1664

Hostetin Biomass Heating Project

registration Joint Implementation test project

annexes to registration form

September 1999

SENTER

CONTENTS

PART 2
DESCRIPTION OF THE JOINT IMPLEMENTATION PROJECT

2.A TITLE

Hostetin Biomass Heating Project

2.B PROJECT SUMMARY

The Hostetin Biomass Heating Project is a Joint Implementation demonstration project for the use of wood chips and solar panels for domestic heating. It includes the installation of a 733 kW_{th} wood fuel plant, installation of about four solar panels as well as provision of training and technical assistance. It also includes the establishment of an information centre for biomass energy and other renewable energy sources.

The biomass system will be connected to the new village district heating system and is to replace present brown coal, coal, wood and electricity based heating systems in Hostetin, a small village in the White Carpathians.

Earlier international reports indicate White Carpathian as potential European area for extensive medium scale biomass energy use. The project is strongly supported by the local municipality and inhabitants of Hostetin, the Ministry of Environment and the regional government. The regional government is in particular keen to support the project as part of its policy to promote the utilisation of biomass throughout the White Carpathian region and the project also fits in a national strategy for utilisation of renewable energy sources. This offers an excellent opportunity for the Dutch biomass energy industry to strengthen its position in the Czech Republic in general and in the White Carpathians in particular.

The project is expected to reduce the emissions of the greenhouse gases CH_4 and CO_2 and to reduce the emissions of ash and sulphur dioxide.

Advantages of the project are summarised as follows:

- the project contributes to the reduction of the greenhouse gases CH_4 and CO_2;
- the use of sustainable energy is stimulated by substituting wood for coal, brown coal and electricity;
- the project serves as a demonstration case for other JI projects;
- contacts between Czech and Dutch investors and industries are stimulated and new investments of Dutch industry in the Czech heating sector are facilitated;
- use of a local available fuel increases the autonomy of the region as well as the Czech independency with regard to supply of energy sources.

2.C OBJECTIVES

Long term objectives

To reduce greenhouse gases CH_4 and CO_2 by wide spread utilisation of biomass for energy production.

Specific long term objectives

Specific long term objectives are:

- Demonstration of successful biomass energy systems in industry and public bodies;
- Institutional development of biomass energy in the Czech Republic;
- Creating export opportunities for the Dutch biomass energy industry;
- Continuous exchange of know-how and experiences on biomass energy.

Short term objectives

The short term objectives are:

- Cost-effective reduction of CH_4 and CO_2 by utilisation of currently disposed biomass residues in a 733 kW_{th} biomass heating boiler;
- Replacement of fossil fuels resulting in additionally reduced emissions of ash and sulphur dioxide;
- Strong Dutch positioning in the rapidly developing biomass energy market in the Czech Republic;
- Establishing of a large export market for the Dutch biomass energy industry.

2.D PROJECT DESCRIPTION

2.D.1 Project type

The project is carried out under the PSO programme of the Dutch Ministry of Economic with TEI Twente Energy Institute as applicant, BTG Biomass Technology Group as executing member, KARA Energy Systems as manufacture, Obec Hostetin (Municipality of Hostetin) as recipient, Ecological Institute Veronica as local project management and Bio Pal as local technical assistant.

The project type is characterised by the replacement of the present heating system (brown coal stoves, coal stoves and electric heating systems) of 68 houses with a 733 kW_{th} boiler combusting clean biomass and four solar systems. Besides the delivery of hardware the project will organise information exchange & dissemination activities in the field of biomass energy by the use of a “Energy Centre Hostetin”.

Biomass as a renewable energy source

Wood residues from forestry activities and urban areas are a big renewable resource which, in the form of wood chips, may be utilised for energy production. The biomass fuelled boiler will not add new emissions of carbon dioxide (CO_2) to the atmosphere. This is a result of the fact that the wood fuel, while it is grown, absorbs all the CO_2 which it will emit later on when it is burnt. The size of CO_2 emission reduction is equal to the CO_2 otherwise emitted by the replaced non-renewable fuel. The idea of CO_2 emission reduction by biomass substitution for fossil fuels is illustrated in Figure 1.

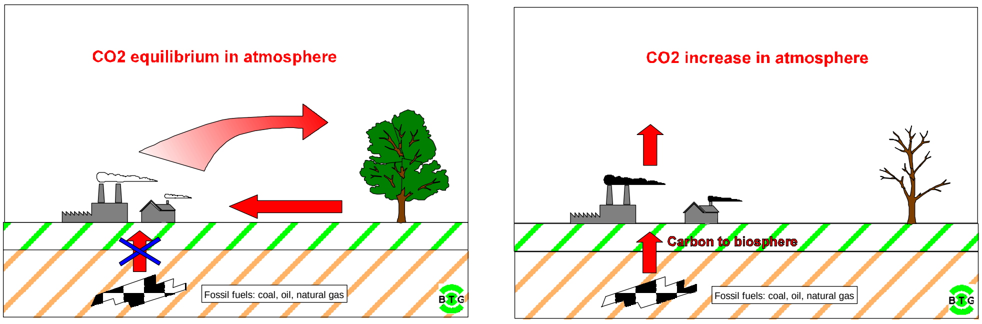

Figure 1, The closed (left) and open (right) carbon cycle.

The utilization of biomass as a substitute for fossil fuels results in a net decrease of CO_2 emissions if at least one of the following conditions is satisfied:

1. Either the biomass is provided from a renewable source,
2. Or the biomass is taken from a source which is otherwise converted into CO_2 without making efficient use of it.

In the case of this project both condition apply: The biomass concerned is waste wood residues from urban green areas which is a renewable resource.

2.D.2 Project planning

Following table gives an overview of the scheduled planning of this project.

