Pálhalma Biogas Joint Implementation Project

Baseline Study

DRAFT

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Abbreviations

Bo	Methane Producing Capacity
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalents
EF	Emission Factor
e.g.	example given
ERU	Emission Reduction Unit
EU	European Union
G	Giga
GHG	Greenhouse Gas
GWh	Gigawatt hours
GWP	Global Warming Potential
h	hours
ha	Hectare
hd	Head
HPP	Hydro Power Plant
IPCC	Intergovernmental Panel for Climate Change
IRR	Internal Rate of Return
JI	Joint Implementation
Kft.	= Ltd; Limited Company
kg	Kilogram
km	Kilometer
kV	Kilovolt
kWh	Kilowatt hours
MCF	Methane Conversion Factor
MM	Manure Management
Mo	Month
MW	Megawatt
MWh	Megawatt hours
No	Number
NPP	Nuclear Power Plant
NPV	Net Present Value
Lu	Lump sum Payment
PA	Palhalmái Agrospeciál Kft.
PCF	Prototype Carbon Fund
PDD	Project Design Document
PIN	Project Idea Note
t	tons
TWh	Terrawatt hours
UNFCCC	United Nations Framework Convention on Climate Change
VS	Volatile Solids

1 Project Information

1.1 Project Abstract

The project developer is Hungarian Pálhalmai Agrospeciál Kft. The company was founded in 1950 by the Hungarian Ministry of Justice and is still 100% state owned and under the responsibility of this ministry. The company's full name is Pálhalmai Agrospeciál Agriculture, Production, Distribution and Service Kft and it provides a broad range of products and services in the agricultural and industrial sector. In addition the company provides jobs for prisoners.

Pálhalmai Agrospecial Kft. is located in Pálhalma about 3 km from the town Dunaújváros in the region of Fejér County (Komitat).

The Pálhalma Biogas Joint Implementation Project foresees the installation of a biogas plant, that is fed with agricultural feedstocks primarily from the animal husbandries (pig and cattle), energy crops and slaughterhouse wastes.

Due to the controlled anaerobic fermentation, the biogas capturing and the combustion of the biogas in a combined heat and power engines, the methane emissions are avoided. In addition electricity and heat is produced from renewable energy and displaces electricity and heat from fossil fuel fired power plants.

The following table shows the time schedule of the Pálhalma Biogas JI-project.

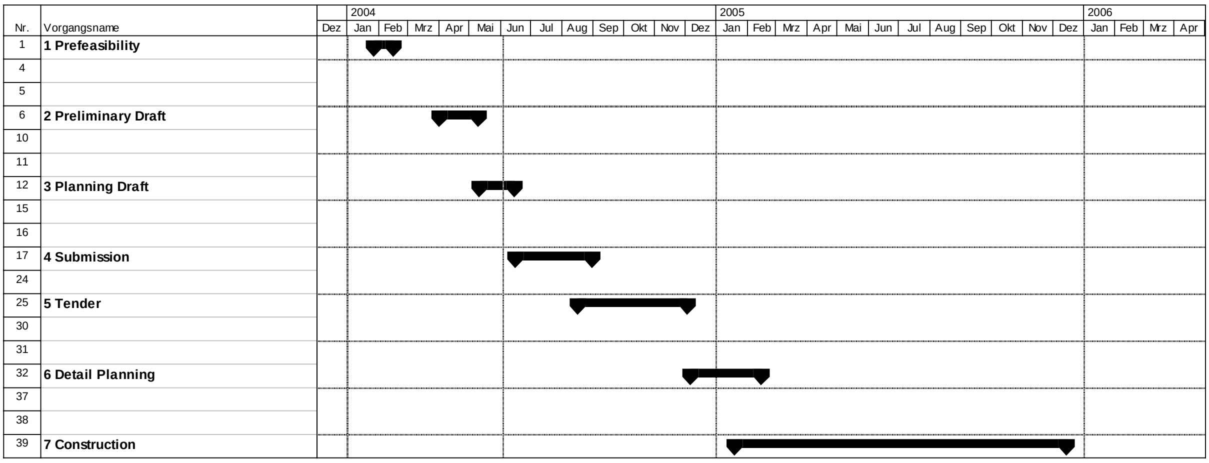

Table 1: Time Schedule Pálhalma Biogas Project

A more detailed time schedule is attached in Annex: Project Time Schedule.

1.2 Project Participants

1.2.1 Project developer

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Since the Palhalmái Agrospeciál (PA) Kft was founded in 1950 by the Ministry of Justice, the farm employs prisoners from the neighbouring jailhouses. After the collapse of the communism in 1989/1990, the company remain in state-ownership as according to Act No. 1992/LIII 2§ (3) enterprises with functions of public concerns remain state-owned. In 1994 the company was restructured and transformed into the state owned limited liability company Pálhalmai Agrospeciál Kft (seed capital € 1,400,000).

Activities and Experiences
The full name of the company is Pálhalmai Agrospeciál Agriculture, Production, Distribution and Service Kft" The field of activities and experiences are:

- Agricultural Production: Pig and cattle feeding is one of the main activities of PA Kft. Except a small number, the livestock is sold. In addition, milk production became an important factor in the last years. The company farms fields with a total area of about 4.420 ha.
- Crop Production: Currently the produced crops are used by about 30% in the husbandries and about 70% of produced crops are sold (sunflowers and maize) to local partners. (Hungrana Kft and Héliosz Coop Kft .
- This sector comprises: radiator production, steel construction and manufacturing, zinc galvanization, as well as laundry and tailoring.

In all sectors the company has to provide employments for prisoners, who get different kinds of training there.

For more detailed information please see PDD chapter A.3.1.

1.2.2 Project Partners

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  Responsibility: Project Management and Coordination

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1.3 Hungary's Experience in JI and Baselines

Hungary has complied with the requirements of the United Nations Framework Convention on Climate Change (UNFCCC) and the government has ratified the Kyoto Protocol on 28th August 2002

Hungary supports the implementation of the Kyoto Protocol. The government is committed towards both Joint Implementation (JI) and emissions trading and will participate in the EU emissions trading scheme, scheduled to start in 2005. Hungary will have no problems to meet its Kyoto target of 6% reduction and is expected to have approximately 16 million tonnes of CO2e surplus during the first commitment period, 2008-2012.

In 2003, Hungary and Austria signed a Memorandum of Understanding (MoU) on co-operation in reducing GHG emissions under article 6 of the Kyoto Protocol (http://www.ji-cdm-austria.at/images/download/mou_hungary.pdf).

In Hungary JI is seen as an economically feasible way to reduce GHG emissions and obtain economic, technical and expert support at the same time. There is big potential for emission reductions in Hungary, Hungary also has already experience as a host country in some JI-projects (e.g.: “Pannonpower” for the PCF).

In September 2000, the Hungarian Government issued a Governmental Decree on Hungary's Strategy on Climate Protection. The Ministry of Environment and Water is the responsible authority to meet the Kyoto commitment in cooperation with other ministries and agencies. The Decree requires elaborating the domestic institutional and regulatory framework of JI. The main sources of greenhouse gas emissions are energy production, some industrial activities, transport and the intensive agricultural production.

Hungary has set up the national greenhouse gas inventory – GHG of anthropogenic emissions by sources and removals by sinks of greenhouse gases and submitted it to the Secretariat of the Framework Convention on Climate Change.

The Ministry of Environment and Water is responsible for Hungary´s Kyoto related issues:

Ministry of Environment and Water
1011 Budapest, Fo u. 44-50, Hungary

2 Description of the Current Situation

PA is a 100% state owned company and under the responsibility of the Ministry of Justice. Since its foundation in 1950, PA has been active in the field of agriculture and its main objective has been to provide employment for Hungarian prisoners. This system of imprisonment is intended to maintain even under EU-legislation[1].

Beneath the field of agriculture, PA does also provide industrial services as radiator production, steel construction and manufacturing, zinc galvanization, as well as laundry and tailoring. As of the project is affecting the agricultural sector only, this sector is described more in detail

2.1 Agriculture of PA

PA farms fields with more than 4,420 ha, by about 30% of the harvest are used to produce fodder for the four pig and cattle husbandries in Újgalambos, Bernátkút, Parrag and Hangos, about 70% of produced crops are sold. The following figure shows the landed property of PA. Animal husbandries are coloured in orange; the proposed site of the biogas plant is marked in red.

[1] Compare Annex: Statement of the General Director of Hungarians Prison Service

Figure 1: Landed property of PA

Pig husbandries are situated in Újgalambos and Bernátkút. In total the stock is 10540 (year: 2003). The majority of the pigs (8038) are kept in Újgalambos, where also the pig breeding farms and heated pigsties for shoats are located. In Bernátkút there are only pig fattening farms. PA sells the majority of the livestock, only a small amount is slaughtered in the own slaughterhouse.

The pigsties are mucked out daily. The muck is stored for more than 6 month before it is used for fertilizing fields. The storages do not have any leakproof grounds or facilities to protect the environment against infiltration emissions into the ground.

In Hangos and Parrag there are cattle husbandries located. Whereas in Parrag the cattle are fattened, in Hangos diary cattle are kept. The milk production has been increased in the last years to 5,000,000 l per year and became an important factor in PA.

Also the manure systems at Hangos and Parrag will have to be rebuilt due to the environment is insufficiently protected against emissions.

The next table shows the animal stock of PA in 2003.

	Type of animal	Stock in 2003	Output
Újagalambos	Pigs	8038	Livestock
Bernátkút	Pigs	2502	Livestock
Parrag	Non diary cattle	690	Livestock
Hangos	Diary Cattle	709	Milk

Table 2: Livestock of PA

It is expected that the number of animals will slightly increase in the next years. PA has enough capacities to have much more animals than today.

Figure 2: Pig and Cattle Husbandries of PA

Fertilizing
PA needs chemical fertilizer to fertilize its fields. Following products are applied to the fields.

Demand of chemical Fertilizer	kg/a
Nitrosol	160.000
Karbamid	394.910
Fertisol	62.960
MAS	275.000
MAP 11:52	133.300
K-60	293.110
Total	**1.319.280**

Table 3: Chemical Fertilizer Demand

Data sheets of the different types of chemical fertilizers are shown in Annex: Chemical Fertilizers of PA.

2.2 The Laundry

In 2003 PA enlarged its business segments by laundry services. In Bernátkút a laundry has been set up. Primarily the reasons for this decision were:

- Creation of 45 jobs for female prisoners. Job creation of workplaces for inmates is very important for PA as they are instructed to employ prisoners (please compare Project InformationAnnex: Statement of the General Director of Hungarians Prison Service). As these are indoor workplaces, inmates can be employed the whole year round.
- Diversification of the PA fields of business reduces dependence on individual branches.

In 2004 the modernization process of the laundry was accomplished and PA got the approval to wash laundry for hospitals according to sanitary conditions of Hungarian health authority (ANTSZ).

Currently prisoners are working in 2 shifts in the laundry. About 1250 t laundry is washed annually. Because of the great demand for services in washing laundry from hospitals, it is envisaged to enlarge the amount of working places by a 3 shift work.

In the laundry there two gas boilers and one steam boiler installed. The boilers are operated by natural gas. The gas boilers heat water up to 60°C. This water is used for the washing machines. For the standard stage of the washing program, 60°C hot water is sufficient. The special washing program (used to wash laundry from hospitals,..) requires hot water with 90°C. Therefore steam is directly injected into the washing machines to heat the water there. Steam is also used for ironing. The boilers in the laundry have an efficiency of 90%.

Figure 3: Gas boiler for hot water production

Figure 4: Gas steam boiler for steam production

2.3 Adonyhús Kft.

Adonyhús Kft is part of the agricultural cooperative society holding “Adony Március 21.Szövetkezet”. Beneath Adonyhús Kft there are 7 other agricultural and agricultural service companies under this holding, like the sunflower - oil production company Héliosz-Coop Kft.

