C e n t e r f o r E n e r g y E f f i c i e n c y

EnEffect

Utilization of Waste Wood for Centralized Heat Supply to Buildings in Bulgaria

Feasibility Study Summary

Sofia, February 2003

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Introduction

The main objective of this study is to assess the feasibility of waste wood utilization for centralized heat generation for space heating using highly efficient boilers, incl. pyrolysis boilers and the potential of this type of projects as Joint Implementation projects.

The Bulgarian project has been selected on the following grounds:

- The Bulgarian State has demonstrated its great concern about climate change issues since Rio Conference in 1992. At the moment Bulgaria has elaborated Bulgarian National Policy to address Climate Change. The country ratified the Kyoto Protocol in 2002;
- There is a big room for international cooperation in Bulgaria in the field of climate change (in 1999 Bulgaria was 51% below the emission level of the baseline year 1988 according to the 3rd National Communication on Climate Change);
- JI projects are one way to attract foreign investments as well as environment friendly technologies in a country which is facing difficulties in the process of transition to a market economy;
- Unemployment rate in the forest and mountain regions of Bulgaria is over 20%. Implementation of the project will allow the creation of new jobs in waste wood collection and processing, processed waste wood supply, as well as installation, operation and maintenance of heating facilities.

The counterparts for the study are:

i) Centre for Energy Efficiency EnEffect (a non-governmental organization) - leader and main contractor for carrying out the study.

ii) Energy Institute JSC (a shareholder consultancy company) - provides expert support for the assessment of some of the technical issues and the estimation of emissions reductions.

iii) Municipality of Haskovo – project owner

iv) ERATO Holding (a shareholder manufacturing and services company) – local partner.

1. Policy and Institutional Background in the Country

1.1. National climate change policy

By signing and ratifying the United Nations Framework Convention on Climate Change (UN FCCC) as Annex I Party, Bulgaria has demonstrated its concern about global climate change and its political will to fulfill the commitments under the Convention. Bulgaria ratified the Kyoto Protocol in 2002, thus assuming the obligation under the Protocol is to implement adequate policies and measures to achieve reduction of its GHG emissions by 8% during the period 2008-2012 compared to the amount of emissions during the base year 1988.

Bulgaria has developed a National Action Plan on Climate Change (NAPCC), including specified policies and measures for GHG emissions mitigation. The plan was adopted by the Bulgarian government in June 2000. Since January 2003 an up-date of the NCCAP has started, supported by the government of the Netherlands.

The Bulgarian national policy to address climate change is coordinated by the ***Ministry of Environment and Water*** (MOEW). This ministry is responsible for the reporting the annual inventories of GHG emissions and the national communications to the Climate Secretariat. The MOEW is the driving force for climate change mitigation policies and measures in the country and is also responsible for the participation of the country in the flexible mechanisms of the Kyoto Protocol.

Two other bodies are supporting the MOEW in its climate change activities: the Intergovernmental Commission on Climate, established in July 2000 to control and coordinate the activities of ministries and agencies during the implementation of the NAPCC, and the Steering Committee for Joint Implementation projects. The Steering Committee evaluates the proposed JI projects according to the existing national criteria for JI projects on the basis of a Project Design Document.

1.2. National energy policy and national policy on the utilization of renewable energy sources

Bulgarian energy sector holds a key position in the national economy. Some of the problems related to this sector's development are the limited national energy resources, the high share of imported energy resources in the general structure of the international trade balance of Bulgaria, the high energy intensity of industrial production, and the subsidies to some energy resources production.

The last few years are characterized by a process of restructuring, privatisation and liberalization in the energy sector. The total primary and final energy consumption, which were relatively steady for the period of 1985 – 1988, underwent steep decrease in the last decade.

Bulgaria imports over 70% of the energy carriers demanded, including almost all liquid fuels and natural gas. The local production of these energy sources is beneath 1% of the gross consumption. High caloricity bituminous and anthracite coal is also imported.