Planning sheet of the project. Month 1 = January 1999

Phase/month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Product 1: Inception Report																								
Inception activities	■	■																						
Detailing the financial feasibility		■																						
CV's M. Kundrata, Y. Gailly and R.		■																						
Insight in wood supply (overview)		■																						
Detailing energy saving measures		■																						
Product 2: Demonstration Plant																								
Kara prepares final design and		■																						
Design & engineering for the biomass		■	■																					
Construction (Kara, NL)			■	■	■	■	■																	
Inspection in NL (BTG)							■																	
General local preparations/civil works			■	■	■	■	■	■	■															
Installation of district heating network				■	■	■																		
Construction of boiler house,					■	■	■	■																
Transport from NL to CZ (Kara)								■																
Installation, training and commissioning									■															
After care (Kara/BTG)										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Product 3: Transfer of know-how																								
Preparations (TEI/Veronica)	■																							
Proposal on expenses to Senter for		■																						
Draft info package village / draft		■																						
Draft materials & formats, installation of			■																					
Establishment of Info Centre, web site,				■																				
Information material Energy Conf in					■																			
Video and photo's of construction				■	■	■	■	■	■															
Extensive Information Campaign (TV,									■															
Information Centre operation				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Information Exchange				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Preparations Biomass Energy Course					■	■	■	■	■	■														
Biomass Energy Course (BTG/Veronica)											■													
Veronica House with permanent													■	■	■	■	■	■	■	■	■	■	■	■
Product 4: Joint Implementation																								
Letter of Intent (Dutch Ministries)	■	■																						
Registration at JIRC (BTG)									■															
Baseline monitoring (Veronica)										■	■	■												
Monitoring (Bio Pal)												■	■	■	■	■	■	■	■	■	■	■	■	■
Evaluations and presentations in NL													■	■	■	■	■	■	■	■	■	■	■	■
Quarterly reports (BTG)			■			■			■			■			■			■			■			■
Go/no go points			■						■															

2.D.3 Organisational structure

TEI is applicant for this project. BTG is the project co-ordinator for this project. The partners are Obec Hostetin (Municipality of Hostetin), KARA Energy Systems, Ecological Institute Veronica and Bio Pal. KARA Energy Systems will manufacture and implement the biomass fired heat boiler. Obec Hostetin is the recipient, Ecological Institute Veronica is responsible for local project management. Bio Pal is the local technical assistant in the Czech Republic.

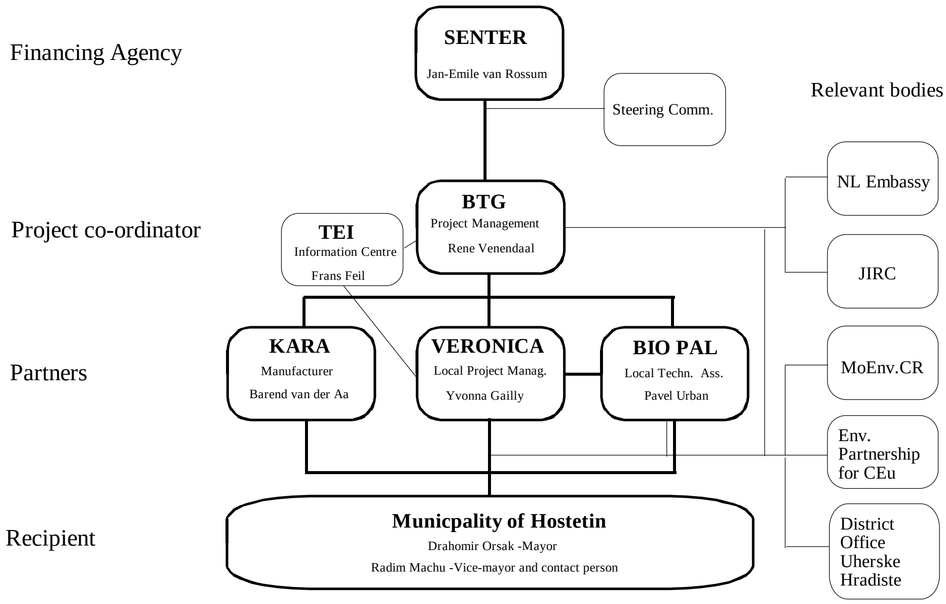

Figure 2 Organisation chart

2.D.4 Technical risks

In general it can be stated that the technical risks of this project are very limited as a commercially proven technology will be used. The hardware from The Netherlands will be of a high quality and will be constructed and installed by a qualified manufacturer.

Supposed investments in energy saving measures done by consumers would reduce heat consumption. A decreased heat load can be avoided by a prospective new connection to the district heating network.

The biomass needed for this project has to fulfill specific specifications. If the biomass differs from the requested specification technical problems could occur. To overcome this problem the requested specifications for the biomass are included into the delivery contracts.

2.D.5 Organisational risks

Whereas Obec Hostetin is responsible for its operation and maintenance, there could be a risk of improper maintenance of the installation due to limited financial funds. However, this risk is minimized because of Obec Hostetin's direct interest with proper maintenance. Lack of maintenance would immediately affect the village's own heat provision.

An interrupted fuel supply could influence the success of the project. To over this risk contracts with neighbour waste wood producers have been signed.Back-up supply is partly secured by local villagers, which are in possession of forests. This would provide wood from some 170 ha. Assuming 2 t/ha/yr, this would bring 340 t/yr, almost 50% of the required amount.

2.D.6 Economic risks

An economic risk could be the price of the fuel used in this project. To overcome this risk contracts have been signed for supply of waste wood at a price 100 CZK/ton.