Adonyhús Kft is a pork production company. They have pig husbandries and a slaughterhouse. Their stock is about 7.030 pigs. Adonyhús Kft. has a liquid based MM-system (manure ponds). About 25.000 m³ liquid-manure is produced in the husbandries annually.

Figure 5: Lagoon to store liquid pig manure at Adonyhús Kft.

Adonyhús Kft. slaughters about 10.000 pigs annually. Adonyhús Kft. intends to deliver about 440 tons of slaughterhouse wastes to the biogas plant that are used as feedstock there.

2.4 The Hungarian Electricity Sector

The reform of the electricity industry commenced in 1994-95, when Act No. XLVIII of 1994 on the Production, Transportation and Supply of Electricity was formulated and came into effect. In 1995, the privatization of the public concerns in the sector began.

2.4.1 Market Structure

Privatization took place in several phases. At present, the majority of power stations and 100% of the electricity suppliers (today called network and service provider companies as a result of privatization) are privately owned. The endeavors of the European Union to establish a uniform internal market have included the liberalization of the energy sector. As a result, Act No. CX of 2001 on Electricity came into effect on 1 January 2003.

As the first step towards the liberalization of the market, the Government decided on a 30-35% authorization level in order to facilitate partial liberalization of the market (that corresponds to the above-mentioned 6.5 GWh/year limit). Thereafter, tracking the liberalization of the market in the EU was the objective. In the meantime, the EU reviewed its Directive 96/92/EC (concerning common rules for the internal market in electricity) and adopted a policy of accelerating the opening of the market. This means that from 2004, all consumers other than household consumers shall be authorized consumers in the member states of the EU, while from 2007, households shall also be authorized, i.e. the market shall be 100% liberalized.
The following figure shows the model of the Hungarian electricity market.

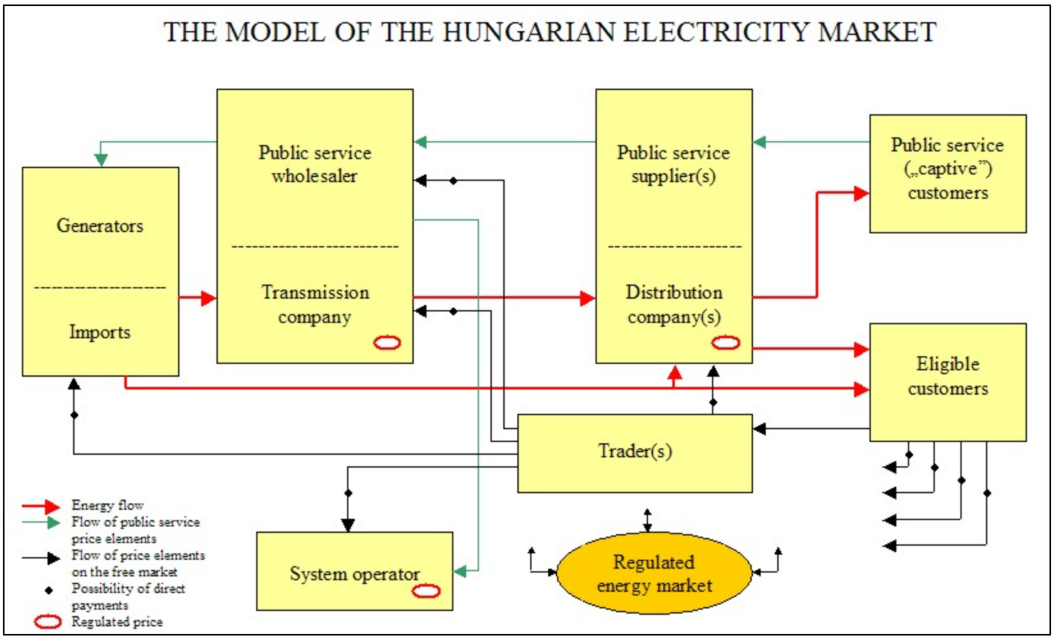

Figure 6: Electricity Market Model[2]

The producers produce the electricity and feed it into the transmission or distribution networks. As regards licensing, the built-in production capacity of the power stations is the decisive factor, power stations with built-in capacity of at least 50 MW require licenses.

The transmission and distribution network license holders are responsible for the "transportation" of electricity, its transmission and distribution from producers to consumers. These market players are obliged to provide free access to the networks without discrimination.

The systems controller plans and controls the operations of the electricity system. It is independent of producers, traders and consumers. Its tasks comprise system level operative control, resource planning, preparation for network operations, the settlement of electricity and the provision of system-level services.

The following list and the affiliated figure show the main companies of the Hungarian electricity market system.

Generation licensees:

- AES Tisza Erőmű Kft. www.aes.hu
- Bakonyi Erőmű Rt. www.bakonyi.hu
- Mátrai Erőmű Rt. www.mert.hu
- PANNONPOWER Rt. www.pannonpower.hu
- Vértesi Erőmű Rt. www.vert.hu
- Paksi Atomerőmű Rt. www.npp.hu
- Csepeli Áramtermelő Kft. www.atel.hu
- Budapesti Erőmű Rt. www.bert.hu
- EMA-POWER Kft. www.emapower.hu
- GTER Kft. www.mvm.hu/main.php

Distribution and public service supply licensees

[2] Source: Hungarian Energy Office

- Észak-dunántúli Áramszolgáltató Rt. www.edasz.hu
- Délmagyarországi Áramszolgáltató Rt. www.demasz.hu
- Dél-dunántúli Áramszolgáltató Rt. www.dedasz.hu
- Tiszántúli Áramszolgáltató Rt. www.titasz.hu
- Budapesti Elektromos Művek Rt. www.elmu.hu
- Észak-magyarországi Áramszolgáltató Rt. www.emasz.hu

Transmission and public service wholesale licensee

- Magyar Villamos Művek Rt. www.mvm.hu

System opration licensee

- Magyar Villamosenergia-ipari Rendszerirányító Rt. www.mavir.hu

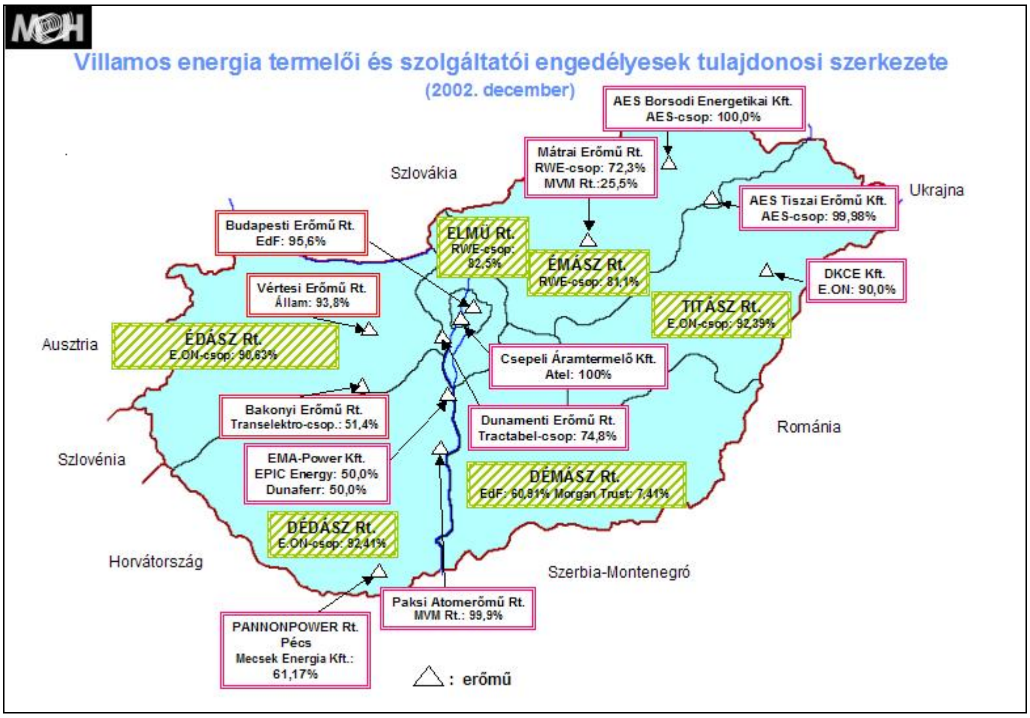

Figure 7: Hungarian Electricity Market

Finally the electricity distributors and the interconnections of the Hungarian grid are shown.

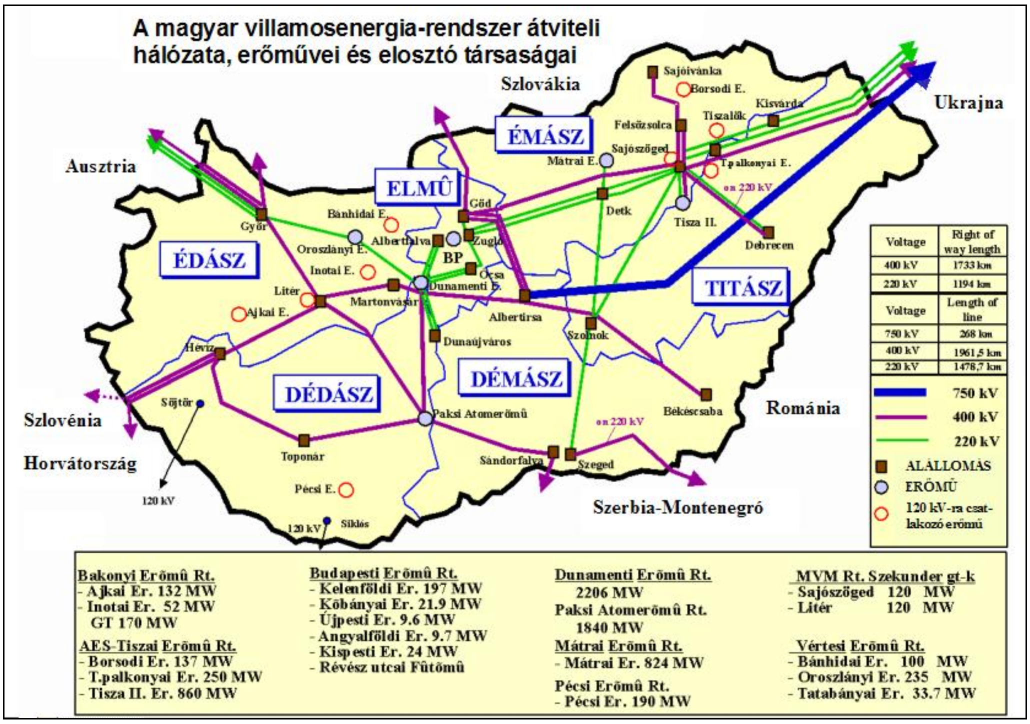

Figure 8: Electricity Distributors in Hungary[3]

2.4.2 Capacities and Generation

In 2002, the Hungarian electricity supply industry comprised about 8,184 MW (commissioned capacity; C.C.) of public utilities capacity and about 127 MW of industrial autoproduction. The available capacity (A.C.) of the public power plants amounts to 7,850 MW. The following table gives an overview on the generation capacities of the Hungarian public power plants 1990 – 2002.

Generation Capacities of Public Power Plants

Item		1990	2000	2001	2002	Increase MW (2002-2001)
C.C. Public Power Plants	MW	6,973	8,210	8,265	8,184	-81
A.C. Public Power Plants	MW	6,868	7,766	7,803	7,850	47
Peak Load	MW	4,181	5,394	5,761	5,726	-35

Table 4: Generation Capacities 1990-2002[4]

Table 5 shows the plant categories and the corresponding commissioned capacities of the Hungarian public power plants. Commissioned capacities of the thermal power plants amount to 6,270 MW. Therefore the Hungarian generation capacities are dominated by thermal power plants (76.6%) and nuclear power plants (22.8%).