The basic domestic energy resource is the low-quality lignite, extracted in the "Mariza East" open-pit mining complex. This resource is used for generation of about 35% of the electricity produced in the country.

Under these preconditions the use of ***Renewable Energy Sources*** (RES) is a significant alternative in forming the country's energy balance. The potential of RES is assessed to be high in numerous studies. Nevertheless, the actual utilization of this potential is low – so far, the greatest development has taken place for utilization of the hydro potential. The difficulties in RES potential utilization are complex, including technological, legislative, geographical and other issues. As a result, the share of RES (except hydro) in the energy balance of the country has only been 0.4% so far.

This situation led to initialising a ***National Programme for Renewable Energy Sources*** (NPRES), which is not yet approved by the government. The actual start of large-scale market penetration of RES is still pending. Some projects implemented so far have been financed exclusively from external/foreign sources. Nevertheless, the first steps in this direction are already underway and all in all there are no real barriers to the implementation of concrete projects.

1.3. National JI policy, institutional infrastructure, procedures

The Kyoto mechanisms Joint Implementation (JI) and International Emission Trading are looked at by the government as opportunities for co-financing and financing of GHG mitigation measures together with possibilities to obtain economic, technical and expert support. These mechanisms set also options for economic benefits from the GHG mitigation policy in the country.

A ***Joint Implementation Unit*** (JI Unit) in Bulgaria was created in 2000 with support from the government of the Netherlands. The JI Unit is under the direct supervision of the Ministry of Environment and Water.

Criteria for JI projects selection have been developed and approved. They were mainly connected with the Memorandum of Understanding between Bulgaria and the Netherlands, and are currently under revision to incorporate the interests of more partners. The basic requirements to the GHG emission reduction projects offered as JI projects include: feasibility, transparency, simplicity and predictability.

Besides these general requirements the projects should meet, the project proposals should be evaluated in compliance with the following criteria:

- project admission requirements - aims at exclusion of project proposals that fail to meet the basic requirements of a JI project, and especially the requirement for the project to offer a well-founded baseline scenario and an actual evaluation for the emissions reduction upon project application;
- general evaluation criteria - include the agreement of the project with the priorities set by the host country;
- environmental criteria for project evaluation - the project should bear environmental additionality in relation to the baseline scenario; guaranteed economic and effective usage of the natural recourses and no adverse effect on other regional/local environmental indicators;
- social, financial and economic criteria;
- technical and technological criteria.

In 2000 Bulgarian government signed a Memorandum of Understanding with the government of the Netherlands for the implementation of JI projects under an Emission Reduction Unit Procurement Tender (ERUPT) procedure and dividing the emission reductions between the two countries. 6 Bulgarian projects have been submitted to the first two tenders, mainly projects for utilization of RES. Unfortunately, no one of these projects was successful – the Dutch government approved none from the 6 projects submitted. A third tender was opened for proposals on 25 October 2002 until 30 January 2003. Several proposals are expected to be submitted to this tender.

Another partnering program under Article 6 of the KP is the Prototype Carbon Fund (PCF) at the World Bank. The Host Country Agreement between Bulgaria and the EBRD as a Trustee of the Prototype Carbon Fund was signed on 14 November 2002.

1.4. GHG emissions inventories and projections

Bulgaria develops and periodically updates the inventories of greenhouse gas (GHG) emissions by sources and removals by sinks using the methodology for GHG inventory preparation approved by the Parties to the UNFCCC.

The inventory starts with the year 1988, which is the base year for implementation of the UNFCCC in Bulgaria. It covers emissions of main GHG gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O); GHG precursors (NOX, CO and NMVOCs); and sulphur dioxide (SO_2). The emissions of Hydro Fluorocarbons (HFCs) and Perfluorocarbons (PFCs) were addressed in the studies that began with the base year in Bulgaria for these gases – 1995. The emissions were re-calculated in accordance with IPCC Revised Guidelines 1996.