Heating costs may be relatively high in the beginning compared to gas fuelled systems (villagers tend to compare heating costs with those of relatives in other villages which are connected to gas). This difference is, however, expected to develop in favour of the biomass systems as gas prices are expected to increase substantially in the next 2-3 years. Expected is a doubling of gas price for domestic use by 2002. At present heating costs are expected to be around 160 CSK/GJ which is still well below the average district heating price of 200 CSK/GJ.

It is essential that the project can be continued during a reasonable lifetime of about 15 yr. If shorter, the actual cost of realised emission reductions will turn out to become much higher.

2.D.7 Current status

The project has started on January 1, 1999. Within the inception phase the contracts are signed with Ecological Institute Veronica, Municipality of Hostetin, Bio Pal and TEI.

The engineering and construction of the installation in The Netherlands are finished by KARA. The construction of the district heating network and civil works are executed in the village Hostetin.

The Information Centre has been established and a setup has been made for the information exchange by World Wide Web.

The activities around the energy saving measures are started. During a summer course in 1999 a training is given on insulation of windows in the houses. As example one public and three private houses are insulated.

2.D.8 Letter of intent

The Letter of Intent from both the Dutch Ministry of Economic Affairs and the Czech Republic Government is duely signed. BTG has no influence on this process and will depend on the progress in the negotiation between the two signed governments.

2.D.9 Monitoring

Reduction of CO_2 is established in relation to the base line case. The following emission balance shows the emission of greenhouse gases for the base line and project alternative. The last row summarises the net CO_2 equivalent emission avoided by the project. CO_2 emissions from combustion of wood residues are cancelled out by the CO_2 uptake of the same wood during growth. The items of which the emissions are cancelled out appear italic in the balance.

Emission balance comparing present situation (stoves and electric heating) and biomass fuelled boiler

Global warming effect	**Base line (present situation)**	**Project (biomass fuelled)**
CO_2 emission	from coal, brown coal and *wood* combustion in stoves	
	biological degrading wood residues	*from biomass combustion*
	from brown coal combustion in power plants to produce the needed electricity in the electricity based heating system	
	from coal, brown coal and wood transport to Hostetin	from transport of biomass from wood resource to Hostetin
CH_4 emission (CO_2 equivalence factor: 21)	biological degrading wood residues	
	from coal, brown coal, wood combustion in stoves	
CO_2 uptake	*by growing tree parts which, in Baseline, will become processing residues*	*by growing tree parts which are used as fuel (In Baseline these would become processing residues)*
Net CO_2 equivalent emission **avoided** by the **project**	CO_2 from coal, brown coal combustion in stoves + CO_2 from brown coal combustion in power plants + CO_2 from coal, brown coal and wood transport to Hostetin - CO_2 from transport of biomass from wood resource to Hostetin + 21x CH_4 from biological degrading + 21x CH_4 from combustion in stoves	

Calculations of CO_2 equivalent emissions are primarily based on the consumption of coal, brown coal and electricity needed in the present heating system of 68 houses. Using the specific CO_2 equivalent emission (t $CO_2/GJ_{primary\ energy}$), the avoided t CO_2 equivalent of (brown) coal combustion and transport of the fuel will be calculated.

Proposed method of monitoring is to register the following parameters:
- Actual quantity of heat made available to the district heating system;
- Wood amount combusted.

2.E BENEFITS OF THE PROJECT

2.E.1 Environmental benefits

The wood fuelled boiler avoids the use of fossil fuels, thereby reducing the emission of greenhouse gas in the atmosphere and reducing the SO_2 emissions. The quantity of avoided CO_2 emission for the 733 kWth is 3,355 t CO_2 eq./year. The SO_2 emissions will be reduced by 19.3 t SO_2/year.

The wood fuel used is a renewable energy source which replaces the fossil fuel coal.

By the use of wood residues a biological degrading of wood is avoided and the emission of the produced methane is avoided.

2.E.2 Social-cultural benefits

Wood is a locally available fuel. This increases the value added of the region in question.

Advantage from a national perspective is the increased supply security of energy sources due to the local availability of wood.

2.E.3 Economic benefits

The project is a collaboration of Dutch and Czech partners with regard to both investments and organisation. The successful project serves as a demonstration case for other possible investments of Dutch parties in the heating sector and stimulates new investments.

The project will save expenses for (brown) coal fuel.

2.F RELATION WITH NATIONAL DEVELOPMENTS

Czech National Programme for Energy Saving and Use of Renewable Energy Sources

The Concept of the National Programme was agreed by the Czech government on July 8, 1998. The detailed National Programme for the year 1999 elaborated by the Ministry of Industry and Trade and Ministry of Environment was submitted to the Czech government on December 7, 1998.

The material is based on the Frame strategy for decreasing the energy demand of the Czech republic. The Czech republic was obliged to develop such strategy by its signature and ratification of the Protocol of Energy savings and connected environmental aspects which is a part of the European Energy Chart. (The Protocol entered into force on April 16,1998).

According to the estimation of the Czech Ministry of Environment the potential for savings and renewables in the Czech Republic is about 35% of the nowadays use of primary sources (390 - 430 PJ/y). The renewables themselves could contribute by about 8% (90 - 100 PJ). The contemporary use of renewables is about 2% of the use of primary sources. In this figure are included also big hydro energy plants.
(Recommendation of EU - 12%, the official estimation for the Czech Republic in 2010 is 5-6%).

Financial part

In the Concept it was supposed the National programme will obtain about 1.2 billions CZK for the year 1999. Nevertheless in the reality less than 60% of the proposed amount was allocated to the Programme from the state budget (no increase was achieved in comparison with the year 1998!).