[3] Source: Hungarian Energy Office http://www.eh.gov.hu/
[4] Source: MVM; Statistical Data 2002 http://www.mvm.hu/

Power Plant Categories 2002			
Item	C.C. Public Power Plants	Number	Total Comissioned Capacity
Hydro Power Plants	< 30 MW	45	48
Thermal Power Plants	< 20 MW	48	375
	20-50 MW	12	326
	51-100 MW	11	680
	> 100 MW	29	4,889
Nuclear Power Plants	> 200 MW	8	1,866

Table 5: Commissioned Capacities per Category

In 2002, the Hungarian public power plants produced about 35,000 GWh of electrical energy, dominated by nuclear, natural gas, and coal generation. The following table gives an overview on the gross electricity generation in 2002.

Electricity Production by Energy Sources 2002		
	GWh	%
Coal (Lignite)	8,663	24.8%
Fuel Oil	2,074	5.9%
Natural Gas	10,043	28.8%
Hydrocarbons as total	12,117	34.7%
Fossil Fuels as total	20,780	59.5%
Hydro Power	195	0.6%
Nuklear Power	13,953	39.9%
Total	**34,928**	100.0%

Table 6: Hungarian Electricity Production 2002

In 2002, 40% of the electricity produced in Hungary was generated by nuclear, 28.8% by natural gas, 24.8% by coal and 5.9% by oil. The crucial importance of the Paks nuclear power plant is clearly discernible. Renewables, mainly small run-of-river hydro power stations, amount to less than 1% of power production.

Electricity imports reached 12,605 GWh, while exports from Hungary reached 8,349 GWh, resulting in net imports of 4,256 GWh. The following table shows the electricity actually measured on the border crossing lines, including the transit deliveries. The contractual export-import values differ significantly from the physical values, but the balance is of course the same.

Export - Import 2002			
Item		Physical deliveries	Contractual deliveries
Import	GWh	12,606	7,624
Export - Import in 2002	GWh	8,349	3,367
Balance	GWh	4,256	4,256

Table 7: Actual Export-Import Deliveries 2002

3 Baseline Determination Methodology

3.1 Baseline Methodology Review

The baseline determines and documents in a methodological way which is the most likely scenario in absence of the project and which emissions would occur according to this scenario.

General Options
The most important question to be answered when asking for the most probable baseline scenario for the proposed project is: How would the electricity produced by the proposed Green Energy generation plants be produced in absence of this project and which are the main determinants for answering this question?

Generally, baseline methodologies fall into two broad categories, project specific and multi-project approaches. The following list provides an overview on the most commonly used methods. Many more are mentioned in literature[5], but they can be considered to be adequately covered by the list below.

The following basic options of baseline methodologies have been dealt with:

- project-specific baselines:
    - investment analyses
    - control group
    - scenario analysis.
- standard oriented/ multi-project baselines

Project specific baselines
With a view to the project specific baselines it is often argued that project type, project size and data availability are main factors determining the choice of the baseline methodology.

The control group approach asks for finding a similar country/region/project with circumstances comparable to the project area in order to monitor developments without a JI project. Control group defining for electricity baselines be hard to find due to historically different circumstances regarding natural resources, technology, economical aspects, status and policy of market liberalization, etc.

The investment approach identifies all conceivable and realistic development alternatives taking into consideration technical, economic, political, social and environmental aspects and ranks them according to their economic benefit, e.g. through determining the Internal Rate of Return. The alternative with the highest return is defined as the baseline alternative. Due to the fact that economic aspects are the key determinants for this aspect this approach asks for a decision model driven mainly by economic forces and the clear comparability of different options.

[5] Sources among others: PCF, Ministry of Spatial Planning, Housing and Environment/NL, IEA, OECD

(Risk based) scenario analyses investigate possible development scenarios without the project taking into consideration various influencing factors such as technology, policy or market constraints. Options leading to a too high risk are ruled out and the most probable scenario is chosen as the baseline. The main challenge of this approach is to select the most important influencing factors and to identify the best/most reliable data sources for the investigation.

Multi-project approaches

There are a number of different approaches for multi sector baselines. They may range from average emissions rates for a sector to technology standards to comprehensive modeling within a particular sector (for example a least cost dispatch analysis of the electricity sector). Despite the variety of approaches the outcome remains the same, which is to provide a set of standard figures to be used as a baseline for a number of different projects. This can also be benchmarks and – like for the project specific baselines – would be expressed in the form of an emissions rate per unit of activity (for example tons CO_2 e/GWh).

The multi-project approach is advocated because using such methods will significantly reduce transaction costs for JI projects. That is, the costs of developing baselines for JI projects will be much lower when developed in countries that already have multi-project baselines and therefore the costs to project developers and investors are lowered considerably. This approach will therefore also promote the number of projects that are implemented through these mechanisms as well as promote the implementation of the smaller sustainable energy projects. Additionally there will be more predictability for the project developer on the number of ERU's that will be acquired from a project.

Multi-project baselines for the Electricity sector

For the electricity sector, multi-project baselines have been widely used in JI and CDM projects. The reason for this is that the implementation of one project has (marginal) implications on the entire electricity sector. Therefore project specific baselines are not adequate and multi-project approaches are preferred.

In the following section, the different baseline methodologies based on multi-project approaches are analyzed and their adequacy for the proposed project is investigated. Institutional conditions, the data availability and the specific feature of the Slovak electricity sector have to be taken into account when finally selecting the most appropriate baseline methodology.

Average emissions rate (all plants)

This is by far the simplest methodology for determining the baseline. It assumes that the project will displace a part of the overall electricity generation mix. The problem with this method is that it will include all plants with low operating costs that would normally operate as base load, including hydro or nuclear. However, it is unlikely that a new investment would displace generation from these plants and far more likely that an investment would displace the plants with higher operating costs such as oil and gas plants. This methodology may therefore not be accepted by investor countries, particularly when there is a large proportion of hydro and nuclear in the host countries generation mix.

Average emissions rate (excluding nuclear and hydro)

There will generally be technologies that will continue to operate despite the introduction of a JI project. The best example is storage hydro, which is extremely flexible and tends to operate at periods of high load. This is not because of high operating costs, but rather due to the ability to shift the hours of generation.

It has also been a trend in baseline determination to date to eliminate generation from all hydro and nuclear because the low operating costs mean that their generation will not be influenced by new plants in the grid. If hydro and nuclear are excluded from the baseline, the assumption needs to be clearly documented and justified.

Average emissions for each load category
This involves grouping the load profile into different load categories, such as seasonal, peak, shoulder and base loads. Having identified the load profile of the project, a direct comparison can be made with the same load category in the baseline projections.

Marginal plant only (Least cost dispatch analysis)
The least cost method assumes that the plants running at the margin (with the highest cost) will be the first to be replaced. The method should show the generation by each plant for each hour (or group of hours) in the year. The assumption is that the introduction of the new capacity will push out plants that are currently operating at the margin in the load duration curve. This analysis would require an evaluation of the last unit(s) to be switched on for each hour (or group of hours) in the year and thus the hourly marginal emissions rate. This type of approach is though to be the most accurate in terms of which unit will actually stop generating. The negative aspect is the quality and quantity of data necessary for this method.

Operating margin/build margin (IEA/OECD)
The OECD recommends a weighted average of both operating margin and build margin. This is based on the assumption that a JI project is likely to affect the operation of existing and new plant in the short term (operating margin) as well as delay the implementation of new plant in the long term (build margin). It is possible to use an electricity sector model to project both the build margin (projected new capacities) and also the operating margin.

3.1.1 Baseline Methodology Selection

State owned companies such as PA uses a variety of criteria to evaluate major investment decisions. These include social, environmental, political and economic criteria. Anyway, to find the baseline scenario for the GHG emission sources of the proposed project – investments on basic facilities of the agricultural farms - PA finally makes decisions based on economic criteria.

Consequently the investment approach has been chosen to be the best methodology for the determination of the baseline scenario with regard to the MM-systems.

The electric sector baseline methodology is defined by data availability of the Hungarian electric sector. In the case of the Palhalma project data for elaborating a least cost dispatch analysis are not public available.

Therefore an average emission approach excluding hydro and nuclear has been chosen for the Palhalma Joint Implementation project. The generation of the Palhalma JI project will directly affect the generation of power plants connected to the Hungarian grid; displacing those that have the highest marginal costs. Due to their low marginal costs, nuclear power plants are dispatched as base load, and their operation will not be influenced by the proposed project. Also the generation of the hydro power plants, which have the lowest operational costs, will not be affected by the Palhalma project.

Actual electricity sector data are published by MVM Rt ('Statistics of the Hungarian Power System'). In addition, the applied baseline methodology takes the expected development of the Hungarian electric power system into consideration, using the electric market forecast data published by the International Energy Agency.

3.2 Implausible Development Scenarios

In the IPCC Guidelines[6] possible MM-systems are listed in general. In the case of PA following scenarios are implausible:

3.2.1 Business as Usual

Currently the manure management (MM) systems of PA do not comply with any national or EU legislation. The systems at the animal husbandries do not have any leak proof grounds or facilities to protect the environment against infiltration emissions into the ground.

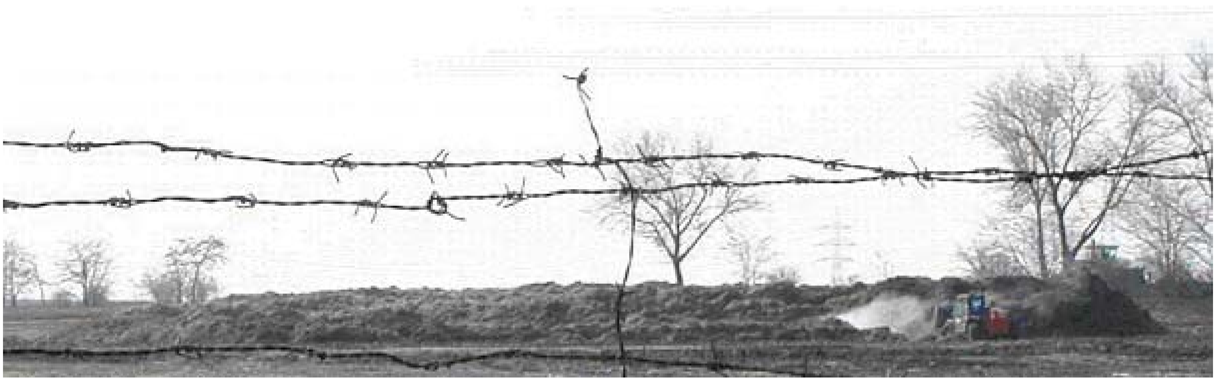

Figure 9 Manure Storage at Ùjgalambos

[6] IPCC Good Practice Guideance and Uncertainty management in National Greenhouse Gas Inventories Table 4.10.

The picture above shows the huge existing hills of muck at Ùjgalambos. It is not possible to continue with the current situation as these systems do not protect the environment against liquid emissions.

The picture below shows a waste storage at Hangos. Here, the ground is paved, but the liquid run off is not treated or collected in a proper way.

Figure 10: Manure Storage at Hangos

By and large the other storages at Parrag and Bernátkút are affected to the same deficiencies.

According to Hungarian regulation 49/2001 (IV.3)[7] PA has to secure leak proof reservoirs for manure storage. Hence, business as usual (BAU) of current manure management is not possible in future and thus BAU is not considered as likely baseline scenario.

3.2.2 Daily Spread

"Dung and urine are collected by some means such as scraping. The collected waste is applied to fields".

Daily spread is not possible because according to Hungarian regulation 49/2001 (IV.3) liquid manure has to be stored for 4 month and solid manure has to be stored for 8 month before it is allowed to apply it to fields.

[7] This regulation complies with the EU Council Directive 91/676/EEC of 12 December 1991 (OJ L 375, 31.12.1991).

3.2.3 Dry Lot

"In dry climates animals may be kept on unpaved feedlots where manure is allowed to dry until it is periodically removed. Upon removal the manure is spread to fields."

This MM system is implausible because Hungary´s climate is not dry. Furthermore unpaved feedlots are not plausible for large scale farming like at PA or Adonyhús.

