	2009	2010	2011	2012	*Average in 2008-2012*
	Emissions reduction											
16	CO2 eq. emissions from generation	tonnes	166 285	163 414	160 543	157 673	154 802	151 710	150 590	147 686	144 781	*149 914*
3	CO_2 eq. emissions from biomass delivery	tCO_2/tonne	7 008	7 008	7 008	7 008	7 008	7 008	7 008	7 008	7 008	*7 008*
37	Heavy machinery used on-site	tCO_2	252	252	252	252	252	252	252	252	252	*252*
38	Natural gas start-up firing	tCO_2	60	60	60	60	60	60	60	60	60	*60*
39	Sand and ash transportation	tCO_2	34	34	34	34	34	34	34	34	34	*34*
	Emissions reduction:	tCO_2	158 932	156 061	153 190	150 320	147 449	144 357	143 237	140 333	137 428	*142 561*

Note:
To give a conservative estimation the following factors were eliminated:

- The minimum electricity production levels were calculated. It is noted that the maximum amount could go up to 320 GWh net annually. (Meaning 32,000 tonnes CO_2 eq. surplus emissions reduction annually)
- Avoided methane emissions from sawdust utilization. (Currently approximately 55,000 tonnes of CO_2 eq. annually).
- Electricity supplied to BorsodChem (Approximately 6,500 tonnes of CO_2 eq. annually).

9. MONITORING

The monitoring approach of the project consists of two parts:

I. As described the baseline calculation is based on the default emissions factors provided by ERUPT. The annual monitoring should investigate the actual emissions factors and grid losses in Hungary. Hopefully these emissions factors will be available from official sources such as the national power distributor or the Ministry of Environment. If the emissions factor is not available form official sources a detailed study should be carried out based on

the methodology described in the *Operating Guideline for Baseline Studies, Validation, Monitoring and Verification of Joint Implementation Projects; Volume 2a: Baseline Studies, monitoring and Reporting. Version 2.0* (page 28-33. Ministry of Economic Affairs of the Netherlands)

II. Project-connected GHG emissions must be monitored on an annual basis. The project supplier will be in charge of collection of GHG emissions-related key data as a report from the three main types of organizations that can be identified as responsible for project emissions.

1. The first group are subcontractors of the forest management companies and the stump processing companies who should report their fossil fuel utilization for a given year. It is likely that these small companies will have other activities so an accounting system has to be formed focusing on the amount of wood logged, dragged, and transported with distances to the power plant and the specific fuel utilization for each activity. A uniform reporting format is now being created for these companies. The reported fossil fuel utilizations can be based on bills from filling stations and on mileage indicators. The reporting activity should be part of their contract with the forest management company.

2. The second group is the forest management companies who operate forestry machines at the project. The fuel utilization accounting system has to be in operation at the forest management companies. The fossil fuel utilization can be also based on bills from filling stations or on bills from fuel trading companies. All three forest management companies are certified with ISO 9002 and ISO 14001, therefore the fossil fuel utilization can be accounted with a high level of precision under these quality management systems. The reporting format for these companies can be the same as it is for the first group. The reporting activity should be part of the contract with AES Borsod.

3. The third type is the AES Plant itself. The Plant has to monitor its activity anyhow, so the data collection will be relatively easy. The amount and dry matter content of wood is measured constantly. The amount of gross electricity produced and the electricity utilized on-site is also measured constantly. The heavy machinery used on-site is also measurable and accountable with specific fuel consumptions. The number of start-ups also reportable. The AES Borsod plant is certified with ISO 9002, therefore the fossil fuel utilization can be accounted with high level of precision under the quality management system.

The emissions factor of the train transportation is accounted on the international standards of IPCC, due to the lack of information on the specific local emissions if during the crediting period local factors will be available those should be used. The emission factors for the fossil fuels, which is mostly gasoline is estimated to be calculated on international standards of the IPCC. The heat sold to BorsodChem and the amount of combusted coal is accounted as a regulatory requirement therefore it is not questioning the adequacy of the baseline.

Although the likely sawdust utilization is not accounted, but if used during the crediting period it should be monitored with the accounting of otherwise landfilled amounts. Also the methane forming capability should be monitored.

The likely energy crop utilization connected GHG emissions should be monitored, which is also the responsibility of the supplier. As no exact information is available currently on the type and on the amount of energy crop to be cultivated no monitoring design is created for this activity.

The reports from the first two groups should be collected by AES in hard copy.

Annex A.

Fuel consumption factors	Equipment	Fuel consumption factor		Load capacity	Emissions factors	Note	Source
Logging, lopping and cutting	chain saw	0,55	liters of gasoline/m^3	-	0,001638 tCO_2/tonne	5% oil is also used	1
Dragging equipment	LKT	3,5	liters of gasoline/m^3		0,010422 tCO_2/tonne		1
Road transport	KAMAZ 5511	33,5	liters of gasoline/100km	8 tonnes	0,000112 tCO_2/tonne*km		1
	KAMAZ 4310	24	liters of gasoline/100km	6 tonnes	0,000107 tCO_2/tonne*km		2
Railway transport	N/A	N/A	N/A	N/A	0,000047 tCO_2/tonne*km	27 wagons 49% capacity	3
Transhipment	KAMAZ 5511	0,36	liters of gasoline/m^3	-	0,001072 tCO_2/tonne		1

Density of wood:	0,9 tonnes/m^3	1
Heating value of wood (NCV):	12 MJ/kg	1
Gasoline emissions factor :	0,00268 tCO_2/liter	4

Sources:

1 Communications with forest management companies
2 Personal communications with transportation companies.
3 INFRAS 1995, DETR 1999,
4 UNEP, The GHG Indicator, 2000

Annex A. (continued)

Egererdõ		
Wood supply:	100 000	tonnes
Long distance transport:		
Wood supply:	80 000	tonne
Transport by trucks:	10	km
Transport by train:	100	km
Short distance transport:		
Wood supply:	20 000	tonne
Transport by trucks:	40	km

Északerdõ		
Wood supply:	120 000	tonnes
Long distance transport:		
Wood supply:	50 000	tonne
Transport by trucks:	10	km
Transport by train:	100	km
Short distance transport:		
Wood supply:	70 000	tonne
Transport by trucks:	40	km
Emissions from logging:	360	tCO_2
Emissions from dragging:	2293	tCO_2
Emissions from transhipment:	375	tCO_2
Emissions from transportation:	1161	tCO_2
Total annual emissions:	*4189*	*tCO_2*

Estimated emissions factor on wood supply:	0,019	tCO_2/tonne

Note: Only one of the forest management companies have provided information on the specific fuel consumption of the forestry machines and on wood transportation. Therefore the emissions factor is considered to be a conservative estimate. This emissions factor is used as the emissions factor for the stamp processing and transportation. Although it is a conservative estimate the level of precision marked to be medium (+-15%).