In the plan of the Czech Ministry of Environment (through the State Environmental Fund) there was support of following project:

- substitution of fossil fuels for heating purposes by biomass (also combined with solar) in residential buildings and social care buildings, in healthcare buildings and schools;
- phase out of direct electric heating and substitution by renewable sources;
- phase out of direct electric heating and substitution of fossil fuels for heating purposes by heat pumps;
- construction of small hydro plants;
- construction of wind energy plants;
- construction of biomass plants for combined production of electricity and heat;
- construction of solar systems.

Other programmes of the Ministry of Environment involved in the National Programme:

- Research
- Education

Other Ministries involved in the National Programme:

- Ministry of Industry and Trade - through the Czech Energy Agency - Energy savings in buildings;
- Ministry of Agriculture;
- Ministry of Regional Development.

PART 3
GLOBAL STUDIES

3.A GREENHOUSE GAS EMISSIONS

3.A.1 Step 1: Description of base line and methodology

Base line

The base line consists of 68 houses in the village Hostetin which are currently heated by:

- Central heating with electric boiler or direct electric heating (9 houses);
- Electric (and coal) oven and direct electric heating (27 houses);
- Coal and wood heating (32 houses).

Methodology

The project reduces the amount of greenhouse gases compared to the baseline case. Emissions for the base line case are calculated by an estimation of the fuel use of the 68 houses in Hostetin and the specific emission figures for the stoves. Reduction of CO_2 emission for the project is calculated by comparing emissions of the base line case with emissions of the 733 kW_{th} wood fuelled boiler applied for heating. This is illustrated in the emission balance as shown in the following table.

The last row summarises the net CO_2 equivalent emission avoided by the project. CO_2 emissions from combustion of wood processing residues and biological degrading of wood residues are cancelled out by the CO_2 uptake during its growth. The items of which the emissions are cancelled out appear italic in the balance.

Emission balance comparing present situation (stoves and electric heating) and biomass fuelled boiler

Global warming effect	Base line (present situation)	Project (biomass fuelled)
CO_2 emission	from coal, brown coal, *wood* combustion in stoves	
	biological degrading wood residues	*from biomass combustion*
	from brown coal combustion in power plants to produce the needed electricity in the electricity based heating system	
	from coal, brown coal and wood transport to Hostetin	from transport of biomass from wood resource to Hostetin
CH_4 emission (CO_2 equivalence factor: 21)	biological degrading wood residues	
	from coal, brown coal, wood combustion in stoves	
CO_2 uptake	*by growing tree parts which, in Baseline, will become processing residues*	*by growing tree parts which are used as fuel (In Baseline these would become processing residues)*
Net CO_2 equivalent emission **avoided** by the **project**	CO_2 from coal, brown coal combustion in stoves + CO_2 from brown coal combustion in power plants + CO_2 from coal, brown coal and wood transport to Hostetin - CO_2 from transport of biomass from wood resource to Hostetin + 21x CH_4 from biological degrading + 21x CH_4 from combustion in stoves	

3.A.2 Step 2: Emission of greenhouse gases prior to the start of the project (baseline information present heating system)

The emission of greenhouse gases for twelve successive months prior to the start of the project for the present heating system (stoves and electric heating) are reviewed as follows:

Green house gas	Resulting from:	ton	G.W.P	Quantity (t CO_2 eq./yr)
CO_2 emission	Combustion fossil fuels	1434	1	1,434
	Biological degrading wood residues			Cancelled out
	Transport of (brown) coal and wood in present situation	2.1	1	2.1
CH_4 emission	Biological degrading wood residues	91	21	1,905
	Combustion fossil fuels	0.4	21	8.5
CO_2 uptake	Growing tree parts which, in Baseline, will become processing residues			Cancelled out
Total				**3,350**

Calculations:

CO_2 emissions by combustion fossil fuels

The base line consists of 68 houses which are heated by stand alone separate heating systems (stoves and electric heating). To estimate the fuel used by the present heating system a survey is executed by the 68 households. By the use of the results of this survey the CO_2 emission of the combustion of the fossil fuels of the 68 houses is calculated as follows:

Input parameters	**Brown coal**	**Coal**	**Wood**	**Electricity**	**Source**
Annual consumption (ton)	248	19	190		Veronica (survey)
Annual consumption (kWh)				585,000	Veronica (survey)
Energy content (GJ/unit)	14.73	24.5	9.84	0.0036	Veronica
Efficiency (thermal)	55%	60%	50%	95%	[Okken et al., 1992]
Carbon content fuel (% wet basis)	39.4%	63.3%	29.5%	39.4%	Veronica
Average electrical efficiency brown coal power plants (including losses electrical network)				20%	Veronica
Results					**Total**
Annual secondary energy produced (GJ/yr)	2,009	279	935	2,001	5,224
Annual secondary energy produced (percentage division)[1]	38%	5%	18%	38%	100%
Annual primary energy converted (GJ/yr)	3,653	466	1,870	10,530	16,518
Specific CO_2 emission/GJ primair energy[2]	0.10	0.09	0.11	0.10	
Annual CO_2 emissions (ton/yr)	358	44	cancelled out	1,032	**1,434**

CH_4 emissions by combustion fossil fuels

During the degasification process by the combustion of brown coal, coal and wood in stoves CH_4 is emitted. These emissions are calculated as follows:

Input parameter	**Brown coal**	**Coal**	**Wood**	**Total**	**Source**
Annual consumption (ton)	248	19	190		Veronica
Energy content (GJ/unit)	14.7	24.5	9.8		Veronica
Efficiency (thermal)	55%	60%	50%		[Okken et al., 1192]
Specific CH_4 emissions (g/MJ primair energy)	0.03	0.03	0.15		[Okken et al., 1192]
Result					
Annual secondary energy produced (GJ/yr)	2,009	279	935	3,223	
Annual primary energy converted (GJ/yr)	3,653	466	1,870	5,988	
CH_4 emissions in ton CO_2 eq./yr	2.3	0.3	5.9	**8.5**	

[1] This division will be used in the monitoring phase

[2] $$\frac{molar\,mass\,CO_2(44)\ (\ \ carbon\,content\,fuel(\%)}{molar\,mass\,C(12)\ (\ \ NCV_{fuel}(MJ/kg)}$$

Transport of fuels to the village Hostetin

The fuels used in the present situation are transported by railway and road to the village Hostetin. This transport results in an emission of 2.1 t CO_2 per year.