3.2.4 Pasture/Range/Paddock

"The manure from pasture and range grazing animals is allowed to lie as is, and not managed".

PA does not have significant range grazing animals. However manure from grazing animals is not part of this study.

3.2.5 Pit Storage below animal confinements

"Combined storages for dung and urine below animal confinements."

Because of the long required storage time, pits would be too large to construct pits below animal confinements.

3.2.6 Burning of dung cakes

"The dung and urine are excreted on fields. The sun dried dung cakes are burnt."

The animals considered in this study are not range grazing animals. They are kept in husbandries, so that manure occurs at confined areas. MM-systems are necessary to manage this amount of manure. Dung cakes occur on grasslands where animals are grazing. In the case of PA where animals are kept in confined areas and the manure is managed in systems sun dried dung cakes do not occur. Therefore this scenario is very implausible.

3.2.7 Aerobic Treatment

"Dung and urine are collected as a liquid. The waste undergoes forced aeration in aerobic ponds or wetland systems to provide nitrification and denitrification"

An aerobic treatment and nitrification/denitrification process of manure is not required because PA has enough fields to apply all the nitrogen (170 kg N/ ha). A removal of nitrogen would only make sense if the area to apply the nitrogen is too small. But PA needs even more nitrogen to fertilize its fields as nitrogen is an important nutrient for plants. As it is described in Chapter 2.1 PA buys more than 1,319 t/a chemical fertilizer most of it is nitrogen fertilizer. Therefore an aerobic treatment of the manure is very implausible scenario for PA.

3.3 Plausible Development Options

To fulfill the requirements PA will have to rebuild more or less the whole manure management system. The following scenarios have been elaborated with PA´s managers Mr. Tamás Kovacs, Mr. Gabor Hetyei and Mr. Tibor Szaflary.

3.3.1 Scenario 1 – Solid Based MM-System

PA reconstructs the current MM-systems to comply with legislation. The slurry is stored in sealed tanks and a collecting pit for the liquid run of from will be installed at each husbandry.

The total investment for this is about 245.900 €. The method to apply the substrate to fields will not change. The application costs are about 10€/t.

3.3.2 Scenario 2 – Liquid/Solid Based MM-System

PA would install a new liquid based manure management (MM) system for pigs in Ùjgalambos and Bernátkút. The solid based systems in Parrag and Hangos would be refurbished.

Ùjgalambos	Pigs	Liquid based system
Bernátkút	Pigs	Liquid based system
Parrag	Cattle	Solid based system
Hangos	Cattle	Solid based system

Table 8: MM-Systems at PA

Currently there is a solid based system installed at Ùjgalambos and Bernátkút. But, handling the solids is very costly – especially transportation and spreading them to the fields. Therefore PA would prefer installing a liquid based system for pigs at Ùjgalambos and Bernátkút. The implementation of this system would require reconstruction of the pigsties, but even considering this investment, the liquid based system would be more economic than solid based systems. (Please compare the economy calculation in Annex: Liquid vs. Solid MM-System at Pig Husbandries)

Liquid based systems for pigs are common in this part of Hungary (e.g.: Adonyhús Kft.); especially for large scale pig farming this system is more economic than solid based MM systems.

In Parrag and Hangos (cattle husbandries) PA intends to retain the solid based system. The current systems will have to be refurbished to comply with legislation. Tight grounds and a proper collecting pit for liquids will be installed at Parrag and Hangos.

It is clear that it is not possible to continue with BAU. PA will have to secure leak proof manure storages and thus they have to invest. As it is shown in Annex: Liquid vs. Solid MM-System at Pig Husbandries; a liquid/solid based MM is more economic than a pure solid based MM-system for pigs. Thus PA will have to invest at least in a liquid/solid based MM-system for pigs and the refurbishment of MM-systems in Hangos and Parrag. Therefore the total investment is about 864,686 €.

3.3.3 Scenario 3 – Biogas Plant

PA built a biogas plant that is accomplished by the end of 2005. The biogas plant generates electricity and heat from renewable sources. The biogas plant and its storages solve the MM-problems of PA, as the project displaces the old leaking MM-systems. Electricity is directly fed into the public Hungarian electricity grid. Heat is used as energy source in the nearby laundry. Hot water for washing machines is produced and water for steam production is preheated.

Following feedstocks are fermented in the biogas plant. Pig manure, slaughterhouse wastes and remains from sun flower oil production are delivered from Adonyhús Kft:

Feedstock	
Pig manure	14.400 t/a
Cattle manure	15.000 t/a
Kitchen wastes	60 t/a
Slaughterhouse wastes	200 t/a
Wastewater from pig husbandries	23.120 t/a
Maize silage	12.000 t/a
Pig manure (Adonyhús)	25.000 t/a
Remains from sun flower oil production (Héliosz-Coop Kft)	35 t/a
Slaughterhouse wastes (Adonyhús)	440 t/a

Table 9: Feedstocks

The feedstocks are fermented in a mesophilic (about 38°C) biogas process. Slaughterhouse wastes are sanitized in special facilities before they are fed into the biogas plant. A two-stage fermenting process (primary and secondary digester) provides the full fermentation of the substrate and maximizes the biogas generation. The biogas is combusted in two biogas engines (combined heat and power engines), where electricity and heat is generated (13,376 MWh/a electricity; 14,944 MWh/a heat). The biogas engines do have following characteristics:

Efficiency		**Hours of Operation**	**Electric Capacity**	**Thermal Capacity**
electric	thermal	h/a	kW	kW
38%	46%	8.000	2 x 836	2 x 934

Table 10: Characteristics of the biogas engines

The electricity is sold and fed into the public Hungarian electricity grid. Biogas heat is delivered to the laundry, where natural gas is replaced.

The digested substrates are stored in sealed storages that are dimensioned to store liquids for 120 days to comply with legislation.

The liquid effluent of the biogas plant contains nutrients in a high quality state. PA uses the effluent to fertilize its fields and thus PA is able to reduce its chemical fertilizer demand. Liquids are also much easier to handle compared to solids, so that costs for manure application are reduced.

To build the biogas plant will need a further investment of about 3,581,000 € (considering funds of 1,600,000 € and opportunity costs). (Please refer to Annex: Baseline Scenario Biogas Plant for more details).

Following operational costs are associated with the biogas plant:

Operation costs		
Costs silage	216,000.00	Euro/a
Feedstock transport	36,665.08	Euro/a
Costs digested manure disposal to fields	154,850.58	Euro/a
Electricity demand	29,684.37	Euro/a
		Euro/a
Maintenance, Servicing biogas engine	99,200.00	Euro/a
Maintenance, Servicing engineering facilities	48,585.69	Euro/a
Maintenance, Servicing buildings	9,603.05	Euro/a
Personnel expenses	32,000.00	Euro/a
Insurance	25,798.28	Euro/a
Operation Costs Total	**652,387.05**	Euro/a

Table 11: Annual operational costs of Scenario 3

Beneath costs, operating the biogas plant will also be associated with annual revenues as follows:

Revenues / Savings		
Savings slaughterhouse wastes PA	43,200.00	Euro/a
Reduction of natural gas demand	41,049.64	Euro/a
Substitution of chemical fertilizer	67,440.36	Euro/a
Savings due to liquid manure disposal to fields	105,000.00	Euro/a
Electricity sales high tariff	353,929.06	Euro/a
Electricity sales low tariff	547,969.55	Euro/a
Slaughterhouse wastes Adonyhús Kft.	70,400.00	Euro/a
Revenues / Savings Total	**1,228,988.60**	**Euro/a**

Table 12: Annual revenues of Scenario 3

It should be mentioned that substituted feed in tariffs are only guaranteed until the end of 2010. Afterwards the revenues from electricity sales are calculated with a market price for base load electricity[8].

[8] Current market price for base load electricity is 30.27 € /MWh (www.e-control.at). A price increase of 4.5 % has been assumed.

4 Baseline Scenario Selection

As described in chapter 3.2.1, PA can not continue with the current system due to the current legal situation. PA has to provide leak proof manure storage systems, to protect the environment against liquid emissions. This legal situation makes investments necessary to install an adequate MM system.

There are two scenarios existing with low investment costs.

- Scenario 1: Construction of new basins at each husbandry (Scenario 1)
- Scenario 2: Construction of new basins at the cattle husbandries but installation of a liquid based MM-system at the pig husbandries (Scenario 2).

For cattle husbandries PA would retain the current manure management methods, but for pig husbandries there are two alternatives existing.

- Option 1: to continue using litter in the husbandries ("solid")
- Option 2: to switch to liquid based system, without litter ("liquid"). Such systems are quite common for pig husbandries in this region.

As it is shown in Annex: Liquid vs. Solid MM-System at Pig Husbandries; a liquid based MM system has more investment costs than a solid based system, because the liquid based system requires an adequate canalization system from the pigsties. The reconstruction of the current MM-systems at the pig husbandries would therefore be related to investment costs of about 137,470 € (option 1). Due to the required reconstruction of the pigsties and the required canalization system option 2 would have higher investment costs of about 756,247 €.

To finance investments of the active business PA does not take out loans. For these investments PA uses its cash flow for financing. Therefore PAs investments usually do not exceed about 230 Mio HUF (920,000 €). As scenario 1 as well as scenario 2 do not exceed this range, both of the scenarios are financially feasible for PA.

A more detailed analysis of both Scenarios shows that Scenario 1 is related to higher operating costs than Scenario 2. Handling solids is more costly than handling liquids. A cost comparison of the implementation between option 1 and option 2 in the pig husbandries shows following results (please refer to Annex: Liquid vs. Solid MM-System at Pig Husbandries):

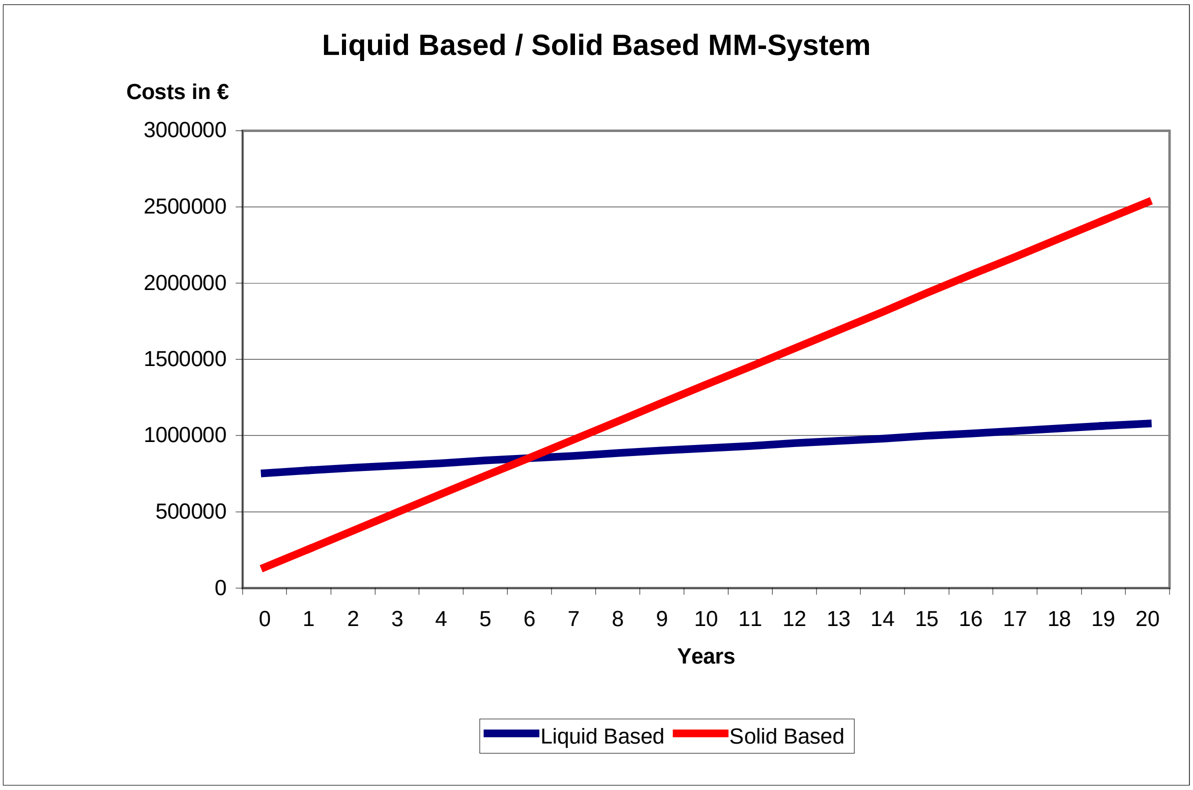

Figure 11: Liquid vs. Solid Based MM-System

In the medium term the liquid based option is more cost effective than the solid based option. The "break even" was calculated by 5.98 years. Considering the long lifetime of more than 20 years of these systems PA would prefer a liquid based MM-system in the pig husbandries and therefore scenario 2.