Input parameters			**Source**
Truck use	Full go, empty return		
Transport distance to coal mines by railway	130	km	Veronica
Transport distance to coal mines by road	50	km	Veronica
Transport distance to brown coal mines by railway	450	km	Veronica
Transport distance to brown coal mines by road	50	km	Veronica
Distance of wood resources to Hostetin	10	km	Veronica
Specific CO_2 emission railway transport	8	g/t km	[Kaltschmitt et al., 1996]
Specific CO_2 emission road transport	76	g/t km	Kaltschmitt et al., 1996]
Results			
Annual coal quantity transported to Hostetin	19	ton/y	this report
Annual brown coal quantity transported to Hostetin	248	ton/y	this report
Annual wood quantity transported to Hostetin	190	ton/y	this report
Annual equivalent railway transport units	114,070	t km/yr	
Annual equivalent road transport units	15,250	t km/yr	
CO_2 emission present transport	**2.1**	**t/yr**	

Anaerobe digestion of dumped wood residues

After wood residues are dumped the available oxygen in the dump is used for the (aerobic) decomposition of organic materials. This process will last a short period (a few days or weeks) because the amount of oxygen is very limited. The heat produced during this phase will cause an increase of the temperature to 30-50°C [Scheepers et al., 1994]. After this aerobic process has been completed the anaerobic digestion will take place in which among other components methane is formed. During this phase the temperature of the dump will decrease in a few years due to a loss of heat to the surrounding.

The annually avoided methane release from anaerobic digestion of the wood residues is determined by the two factors:

- the amount of carbon that is converted;
- the duration period of its degradation.

The amount of carbon in the wood residues is analysed as 50% on dry basis [Landolt-Börnstein, 1972]. In this baseline study two models are used to estimate the amount of carbon available for methane formation:

- The carbon in wood can be divided into the components lignin, hemi-cellulose and cellulose. Under anaerobic conditions lignin decays very slowly [Messner, 1999]. It may last 1000s of years. However, hemi-cellulose and cellulose do decompose under anaerobic circumstances. The carbon in wood consist of about 35% of lignin, whereas the remaining 65% consists of hemi-cellulose and cellulose. This implies that 0.33 kg of carbon is available for the formation of methane for each dry kg of wood.

- In the Waste Management Workbook, published by the Australian Greenhouse Office, calculations are made to estimate the amount of methane out of dumps. According to this workbook the amount of carbon available for methane formation can be calculated with the following equation:

  $$\frac{C_{oe}}{C_o} = 0.014 \times T + 0.28$$

  where C_{oe} is the amount of carbon available for methane formation, C_o is the total amount of carbon, and T is the temperature (°C) [AGO, 1997]. Assuming a temperature of 36°C and an amount of carbon of 0.50 kg per kg dry wood leads to an amount of carbon available for methane formation of 0.39 kg C/kg dry wood.

Not all the available carbon will be converted to methane. Environments which are less favourable for the relevant bacteria results in lower digestion rates. In landfills the part of the available carbon that is converted to methane is 50% to 60% [Scheepers et al., 1994]. In this baseline study is assumed that 50% of the available carbon is converted to methane (forming factor). This leads to a methane emission 0.22 kilograms per kilogram dry wood by using the first model and 0.26 kilograms methane per kilogram dry wood with the second model[3].

The total yield of methane is not released as soon as decomposition commences. The methane is generated over time, and the degradation rate varies across types of organic components. Following table shows the duration over which half of the degradable fraction in dumps is decomposed. In all cases, decomposition of the remaining degradable matter extends over long periods of time.

Duration over which half of the degradable fraction in dumps is decomposed [AGO, 1997]:

Type of waste	**Years**
Food	1
Garden	5
Cardboard	15

[3] Use has been made of the respective molar mass of 12 and 16 for C and CH_4

The basic pattern is that methane generation from a particular quantity of waste is highest in the two years after waste has been dumped. During this time, anaerobic digestion of most of the degradable content of wastes occurs [AGO, 1997]. Therefore, in this project is assumed that the methane emission of a kg dumped wood residues is 0.22 kg methane and this methane will be released over two years.

The method used as described results in a CH_4 emission of 1,910 ton CO_2 eq. by dumping 763 ton wood. Because of an emission period of two years, 955 ton CO2 eq. will be emitted in the first year. In the following years 1,910 ton CO_2 eq. will be emitted.

With the method described the CO_2 emissions is calculates as follows:

Input parameters			**Source**
Carbon content wood	50%	dry basis	[Landolt-Börnstein, 1972]
(hemi-)Cellulosis content of C in wood	65%		BTG analysis
Forming factor (available C to methane)	50%		[Scheepers et al., 1994]
Moisture content wood	55%		assumed
Annual quantity of wood not dumped	388	ton wood (at 55% moisture, wet basis)	this report
CO_2 equivalent of CH_4	21	t CO_2 eq./t CH_4	IPCC
Emission period	2	year	this report
Results			
Specific methane emission	0.22	kg CH_4/kg dry wood	
Quantity CH_4 produced	0.12	kg/kg wood (at 55% moisture, wet basis)	
Quantity CH_4 produced	23	ton CH_4/yr	
Annual CH_4 emission in CO2 equivalents	486	t CO_2/yr	