A biogas plant (scenario 3) is also able to meet the legal requirements for MM-systems. Furthermore the biogas plant is more than an investment for daily business, it expands PA´s product and service portfolio, as it produces energy and disposes organic "wastes". However, PA would not be able to finance it without an investment loan as the total investment costs are more than 6 Mio. €.

A financial analysis has been elaborated that is attached as Annex: Baseline Scenario Biogas Plant. IRR and NPV have been calculated for the biogas plant that shows following figures.

Financial Results	
IRR	5.3%
NPV	-463,691

Table 13: Economic Values of a biogas plant – Baseline Scenario

In contrast to scenarios 1 and 2, which would be financed out of the cash flow/regular investment program, PA would have to take out a loan. With an IRR of 5.3% and a NPV of -462,691 € the project is not attractive enough to be able to secure financing.

A sensitivity analysis on the investment cost and on the baseload price increase has been done. The increase of the baseload price increase is an important factor as the current regulation that guarantees a feed in tariff for electricity from renewable sources expires by the end of 2010 and it has to be assumed that after 2010, the feed in tariff complies with market prices for baseload electricity then.

An increase of the feed in tariff is very likely in the future. The electricity demand especially in Eastern Europe will increase that the currently installed capacities will not be able to meet. Moreover there are many power plants that have to be decommissioned because of lacking environmental or safety standards. Consequently new power plants will have to be constructed that will be associated with higher prices for baseload electricity. Therefore an price increase of the current market prices for baseload electricity of 4.5% per year on average has been assumed.

Beneath the sensitivity of the financial figures on the baseload price increase, the influence of a change of the investment costs has been analyzed. The results are shown below:

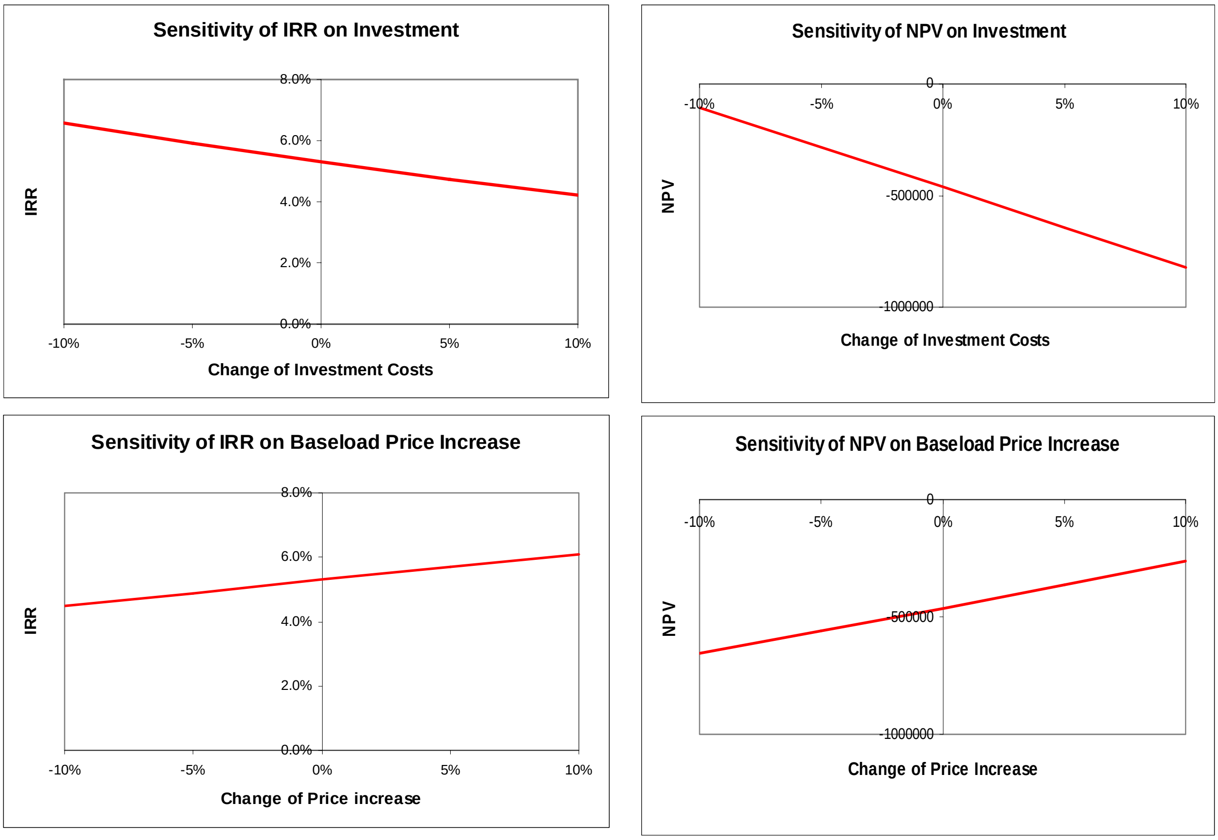

Table 14: Sensitivity Analysis

The sensitivity analysis demonstrates that even with a 10% reduction of the investment costs Scenario 3 shows a negative NPV and an IRR of 6.58% (The assumed discount rate is 7%)

The sensitivity of IRR and NPV on the baseload price increase that results in the assumed feed in tariff after 2010 shows that baseload price has to increase annually by 5.6 % on average, that the NPV of Scenario 3 is positive.

5 Project boundary

The project boundary is defined in terms of the system influenced by the operation of the proposed project.

As it is shown in the following figure, the project boundary includes following the anthropogenic and significant GHG emission sources that are affected by the proposed project.

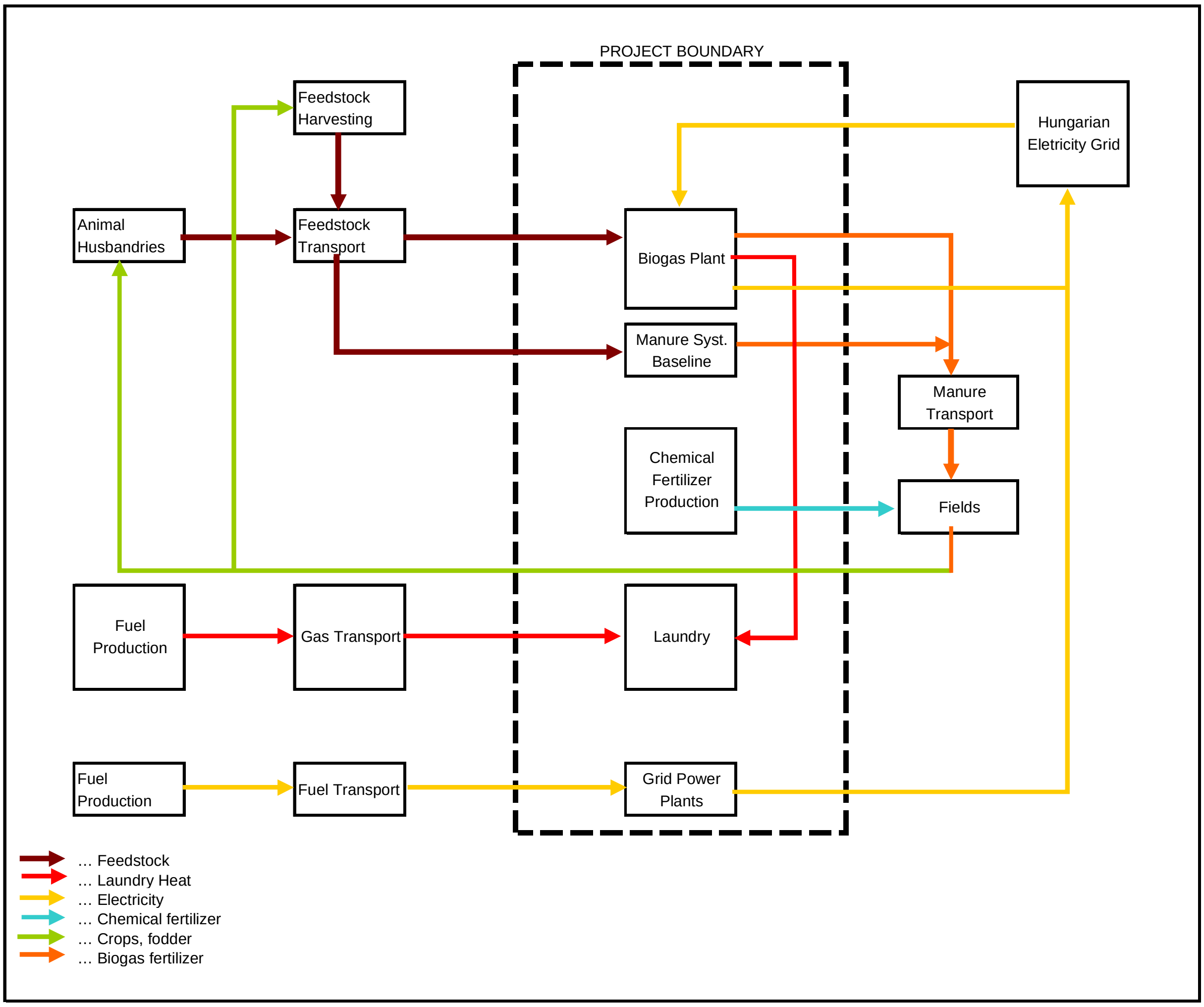

Figure 12: Project Boundary

The Biogas Plant is the heart of the proposed JI project. It is part of the project scenario and substitutes the conventional manure management systems of the baseline scenario. Methane emissions will be avoided by the biogas plant through capturing and combustion of the methane. Additionally energy crops are used to increase the production of biogas that is used to produce electricity and heat.

In the conventional manure management systems methane is produced under anaerobic conditions and released into the atmosphere. These systems are part of the baseline scenario that are substituted by the biogas plant (please refer to Chapter 6 "Description of the Baseline Scenario").

The biogas plant will generate electricity from renewable energy sources that will be fed into the Hungarian public electricity grid. Its operation will therefore directly affect the power plants connected to the grid by displacing output of those that have the highest marginal costs, since Hungary's law stipulates that power from renewable energy sources has to be taken over by the grid operator.

In the project scenario the heat from biogas will be used to heat water in the nearby laundry. Currently the laundry uses natural gas as energy source. Demand of natural gas will be reduced by using heat from the biogas plant.

The centralization of the manure management system in the project scenario will lead to an increase of transportation. The feedstock will have to be transported from the different animal husbandries (Parrag, Bernátkút, Hangos and from Adonyhús Kft.) to the biogas plant. Compared to the baseline scenario where each animal husbandry would have its own manure management system, the project would lead to an increase of transportation of about 81 km/day. However, calculating with emission factors from the IPCC Guidelines[9] the emissions caused by the additional transport is about 23.08 tCO_2e/year (<1% of total ER per year). As this is not a significant GHG source the transport of the feedstock will not be inside the project boundary.