3.A.3 Step 3: Emission of greenhouse gases during the period of the project without the proposed reduction measures

The emission of greenhouse gases during the period of the project without the proposed reduction measures are the same as under baseline. For 15 years of project (without mitigating measures), the emissions of the first 5 years are given:

Year	1	2	3	4	5
CO_2 (t CO_2 eq./yr)	1,437	1,437	1,437	1,437	1,437
CH_4 (t CO_2 eq./yr)	961	1,914	1,914	1,914	1,914
N_2O (t CO_2 eq./yr)		0	0	0	0
HFK's (t CO_2 eq./yr)	0	0	0	0	0
PFK's (t CO_2 eq./yr)	0	0	0	0	0
SF_6 (t CO_2 eq./yr)	0	0	0	0	0
Other	0	0	0	0	0
Total (t CO_2 eq./yr)	2,398	3,350	3,350	3,350	3,350
Total (t CO_2 eq.; 15 yr project lifetime)	49,300				
Discounted to year 1 (15 yr project lifetime)	33,866				
Discount rate (%)	5%				

Although not specifically demanded by JIRC, also the discounted emissions of a project lifetime of 15 yr has been displayed.

3.A.4 Step 4: Emission of greenhouse gases during the course of the project with the proposed reduction measures

The CO_2 emissions from fuel wood combustion is cancelled out by the growing tree parts. The CH_4 is not formed because the wood is used in the wood fuelled boiler instead of dumped. The emissions that occur are the emissions during transport of the biomass to the village Hostetin. These emissions are calculated as follows:

Input parameters			**Source**
Capacity	733	kW_{th}	
Capacity factor[4]	23%		
Efficiency wood boiler	70%		KARA
Net calorific value wood (55% MC_w)	9.84	MJ/kg	estimated
Density of processing residues	130	kg/m^3	estimated
Truck use	Full go, empty return		
Distance wood source to boiler	10	km	Veronica
Specific CO_2 emission	76	g/t km	[Kaltschmitt et al., 1996]
Results			
Annual full load equivalent capacity	23,116	GJ/yr	
Annual secondary energy produced	5,244	GJ/yr	
Annual primary energy converted	7,491	GJ/yr	
Annual wood quantity	761	t/yr	
Annual equivalent transport units	7,613	t km/yr	
CO_2 emission wood transport to boiler	0.6	t/yr	

For 15 years of project the emissions of the first 5 years are given:

Year	**1**	**2**	**3**	**4**	**5**
CO_2 (t CO_2 eq./yr)	0.6	0.6	0.6	0.6	0.6
CH_4 (t CO_2 eq./yr)	0	0	0	0	0
N_2O (t CO_2 eq./yr)	0	0	0	0	0
HFK's (t CO_2 eq./yr)	0	0	0	0	0
PFK's (t CO_2 eq./yr)	0	0	0	0	0
SF_6 (t CO_2 eq./yr)	0	0	0	0	0
Other	0	0	0	0	0
Total (t CO_2 eq./yr)	0.6	0.6	0.6	0.6	0.6
Total (t CO_2 eq.; 15 yr project lifetime)	9				
Discounted to year 1 (15 yr project lifetime)	6				
Discount rate (%)	5%				

Although not specifically demanded by JIRC, also the discounted emissions of a project lifetime of 15 yr has been displayed.

3.A.5 Step 5: Reduction in the emission of the greenhouse gases during the course of the project with the proposed reduction measures

The difference between the yearly greenhouse gas emission of the present situation to a wood fuelled boiler with a capacity of 733 kW_{th} is summarised below for the first 5 years. Calculated emission reduction is the avoided yearly CO_2 equivalent. As long as the wood fuelled boiler is operational, the CO_2 emission to the atmosphere is reduced.

Emission reduction with project:

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[4] 4,800 running hours: (October-March) and a load factor (average of nominal capacity) of 42% results in a capacity factor of 23% for the wood boiler. The load factor is extrapolated from an average heat consumption of the 68 houses in Hostetin.

Year	1	2	3	4	5
CO_2 (t CO_2 eq./yr)	1,436	1,436	1,436	1,436	1,436
CH_4 (t CO_2 eq./yr)	961	1,914	1,914	1,914	1,914
N_2O (t CO_2 eq./yr)	0	0	0	0	0
HFK's (t CO_2 eq./yr)	0	0	0	0	0
PFK's (t CO_2 eq./yr)	0	0	0	0	0
SF_6 (t CO_2 eq./yr)	0	0	0	0	0
Other	0	0	0	0	0
Total (t CO_2 eq./yr)	2,397	3,350	3,350	3,350	3,350
Total (t CO_2 eq.; 15 yr project lifetime)	49,291				
Discounted to year 1 (15 yr project lifetime)	33,860				
Discount rate (%)	5%				

Although not specifically demanded by JIRC, also the discounted emissions of a project lifetime of 15 yr has been displayed.

3.B OTHER ENVIRONMENTAL ISSUES

3.B.1 Step 1: Baseline for other environmental aspects

The base line consists of 68 houses in the village Hostetin which are currently heated by:

- Central heating with electric boiler or direct electric heating (9 houses);
- Electric (and coal) oven and direct electric heating (27 houses);
- Coal and wood heating (32 houses)."

Methodology

The project reduces the emissions of other gases compared to the baseline case. Emissions for the base line case are calculated by an estimation of the fuel use of the 68 houses in Hostetin (by a survey) and specific emission figures for the stoves used in Hostetin. Reduction of other emission for the project is calculated by comparing emissions of the base line case with the other emissions of the 733 kW_{th} wood fuelled boiler applied for heating.

3.B.2 Step 2: Environmental and safety measures

The wood fuelled boiler is Dutch technology and complies with the local environmental regulations and in the most cases the Dutch regulations. However the dust emissions of the wood boiler are guaranteed at <150 mg/Nm^3 (11% O_2), with an normally expected dust emission of 80-120 mg/Nm^3 (11% O_2). This will fulfill the dust emissions standards of the Czech Republic of 250 mg/Nm^3 (11%O_2).

3.B.3 Step 3: Emission other gases prior to the start of the project (baseline information)

The following table summarises the other emissions by the heating system (brown coal stoves, coal stoves, wood stoves and electric heating) of the 68 houses in the village Hostetin.

Other gases	Quantity (ton/yr)
NO_x	?
O_3	
CO	19.9
SO_x	5.1
Dust	?
Other	

The input parameters to estimate the annual emission of the present heating system in Hostetin (brown coal stoves, coal stoves, wood stoves and electric heating) are as follows:

Input parameters	**Brown coal**	**Coal**	**Wood**	**Electricity**	**Total**	**Source**
Specific NO_x emissions (g/MJ primair energy)					**Veronica**	
Annual NO_x emission (ton/yr)						
CO (g/MJ primair energy)	0.3	0.3	10			[Okken et al., 1992]
CO emissions in ton/yr	1.1	0.1	18.7		**19.9**	
Sulphur emission brown coal power plant (g/kWh)				0.4		Veronica
Sulphur content (% wet basis)	0.9%	0.9%	0.0%			Veronica
specific SO_2 emissions (g/MJ primair energy)	1.2	0.7	0.0	0.0		
Annual SO_2 emission (ton/yr)	4.5	0.3	0.0	0.3	**5.1**	
Annual secondary energy produced (GJ/yr)	2,009	279	935	2,001	**5,224**	
Annual primary energy converted (GJ/yr)	3,653	466	1,870	10,530	**16,518**	

3.B.4 Step 4: Emission other gases during project without mitigating measures

Emissions of other gases during the first 5 years without mitigating measures are equal to those under base line for the lifetime of the project:

Year	1	2	3	4	5
NO_x (t/yr)	?	?	?	?	?
O_3 (t/yr)					
CO (t/yr)	19.9	19.9	19.9	19.9	19.9
SO_x (t/yr)	5.1	5.1	5.1	5.1	5.1
Dust (t/yr)	?	?	?	?	?
Other					

3.B.5 Step 5: Emission other gases during the course of the project with the proposed reduction measures

The following table summarises the emissions of other gases during the first 5 years of the project with the 733 kWth wood fuelled boiler:

Emissions other gases for a 733 kWth wood boiler					
Year	1	2	3	4	5
NO_x (t/yr)	1.5	1.5	1.5	1.5	1.5
O_3 (t/yr)					
CO (t/yr)	0.7	0.7	0.7	0.7	0.7
SO_x (t/yr)	0	0	0	0	0
Dust (t/yr)	0.6	0.6	0.6	0.6	0.6
Other					

These calculations are based on the quantity of exhaust gases emitted during operation at full capacity as well as on the expected capacity factor of 23%. See below review table:

Input parameters			**Source**
NO_x emission level*	259	mg/Nm^3	KARA
CO emission level	112	mg/Nm^3	KARA
Dust emission level	95.3	mg/Nm^3	KARA
Exhaust gas (at full capacity)	2,921	Nm^3/hr	KARA
Results			
Annually exhausted	5,805,096	Nm^3/yr	
at Capacity Factor =	23%		this report
Annual NO_x emission	1.5	t/yr	
Annual CO emission	0.7	t/yr	
Annual dust emission	0.6	t/yr	
NO_x emissions below 400 mg/Nm^3. Measurements similar boilers with similar fuel, showed emissions below 200 mg/Nm^3			

3.B.6 Step 6: Emission reduction of other gases during the course of the project with the proposed reduction measures

The following table summarises the emission reduction level of other gases for the project.

Emissions reduction other gases during project with mitigating measures					
Year	1	2	3	4	5
NO_x (t/yr)	-1.5	-1.5	-1.5	-1.5	-1.5
O_3 (t/yr)					
CO (t/yr)	19.3	19.3	19.3	19.3	19.3
SO_x (t/yr)	5.1	5.1	5.1	5.1	5.1
Dust (t/yr)	-0.6	-0.6	-0.6	-0.6	-0.6
Other					

Note that dust and CO emissions are based on guaranteed levels. Actual emissions during project will be substantially lower.

PART 4
ECONOMIC ASPECTS OF THE JOINT IMPLEMENTATION PROJECT

This Annex reports the incremental costs of the project as compared to the base line case to compute the costs attributable to CO_2 emission reduction.

4.A COSTS

4.A.1 Step 1: Specified costs

The table below shows the costs of the JI project. The costs of the project case (biomass boiler with a capacity of 733 kWth and 4 solar boilers) and the base line case (68 houses heated with (brown) coal stoves, wood stoves and electric heating systems) are represented. The third column represents the incremental costs of the project.

		Project (biomass boiler and 4 solar boilers)	**No project (present situation)**	**Incremental**
A	Investments in equipment, systems and techniques			
	Deliveries by Senter	677,210	0	677,210
	Deliveries by foreign partners	1,129,000	0	1,129,000
	Total investment	1,806,210	0	1,806,210
B	Labour cost for construction	68,960	0	68,960
C	Operational costs (yearly)			
C1	Labour costs	7,000	0	7,000
C2.1	Wood	18,271	5,697	12,575
C2.2	Coal, brown coal, electricity	0	65,264	(65,264)
C3	Other materials	0	0	0
C4	Maintenance	10,158	2,720	7,438
C5	Dumping wood	0	0	0
	Total operational costs	35,429	73,681	(38,252)
D	Payments to others	0	0	0
E	Costs Baseline study	0	0	0
F	Monitoring	29,295	0	29,295
G	Training	50,431	0	50,431
H	Other costs	0	0	0
	Input parameters			
	Labour costs (1 person full time)	7000	0	NLG/yr
	Fuel consumption	761	248 t brown coal, 19 t coal, 190 t wood, 585 MWh electricity	ton/yr
	Price fuel	24	108 NLG/t brown coal, 180 NLG/t coal, 30 NLG/t wood, 0,06 NLG/kWh electricity	NLG/ton
	Maintenance	1.5% of the investments of the wood boiler	40	NLG/yr/stove
	Number of stoves		68	

4.A.2 Step 2: Total cost during project lifetime

The project will be ended after two years monitoring has been completed. Overall project cost are reported in the previous section.