Fuel production and fuel transport of the grid power plant are also not included in the project boundary. In the project scenario fuel demand will be reduced due to displacement of grid electricity by the project and hence less GHG emissions will occur during fuel production and transport. However, these sources are not inside the project boundary since the GHG reduction cannot be calculated at an acceptable degree of certainty. Fact is that GHG emissions of fuel production and transportation will be reduced and if is not within the project boundary, this will contribute to a conservative bias of the baseline.

The fermented manure is a high quality fertilizer. The nutrient losses will be reduced to a minimum in the project scenario, as all storages will be covered. Hence, the demand of chemical fertilizer can be reduced by applying biogas manure to the field. As chemical fertilizer production is a significant GHG-source, it will be considered in the project boundary.

Applying nitrogen fertilizer to fields will lead to GHG-emissions from soils in general. However, as the project (fermented manure in the project scenario instead of not fermented manure and chemical fertilizer in the baseline scenario) will not have a significant effect to the GHG-emission from soils and those emissions cannot be determined in an acceptable decree of certainty, GHG-emissions from soils will not be considered within the project boundary. Anyway, according to a research from K. Möller (2003)[10] the application of fermented manure will lead to less GHG emissions (N_2O) compared to the application of not

[9] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual; Page 1.82; Table 1-39. Please note, that emission factors for heavy duty vehicles (30 l/ 100km) have been used for this calculation.
[10] K. Möller (2003), "Systemwirkungen einer "Biogaswirtschaft" im ökologischen Landbau: Pflanzenbauliche Aspekte, Auswirkungen auf den N-Haushalt und auf Spurengasemissionen"; Page 9; http://www.uni-giessen.de/orglandbau/biogas-uebersicht

fermented manure, as anoxic conditions will be avoided due to the degradation of carbon during the biogas process which results in less bacteria activity in soils. *C. Lampe et al*. report that application of chemical (mineral) fertilizers is related to 22% more GHG emissions compared to liquid manure[11].

PA will grow and reap additional energy crops (maize) in the proposed project (3500 t dry matter). According to C.Wells[12] maize cropping is related to 87.1 kgCO_2e / t dry matter, including fertilizing seed production and harvesting. This results in additional GHG emission of below 1% of the total GHG baseline emissions. So this is not a significant amount and thus outside of the project boundary.

Leakages

Leakage refers to significant project induced changes in CO_2e emissions that occur outside the project boundaries. In Figure 12 GHG sources outside of the project boundary are indicated.

The project will not have any effects on the husbandries of PA or Adonyhús Kft. The enteric GHG emissions of the animals will not change because of the proposed project.

As it described before feedstock harvesting, feedstock transport and manure transport are not significant sources.

Fossil fuel transport and production (grid power plants) may be significant source. But they cannot determined in an acceptable degree of certainty and hence outside of the project boundary. Also displacing application of chemical (mineral) fertilizers by biogas fertilizer will lead to a reduction of GHG emissions. But these issues have not been explored sufficiently to allow acceptable determination of the GHG emissions. However, these kinds of impacts basically constitute of "positive" leakage.

Finally, no significant leakage can be anticipated in the proposed project.

[11] Carola Lampe et al, 2003; "Einfluss der N-Düngung auf die N_2O Emissionen auf Grünland"; page 39; http://www.riswick.de/pdf/gruenland/gruenlandtagung2003.pdf (from page 36 to 42).

[12] C.Wells 2001 "Total Energy Indicators of Agricultural Sustainability: Dairy Farming Case Study"; http://www.maf.govt.nz/mafnet/publications/techpapers/techpaper0103-dairy-farming-case-study.pdf

6 Description of the Baseline Scenario

6.1 MM-Systems of PA

At the pig husbandries in Ùjgalambos and Bernátkút liquid based systems (anaerobic lagoons) will be installed. The systems will be leak proof sealed to comply with Hungarians regulation 49/2001 (IV.3). The systems will have a storage capacity of 4 month as it is required and are built for 13.000 (current 10500) pigs in total. Because of the change to liquid based systems, litter will not be necessary in the pig husbandries anymore.

The MM-systems at Parrag and Hangos will be rebuilt. Leak proof solid storages will be built to store cattle wastes for 8 month. About 1800 t of litter will be necessary for the cattle husbandries in Parrag and Hangos. The litter will be managed together with the manure in the MM-system.

Ùjgalambos	Pigs	Liquid based system
Bernátkút	Pigs	Liquid based system
Parrag	Cattle	Solid based system
Hangos	Cattle	Solid based system

Table 15: PA MM-systems - Baselinescenario

6.2 MM- System at Adonyhús Kft.

The current system (anaerobic lagoons) will be retained. The manure ponds will be sealed to comply with legislation.

6.3 Laundry

The laundry will not to change its energy source as the installations are quite new. Natural gas will be used to heat water and produce steam as it is described in Chapter 2.2.

6.4 Chemical Fertilizer Demand and Production

PA will retain to fertilize its fields with chemical fertilizer. The products will remain the same as they are used actually. The fertilizers will be produced in factories with “Average Europe “- standard.

6.5 Electric Grid Power Plants

In the baseline scenario PA do not generate electricity and thus grid electricity is not displaced. Without the biogas plant the grid power plants operate like it is described in Chapter 2.4.

7 Description of the Project Scenario

PA built a biogas plant that is accomplished by the end of 2005. The biogas plant generates electricity and heat from renewable sources. The biogas plant and its storages solve the MM-problems of PA, as the project displaces the old leaking MM-systems. Electricity is directly fed into the public Hungarian electricity grid. Heat is used as energy source in the nearby laundry. Hot water for washing machines is produced and water for steam production is preheated.

7.1 Feedstocks

Following feedstocks are fermented in the biogas plant. Pig manure, slaughterhouse wastes and remains from sun flower oil production are delivered from Adonyhús Kft:

Feedstock	
Pig manure	14.400 t/a
Cattle manure	15.000 t/a
Kitchen wastes	60 t/a
Slaughterhouse wastes	200 t/a
Wastewater from pig husbandries	23.120 t/a
Maize silage	12.000 t/a
Pig manure (Adonyhús)	25.000 t/a
Remains from sun flower oil production (Adonyhús)	35 t/a
Slaughterhouse wastes (Adonyhús)	440 t/a

Table 16: Feedstocks

Before slaughterhouse and kitchen wastes are put into the digesters, the wastes are sterilized in a sterilization facility[13].

7.2 Feedstocks Input

Solid feedstocks are delivered into the acceptance hall and dumped into two feedstock batchers. Each of these batchers is dimensioned to store feedstock for 2 days. In the batchers the feedstock is cut with a milling machine and fed into the primary digesters via worm type feeders.

Wastewater from the pig husbandries in Ùjgalambos is directly fed in the mixing pit. The other liquid substrates from Adonyhús Kft. are collected in an acceptance pit to ensure accounting of delivery.

[13] According to EU-regulation 1774/2002/EG slaughterhouse wastes (category 2 and 3) has to be sterilized before fermentation in biogas plants.

7.3 Primary Digesters

The primary digesters are designed as complete-mixed digester or as plug-flow digesters[14]. To ensure a retention time of about 23 days the total volume is 6000 m³ (2 complete-mixed digesters with 3000m³ each) and 3000 m³ (3 plug-flow digesters with 1000³ each) respectively. The digesters are heat insulted to reduce heat demand.

2 paddle agitators in each complete mixed digester and 1 vertical paddle agitator in each plug-flow digester ensure mixing of the substrate. Heat from the biogas CHP is used to heat the digesters. The primary digesters are operated mesophilic at a temperature of about 38°C.

7.4 Secondary Digesters

Secondary digesters ensure the full fermentation of the substrate. They are designed like complete-mixed digesters. The retention time there is 30 days that means that they have total volume of 8.500 m³ (2 secondary digesters with 4500 m³ each). The secondary digesters are also operated mesophilic (about 38°C).

7.5 Gas Holder

Above each secondary digester there is a gas holder installed. The total volume of the gas holder is 2.640 m³. With this amount of biogas the engines are operating approximately 4 h at full load.

7.6 Biogas CHP

In the digesters approximately 6.000.000 m³ biogas per year with about 60% methane is produced during the degradation process by the bacteria. The biogas is combusted in biogas engines (combined heat and power engines), where electricity and heat is generated (13,376 MWh/a electricity; 14,944 MWh/a heat). The biogas engines do have following characteristics:

Efficiency		Hours of Operation	Electric Capacity	Thermal Capacity
electric	thermal	h/a	kW	kW
38%	46%	8.000	2 x 836	2 x 934

Table 17: Characteristics of the biogas engines

Before the biogas is combusted in the biogas engines the gas is dehydrated and desulfurized. In the case of a breakdown of the engines there is an emergency flare installed, that avoids methane emissions if the engines are out of order.

[14] The final design of the primary digesters is determined after the tender process in cooperation with the plant constructor.

The biogas plant has an own electricity demand of about 6% of total electricity production (803 MWh/a). Therefore the net amount of electricity that is fed into the public Hungarian electricity grid is 13,376 MWh/a.

7.7 Digested Manure Storage

According to Hungarian regulation liquid manure storages must have a capacity for at least 120 days. Therefore the storages have a capacity of 36.000 m³.

The storages are designed as lagoons. They have a leakage detection system and are covered to avoid nitrogen emissions. The lagoons are surrounded by fences.

7.8 Digested Manure Disposal - Fertilizing

The digested manure is distributed to fields by dribble bar distributors. These systems bring the fertilizers directly to the ground and the nutrient losses are reduced to a minimum.

Because of the high fertilizer quality of biogas manure, the chemical fertilizer demand of PA can be reduced by 814.158 kg in total. The different types of fertilizer are substituted as follows:

Displaced Chemical Fertilizer		
MAP 11:52	126.741	kg
K60	65.061	kg
Nitrosol	0	kg
Fertisol	0	kg
MAS	251.223	kg
UREA	371.133	kg
Total	**814.158**	**kg**

Table 18: Substituted Chemical Fertilizer

7.9 Laundry

Biogas heat is delivered to the laundry. In a heat exchanger the heat is transferred. Out of the exchanger 85°C hot water is piped in two hot water tanks. One stores hot water with 60°C for the standard washing program. The other stores hot water with 85° C for the special washing program. Steam is injected in the washing machines to heat the water from 85°C to the required 90°C. Because of the substitution of natural gas, PA saves costs for natural gas.

8 Additionality

According to the Kyoto Protocol, a JI project should result in a GHG emission reduction that is additional to any that would occur otherwise.

The project results in GHG emission reduction, and thus additional revenues. Considering these revenues in the financial analyses the biogas plant shows economically viable values. Without them PA would not decide to construct the biogas plant.

As it is described in Chapter 11 the proposed project generates 262,000 tCO_2e between 2006 and 2012.

	AAUs		ERUs				
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
GHG ERs in tCO_2e	37,887	37,722	37,561	37,403	37,249	37,142	37,037

Assuming a rather conservative price of 6 €/tCO_2e and an advance payment of 30 %, following JI revenues (including costs for validation and verification) would occur:

		Total	2005	2006	2007	2008	2009	2010	2011	2012	2013
JI Payments											
30% Advance Payment	€		471,601								
JI-Payments			471,601	0	0	0	207,413	224,418	223,494	222,852	222,224
JI-Costs	€		12,000		12,000	6,000	6,000	6,000	6,000	6,000	6,000
JI-Revenues	**€**	**1,512,003**	**459,601**	**0**	**-12,000**	**-6,000**	**201,413**	**218,418**	**217,494**	**216,852**	**216,224**
Assumed Price	6	€/ tCO2e									

Table 19: JI - Revenues

Considering the JI-revenues in the financial analysis of the Baseline Scenario 3 – biogas plant, the Scenario shows economically viable figures[15].

Financial Results		
	with JI	**without JI**
IRR	9.6%	5.3%
NPV	630,732 €	-463,691 €

Table 20: Financial Results of Baseline Scenario 3 – with and without JI revenues

Without JI revenues the project would have an IRR of 5.3% and a NPV of -463,691 € (please refer to chapter 3.3.3). As it is mentioned before the biogas plant expands PA´s product portfolio, but PA would logically expand its lines of business with businesses that ensure economic viable figures. Furthermore PA would need an investment loan that PA would not get without economic viable figures for the project.

[15] Details of Financial Analysis are shown in
Annex – Baseline Scenario Biogas Plant with JI

Considering JI revenues the project shows an IRR of 9.6 % and a positive NPV of 630,732 €. With economic viable figures PA is able to secure financing the biogas plant by taking out a loan for this investment. Therefore the proposed project is additional.

Furthermore the proposed project is the first biogas project that undergoes an official approval process. Because of the non existing approval process for biogas plants PA´s project is a pioneer project in these issues and has to clear the approval hurdle. The project therefore paves the way for other biogas plants in Hungary. Biogas technology is an important technology for the environmentally sound development of Hungary´s agricultural sector. There is a huge potential for this beneficial technology as there are many large scale agricultural farms. The JI status is very important factor for the awareness of the authorities. Hence the JI project helps to accelerate the approval process and provide important arguments for the project and following biogas projects

Additional JI-revenues have an important effect to the projects financial figures. The revenues lead to economically sound figures that allow financing the project. Considering this and the barrier described above make the project additional in the course of JI.

9 Baseline Emissions

9.1 Emissions from MM-systems

Manure is principally composed of organic material. When this organic material decomposes in an anaerobic environment, methanogenic bacteria produce methane (CH_4). These conditions often occur when large numbers of animals are managed in confined areas.

For the calculation of this methane emission factors from the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Chapter 4.3) have been used.

Following equations have been used:

$tCO_2\ e = GWP_{(Methane)} * CH_{4\ [MM]}$

GWP = Global Warming Potential for methane = 21

$CH_{4\ [MM]}$ = Emission Factor $_{[MM]}$ * Population / (10^6 kg/Gg)

Emission Factor (EF) $_{[MM]}$ = emission factor for the defined livestock population
Population = the number of head in the defined livestock population

$EF_{[MM]} = VS_i * 365\ days/year * Bo_i * 0{,}67\ kg/m^3 * MCF_{jk}$

VS_i = daily volatile solids (VS) excreted for animal within defined population i, in kg
Bo_i = maximum CH_4 producing capacity for manure produced by an animal within defined population i, m^3/kg of VS
MCF_{jk} = CH_4 conversion factors for each manure management system j by climate k

9.1.1 Volatile Solids - VS

In the Revised 1996 IPPC Guidelines for National Greenhouse Gas Inventories: Reference Manual page 4.39 (Table B-1) and page 4.42 (Table B-2) following figures of VS for pigs, diary cattle and non diary cattle are found:

Type of Animal	*Unit*	*VS*[16]
Pigs	[kg/hd/day]	0,5
Diary Cattle	[kg/hd/day]	5,1
Non Diary Cattle	[kg/hd/day]	3,9

Table 21: VS of Pigs, Diary Cattle and Non-Diary Cattle

[16] As emission reduction will occur first in 2006 when the biogas plant is operating, Hungary has already been two years in the EU and Western standard in the agriculture sector will be reached.

9.1.2 CH_4 Producing Capacity - Bo

For calculating the methane emissions following CH_4 producing capacity for the different types of manure have been used[17].

Type of Animal	*Unit*	*Bo*
Pigs	[m³CH_4/kgVS]	0,45
Diary Cattle	[m³CH_4/kgVS]	0,24
Non Diary Cattle	[m³CH_4/kgVS]	0,17

Table 22: Bo of Pigs, Diary Cattle and Non-Diary Cattle

9.1.3 Methane emission from Litter

1800 t/a litter will be used in the cattle husbandries in Parrag and Hangos. The organic material is also decomposed in the MM system.

Litter		*Unit*
VS[18]	88	[%]
Bo[19]	0,6	[m³CH_4/kgVS]

Table 23: VS and Bo of Litter

9.1.4 Methane Conversion Factors – MCF

Default MCF values are provided in the IPCC Guidelines for different manure management systems and climate zones.

The MM-systems described in the Baseline Scenario result in following MCFs according to the IPCC Good Practice Guidance and Uncertainty Management in National Green House Gas Inventories page 4.36 (table 4.10)[20].

MM system	*Type of MM*	*MCF*
Ùjgalambos	Anaerobic Lagoon	100 %
Bernátkút	Anaerobic Lagoon	100 %
Hangos[21]	Liquid/Slurry	39 %
Parrag	Liquid/Slurry	39 %
Adonyhús Kft	Anaerobic Lagoon	100 %

Table 24: MCF of MM-systems – Baseline Scenario

[17] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual page 4.39 (Table B-1) and page 4.42 (Table B-2)
[18] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories; Table 4.16
[19] Derived from "Landwirtschaftliche Biogasanlagen" G. Jüngling, 1999; page 17
[20] The annual mean temperature in Pálhalma is below 15°C → „Cool Climate“
[21] An analysis of the existing storages shows that the substrate has a dry matter content of 21 %. Therefore a substrate stored in tanks with sealed grounds would have lower dry matter content. IPCC guidelines draw the line between liquid/slurry and solid MM-system by 20% dry matter content. Thus the MM-systems at Hangos and Parrag would be categorized as liquid/slurry MM-system according the IPPC guidelines.

9.1.5 Development of Livestock – Baseline Scenario

To calculate the emission reductions over the years it is assumed that number of animals will stay constant. In real PA expects an increase of the livestock. These expectations also comply with different studies (e.g. "Agriculture and the Environment in the EU Accession Countries"[22]). However, in order to calculate the emission reduction in a conservative approach, the numbers of animals over the years remain at the level of 2003.

	Type of animal	2003 - 2012
PA	Pigs	10,540
PA	Diary Cattle	709
PA	Non diary cattle	690
Adonyhús Kft.	Pigs	7,030

Table 25: Livestock

9.1.6 Total CH_4 emissions from MM-systems in the baseline scenario

The total CH_4 emissions in tCO_2e are summarized in following table:

PA Kft		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Pigs	t CO_2e	12,179	12,179	12,179	12,179	12,179	12,179	12,179
Diary cattle	t CO_2e	1,738	1,738	1,738	1,738	1,738	1,738	1,738
Non diary cattle	t CO_2e	916	916	916	916	916	916	916
Litter	t CO_2e	5,215	5,215	5,215	5,215	5,215	5,215	5,215
Adonyhús Kft								
Pigs	t CO_2e	8,123	8,123	8,123	8,123	8,123	8,123	8,123
Total	t CO_2e	**28,172**	**28,172**	**28,172**	**28,172**	**28,172**	**28,172**	**28,172**

Table 26: Baseline CH_4 emission from MM-system

9.2 Emissions from Electricity Production in Hungarian Grid Power Plants

The development of the electricity baseline scenario is based on two main sources.
(1) Actual Hungarian Electricity Data (MVM)
(2) Hungarian Electricity Forecast Data (IEA)

Actual electricity sector data are published by MVM Rt. The primary task of MVM Rt is to purchase electricity from Hungarian power stations and abroad, and sell it on to the distribution companies via its supply network. The group is active in the generation of electrical energy, international trade, the development and operation of the national grid and dispatch. MVM is a state-owned company. Therefore MVM is the most accurate actual data source. Apart from its Annual Reports, MVM publishes statistical reports 'Statistics of the Hungarian Power System', which are available at the MVM homepage[23].

[22] http://reports.eea.eu.int/environmental_issue_report_2004_37/en/IssueNo37-Agriculture_for_web_all.pdf
[23] http://www.mvm.hu/

Electricity market forecast data are published by the International Energy Agency (IEA) in its country review of the Hungarian energy sector in June 2003.

The approach to estimating the Hungarian electricity grid emission factor is to use the fuel mix excluding nuclear and hydro and other renewable energy sources. The logic is that the nuclear and hydro will never be displaced because they are the least cost sources. In the absence of more detailed data (otherwise hourly dispatch data will be required) this transparent approach will be applied for this baseline study.

9.2.1 Hungarian Electricity Sector Forecast

In 2002 total amount of electricity produced in Hungary was about 35,000 GWh. As it is shown in Table 27 about 59.5 % of this amount was produced in fossil fuel power plants, about 39.9% in nuclear power plants and 0.6% in hydro power plants. According to the baseline approach, further calculations are based on the figures, given in the last column of the Table 27, the share of fossil fuel based electricity generation.

Electricity Generation 2002	GWh	% total	% fossil
Coal (Lignite)	8,663	24.8%	41.7%
Fuel Oil	2,074	5.9%	10.0%
Natural Gas	10,043	28.8%	48.3%
Hydrocarbons as total	12,117	34.7%	58.3%
Fossil Fuels as total	20,780	59.5%	100.0%
Hydro Power	195	0.6%	
Nuclear Power	13,953	39.9%	
Total	**34,928**	100.0%	

Table 27: Actual Electricity Generation 2002

On of the key factors determining the specific electricity emission factors is the efficiency of the power plants within the project boundary. Plant categories specific efficiencies are published by MVM. Table 28 shows the plant categories specific efficiencies in 2002.

Efficiencies 2002	Electricity Output	Fuel Input	Efficiency
	GWh	PJ	%
Coal	8,663	107.9	28.9%
Fuel Oil	2,074	22.8	32.8%
Natural Gas	10,043	106.5	34.0%
Hydrocarbons as total	12,117	129.2	33.8%
Fossil Fuels as total	20,780	237.1	31.6%
Nuclear Power	13,953	148.8	33.8%

Table 28: Efficiencies 2002

Based on the electricity sector forecast, published by the International Energy Agency, Figure 13 shows the development of the electricity generation up to 2020. The average annual growth rate of the Hungarian electricity generation is forecasted by about 1% per year.

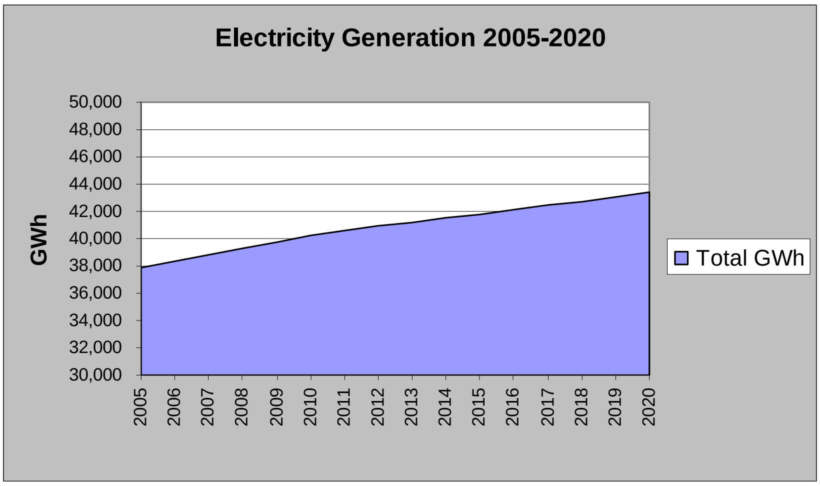

Figure 13: Electricity Generation 2005-2020 (IEA Forecast)

The following table summarizes the IEA forecast of the annual change in fossil fuel electricity generation. Details are described in the 'Energy Policies of IEA Countries, Hungary Review 2003', published by the International Energy Agency[24].

Increase/Decrease IEA		Coal	Oil	Gas
2000-2005	%/a	-2.02%	1.16%	0.85%
2005-2010	%/a	-0.68%	-0.29%	0.98%
2010-2020	%/a	-0.53%	0.42%	0.11%

Table 29: Change in Fossil Fuel Electricity Generation 2000-2020

Based on the actual figures given in Table 27 and the Hungarian specific electricity forecast data summarized in Table 29, the following table gives the expected generation share of fossil fuelled power station until 2012.