4.A.3 Step 3: Annual incremental costs during project lifetime

The following table shows the incremental costs per year for the project. Note that project duration has been taken as 15 years (which is a reasonable project lifetime in view of the technical lifetime of the equipment), although only a duration of 5 years is displayed.

Year	**1**	**2**	**3**	**4**	**5**
Investments	1,806,210	0	0	0	0
Labour cost for construction	68,960	0	0	0	0
Operational costs (yearly)	0	(38,252)	(38,252)	(38,252)	(38,252)
Payments to others	0	0	0	0	0
Costs Baseline study	0	0	0	0	0
Monitoring	14,648	14,648	0	0	0
Training	50,431	0	0	0	0
Other costs	0	0	0	0	0
Total cost	1,940,248	(23,604)	(38,252)	(38,252)	(38,252)
Avoided CO_2 emissions (t CO_2 eq./yr)	2,397	3,350	3,350	3,350	3,350
Discount rate	5%				
NPV of net cost (15 yr project lifetime)	1,500,533				
CO_2 emissions (t CO_2 eq.; 15 yr project lifetime)	49,291				
Specific emission reduction cost (NLG/t CO_2)	30				

The investment costs of the previous table includes the investments by the Czech partners of 1,129,000 NLG. With these investments the specific emissions reduction costs are 30 NLG/ton CO_2. Excluding the investment costs of the Czech partners then the specific emissions reduction costs are reduced to 9 NLG/ton CO_2. Following table shows the incremental costs per year for the project in which the investment costs of the Czech partners are excluded. Note that project duration has been taken as 15 years (which is a reasonable project lifetime in view of the technical lifetime of the equipment), although only a duration of 5 years is displayed.

Year	1	2	3	4	5
Investments	677,210	0	0	0	0
Labour cost for construction	68,960	0	0	0	0
Operational costs (yearly)	0	(38,252)	(38,252)	(38,252)	(38,252)
Payments to others	0	0	0	0	0
Costs Baseline study	0	0	0	0	0
Monitoring	14,648	14,648	0	0	0
Training	50,431	0	0	0	0
Other costs	0	0	0	0	0
Total cost	811,248	(23,604)	(38,252)	(38,252)	(38,252)
Avoided CO_2 emissions (t CO_2 eq./yr)	2,397	3,350	3,350	3,350	3,350
Discount rate	5%				
NPV of net cost (15 yr project lifetime)	425,295				
CO_2 emissions (t CO_2 eq.; 15 yr project lifetime)	49,291				
Specific emission reduction cost (NLG/t CO_2)	9				

4.A.4 Step 4: Specific cost of emission reduction

Costs attributable to the CO_2 emission reduction are the incremental costs of the project compared to the base line case. Specific emission reduction cost were determined by making all future avoided emissions present to year 1. The cost calculated in this manner are a rate which if applied as an emission value would yield a net present value of 0. They are presented as well in the previous table.

4.B DIVISION OF FINANCIAL EFFORTS

The Dutch JI partner (SENTER) will supply the funds for the wood fuelled boiler, the solar collectors and consultancy services. The Czech partners will supply the funds for the district heating network and civil works. The Czech partners are also responsible for the operational costs/benefits occurring during the lifetime of the project.

The following table shows the division of the incremental costs between both partners. The incremental operational costs per year are negative, indicating yearly benefits resulting from the project. This offers possibilities for cost and financial engineering efforts directed towards an acceptable division of the CO_2 credits.

Partner	**Project (with biomass boiler)**	**No project (with coal boiler)**	**Incremental**	**Part of incremental costs (%)**
Investment costs				
SENTER	677,210	0	677,210	37%
Czech partners	1,129,000	0	1,129,000	63%
Total investment	1,806,210	0	1,806,210	100%
Operational costs				
SENTER	0	0	0	-0%
Czech partners	35,429	73,681	(38,252)	100%
Total operational	35,429	73,681	(38,252)	100%
Monitoring, training, construction				
SENTER	148686	0	148,686	100%
Czech partners	0	0	0	0%
Total operational	148686	0	148,686	100%

PART 5
TRAINING

Training of the operators of Obec Hostetin. with respect to operation and maintenance will be carried out by Kara Energy Systems during construction and start-up of the boiler system. Start-up, training during start-up and commissioning takes approximately four weeks.

During the summer course in 1999 a training is given on insulation of houses. As example one public and three private houses are insulated. The biomass course will be carried out under this project and will take 2-3 days. The course will be prepared both in The Netherlands and Czech republic. The experience of BTG is that this type of courses is very effective in transfer of know-how and the accelerated development of new investment projects. BTG has conducting courses for the last 15 years worldwide. The course will be conducted after installation and commissioning of the boiler as to enhance the demonstration value of the plant. The course is specifically designed for local consultants who wish to increase their knowledge on biomass systems and who would be able to pass on the knowledge to others. Another target group are local decision makers on regional and municipality

The “Energy Centre Hostetin” organises information exchange & dissemination activities in the field of biomass energy.

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