Generation Mix	2002	2006	2007	2008	2009	2010	2011	2012
Coal	41.7%	34.9%	34.3%	33.6%	32.9%	32.2%	31.7%	31.2%
Fuel Oil	10.0%	13.2%	12.9%	12.6%	12.3%	12.0%	12.4%	12.8%
Natural Gas	48.3%	51.9%	52.8%	53.8%	54.8%	55.8%	55.9%	56.0%
Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 30: Electricity Generation: Fossil Fuelled Power Plants

As shown in Table 30 Hungarian coal fired power generation will decrease (31.2% of total fossil fuelled power generation in 2012), whereas the natural gas fired power generation will increase to about 56% in 2012.

In order to apply a conservative baseline approach, it is assumed that all new natural gas fired power plants will be combined cycle units with a conversion efficiency of 57.5%. Efficiencies of new oil and coal fired power plants are expected to be 47%.
From an economic point of view it is obvious, that decommissioned coal fired power plants will be those with the lowest conversion efficiency. For the sake of a conservative baseline

[24] http://www.iea.org/

approach and taking the decommissioning of coal fired power plants into consideration, efficiency improvements of coal fired power plants are considered in this baseline study. Therefore the efficiency of coal-fired power plants will slightly increase, resulting in 31.9% in 2012. Table 31 shows the specific plant efficiencies and the total weighted fossil fuelled power plant efficiency.

Total Plant Efficiency		**2002**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Coal Power Stations	%	28.9%	30.1%	30.4%	30.7%	31.0%	31.3%	31.6%	31.9%
Oil Power Stations	%	32.8%	36.4%	36.4%	36.3%	36.3%	36.3%	36.6%	37.0%
Gas Power Stations	%	34.0%	36.5%	37.0%	37.5%	38.0%	38.5%	38.7%	38.9%
Total Efficiency	**%**	**31.6%**	**34.0%**	**34.4%**	**34.8%**	**35.2%**	**35.6%**	**35.9%**	**36.2%**

Table 31: Plant Efficiencies – Total Weighted Efficiency

Increasing total fossil fuel based electricity generation (2005-2012) will be mainly satisfied by gas fired power production, whereas coal based generation will slightly decrease. Therefore the expected total weighted efficiency of fossil fueled power plants will increase from actual 31.6% (2002) to about 36.2% in 2012.

The figures shown above result in Hungarian specific electricity emission factors as shown in Table 32 using IPCC carbon factors of 0.36, 0.26, 0.20 tCO_2 per MWh of fuel input for coal, oil and gas respectively.

Hungarian Emission Factors		**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Electricity Emission Factor	tCO2/MWh	0.81	0.79	0.78	0.77	0.75	0.75	0.74

Table 32: Hungarian Electricity Emission Factors 2006-2012

The specific Hungarian electricity emission factors are expected to decrease in the time span 2006 to 2012. Based on the applied methodology the emission factor for the year 2006 is about 0.81 t CO_2 /MWh and will fall to 0.74 t CO_2 /MWh in the year 2012.

As argued above, these GHG emission factors for electricity generation are conservative and lead to a conservative estimation of emission reductions. As mentioned in the IPCC Guidelines for National GHG inventories, locally available data should be used wherever possible. In the absence of more detailed data, electricity emission factors as described in Table 32 will be used for the Palhalma JI project.

As mentioned in chapter 7.6, the biogas block CHP has an electric capacity of 2*836 kW. Based on 8000 hours of operation the annual electricity output is about 13,380 MWh. The own electricity demand of the biogas plant is about 6% (803 MWh), resulting in total net 12,573 MWh fed into the public Hungarian electricity grid.

Finally, Table 33 summarizes the baseline electricity CO_2 emissions 2006-2012.

Summary Baseline Electricity		2006	2007	2008	2009	2010	2011	2012
Block CHP Net Generation	MWh	12,573	12,573	12,573	12,573	12,573	12,573	12,573
Emission Factor	tCO2/MWh	0.81	0.79	0.78	0.77	0.75	0.75	0.74
Electricity CO2 Emissions	**tCO2**	**10,129**	**9,964**	**9,803**	**9,646**	**9,492**	**9,385**	**9,280**

Table 33: Baseline Electricity CO_2 Emissions

9.3 Emissions from Natural Gas Combustion in the Laundry

The project results in a reduction of gas demand in laundry of 136.832 m³ natural gas.

Laundry Special Washing	[m³ natural gas/a]	12,468.48
Laundry Standard Washing	[m³ natural gas/a]	124,363.64
Total	[m³ natural gas/a]	**136,832.12**

Table 34: Reduced Natural Gas Demand

Calculating with heat value of 10 kWh/m³ natural gas and an emission factor[25] of 0.20196 tCO_2e/MWh the gas demand equals to GHG emissions of 276 tCO_2e/a.

9.4 Emissions from Chemical Fertilizer Production

PA currently uses fertilizers containing nitrogen (N), phosphorus (P) and potassium (K). Beneath chemical fertilizers PA also spreads its manures from pig and cattle husbandries to its fields resulting in following amount of nutrients.

	N		P		K	
Cemical Fertilizer	333,000.40	kg	69,316.00	kg	175,866.00	
Pig manure	60,480.0	kg	86,400.0	kg	57,600.0	kg
Cattle manure	72,000.0	kg	75,000.0	kg	165,000.0	kg
PA´s fertlizer	**465,480.40**	**kg**	**230,716.00**	**kg**	**398,466.00**	**kg**

Table 35: Nutrients PA´s Fertilizer

The effluent of the biogas plant (digested organic material) comprises these nutrients in high quality. The PA biogas substrate contains following amount of nutrients:

		N		**P**		**K**	
	t/a	kgN/t FM	kg N	kgN/t FM	kg N	kgN/t FM	kg N
Pig manure Adonyhús	25,000	4.5	112,500.0	3.5	87,500.0	3.5	87,500.0
Pig manure PA	14,400	4.2	60,480.0	6.0	86,400.0	4	57,600.0
Cattle manure PA	15,000	4.8	72,000.0	5.0	75,000.0	11	165,000.0
Slaughterhouse wastes	640	8.0	5,120.0	2.5	1,600.0	0.15	96.0
Remains from sun flower oil prod.	35	31	1,085.0	1	35.0	51	1,785.0
Kitchen wastes	60	5	300.0	3.3	198.0	5	300.0

[25] The emission factor is derived Table 1-2, page 1.6 of the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories workbook.

Silage	12,000	3.5	42,000.0	2	24,000.0	4.2	50,400.0
Wastewater from husbandries	31,200	1	31,200.0	0.4	12,480.0	0.4	12,480.0
Total	98,335		324,685.00		287,213.00		375,161.00

Table 36: Nutrients of PA´s Biogas Fertilizer

About 73,335 t of biogas fertilizer will be used for fertilizing Pas fields. It is envisaged that he rest will be used by Adonyhús Kft. PA will logically save the fertilizers with the highest costs per nutrient. With using the biogas fertilizer PA displaces following chemical fertilizers.

Substitution	kg	€/kg nutrient
Nitrosol	74,094	0.39
Karbamid	0	0.35
Fertisol	0	0.38
MAS	275,000	0.45
MAP 11:52	133,300	-
K-60	95,305	-
Total	**577,699**	

Table 37: Substitution of chemical fertilizers

GHG emissions from fertilizer production are calculated by using a model established by Hydro Agri Europe[26]. The following tables show the calculation of the GHG emissions in chemical fertilizer production. In general each fertilizer product (for further details please compare Annex: Chemical Fertilizers of PA). Chemical fertilizers consist of one or more building blocks and additives. In the emission factors for each building block listed below are all GHG emissions (CO_2e) from raw material to fertilizer products considered. The fertilizers used by PA are produced in production companies in Eastern Europe (Hungary, Ukraine, Russia, and Croatia). Without much doubt this production companies are relatively old. In order to calculate the emission reduction in a conservative bias, emission factors of "average Europe" technology have been chosen.

Product Name	Building Block *	Emission Factor * tCO2e / t	Substituited Amount t Fertilizer	GHG Emissions tCO2e
K60	MOP	0.34	95	32.40
Karbamid	UREA	0.61	0	0.00
MAP 11:52	MAP 11:52	0.31	133	41.32
Nitrosol	CAN	1.82	74	134.85
Fertisol	AS	0.34	0	0.00
MAS 27	AN 33.5	2.28	275	627.00
Total			**578**	**835.58**
* see Annex "Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production"; G.Kongshaug, 1998				

Table 38: GHG Emissions from Chemical Fertilizer Production

The substitution of chemical fertilizer at PA by biogas manure results 835 tCO_2e per year in total. Following emission factor can be calculated:

ER	835.58	tCO2e
Biogas Fertilizer	73335.00	m³
Emission Factor	0.0114	tCO2e / m³

Table 39: Emission Factor - Substitution of Chemical Fertilizer Production by Biogas Fertilizer

[26] see „Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production"; G.Kongshaugm 1998; the study is part of the Annex: Energy Consumption and GHG emissions in Fertilizer Production

10 Emissions of the Project Scenario

In the project scenario organic material is fermented in the biogas plant. Biogas generated there during the degradation process in the digesters is captured and combusted in the biogas engines. If any breakdown of these engines would happen, the biogas is flared by an emergency gas flare. Except the lagoons to store the digested substrates all tanks and vessels (mixing pit, equalizing tank,…) are designed gas proof. Furthermore air from the acceptance hall is cleaned in a biofilter before it is released to the environment. Anyway, significant amount of methane will not arise there. The digested manure storages are covered so that nitrogen losses are reduced to a minimum.

Consequently only the storages for the digested substrates provide potential sources for GHG emissions. Anyway, methane formation is rather low there, as the substrate has already been fermented before and the hydraulic retention time in the digesters is long (53 days). However, full fermentation cannot be guaranteed. After the fermentation process in the digesters, the formation of 2 % of the total biogas generation potential is realistic. In order to calculate these emissions conservatively, the emissions are calculated with 3 %.

The calculation of the project emissions are shown below, therefore the project is related to 1,526 tCO_2e per year, that results from methane formation in the storages of digested substrates.

PROJECT GHG EMISSIONS		Unit
Total biogas formation	6,026,280	m³/a
% of biogas formation in the storages	3%	
Biogas from storages	180,788	m³/a
% methane in the biogas	60%	
Density methane	0.67	kg/m³
GWP	21	
GHG emissions of the biogas plant	1,526	tCO_2e

Table 40: Emissions of the Project Scenario

11 Emission Reductions

The forecast of the emission reductions can now be derived as the difference between the emissions of the baseline and the project scenarios as it is tabulated below. Therefore the total reduction is 262,000 tCO_2e that is expected to achieve between 2006 and 2012 (AAUs and ERUs).

	AAUs		ERUs				
GHG emissions in tCO_2e	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Baseline Scenario	39,413	39,248	39,087	38,929	38,775	38,668	38,564
Project Scenario	1,526	1,526	1,526	1,526	1,526	1,526	1,526
Emission Reductions	37,887	37,722	37,561	37,403	37,249	37,142	37,037

Table 41: PA Biogas Plant - Emission Reductions

12 Annexes

12.1 Annex: Liquid vs. Solid MM-System at Pig Husbandries

File: < Annex - Liquid vs. Solid >

12.2 Annex: Baseline Scenario Biogas Plant

File: < Annex - Baselinescenario Biogas Plant >

12.3 Annex: Chemical Fertilizers of PA

File: < Annex - Chemical Fertilizer of PA >

12.4 Annex: Project Time Schedule

File: < Annex - Project Time Schedule >

12.5 Annex: Statement of the General Director of Hungarians Prison Service

File: < Annex - Statement General Director of Hungarians Prison Service >

12.6 Annex: Energy Consumption and GHG emissions in Fertilizer Production

File: < Annex - Energy Consumption and GHG emissions in Fertilizer Production >

12.7 Annex – Baseline Scenario Biogas Plant with JI

File: < Annex – Baseline Scenario Biogas Plant with JI >