CO_2 emissions are estimated using both methods recommended in the IPCC Guidelines (the "top-down" (reference) approach and the "bottom-up" approach). The overall estimates of CO_2 emissions and in Bulgaria in 1988 and in the period 1990-99 divided by sectors are given in Table 1. Energy-related activities are the most significant source of GHG emissions in Bulgaria. They comprise fossil fuel combustion and production, transmission, storage and distribution of fuels.

Table 1. CO_2 emissions from fuel combustion in Bulgaria by sectors (Gg)

	1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Energy Industries	37 823	39 664	37 626	34 127	34 632	31 574	32 246	31 286	31 487	27 600	26 322
Manufacturing Industries and Construction	35 756	19 890	12 051	9 694	10 752	11 984	14 582	14 010	13 968	11 401	9 488
Transport	12 639	10 864	6 525	6 435	7 444	6 547	6 845	6 306	5 315	6 475	6 212
Other Sectors	7 612	5 381	4 086	4 612	4 117	3 325	2 621	3 238	2 678	2 989	2 491
Other	1 666	1 006	882	196	733	810	315	261	112	49	0

Source: GHG National Inventory, 1999

Analysis of the overall ***projected emissions*** in Bulgaria during the 1st commitment period 2008-2012 shows that if there were no certain measures taken already for rapid increase of the efficiency of the economy in Bulgaria, the country would not be able to fulfil its Kyoto obligation. During the period, the emissions would have exceeded by 18% the Kyoto target. The measures already taken would guarantee that the country meets the commitment. In addition, a significant potential for emission trading appears. For the "with measures" scenario, this potential is estimated at over 11 million tons of CO_2 equivalent on yearly basis. Should additional measures be implemented, the emission trading potential would reach about 20 million tons.

There is even a bigger potential for emissions reduction in Bulgaria, however it cannot be realised due to lack of investments. Yet the carrying out of Joint Implementation projects in the industry and building sectors, would lead to additional emission reduction.

2. Utilization of Waste Wood Biomass as an Alternative to Fossil Fuels

2.1. Advantages of the utilization of waste wood biomass

The use of wood briquettes and waste wood results in savings in liquid fuel and electricity consumption. Savings of energy carriers lead, in turn, to reduction of harmful emissions in the atmosphere, including some of the major pollutants causing the greenhouse effect – carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). The emissions related to the combustion of biomass are assumed to be zero, because these are considered to be the same as the amount of emissions sequestered during the growth of the forestry biomass.

Waste wood utilization is effective in regions where district heating networks are not developed. Small scale (10-100 kW) boilers burning wood and wooden briquettes could be installed for centralized heating of public and social houses and household, currently heated using electricity, coal and residual oil.

Due to the relatively high electricity, coal and residual oil prices, which impose the necessity of restricted energy use, the heat comfort in the residential and social buildings is at a very low level. The introduction of relatively cheap waste wood for centralized space heating will improve the heat comfort in the public and social buildings – schools, hospitals etc. Although indirectly, this will have a positive effect on the health and healthcare expenses of the residents.

The waste wood utilization will facilitate the waste wood collection at the waste wood processing sites and briquettes production. As a result, the sanitary conditions of managed forests will be significantly improved and methane emissions from the waste wood decay in forests and at landfills will be reduced. The landfill loading will be also reduced and the lifetime of landfills will be extended.

Utilization of waste wood will create new jobs in the activities of waste wood collection and processing, processed waste wood supply, heating systems production, installation, operation and maintenance in the regions with very high unemployment rate. The unemployment rate in the mountainous and forest regions in Bulgaria is very high.

2.2. Resources: Present status of Bulgarian forests and wood biomass

According to data for the period 1996-2000, provided by the Ministry of Agriculture and Forests (the National Forestry Board), the ***forest resource area*** in Bulgaria has comparatively stable ranges of 3.88 to 3.91 mln ha. The forested area of the Bulgarian country territory takes between 31.7% and 34%. Woods cover between 86.6 and 86.8% of this area with a slight tendency for increase from 3.36 to 3.40 mln ha. The share of deciduous forest is 67% of these. This tendency is due to the reduced areas with cut and not recovered forests, and reduced actual uprooting. The recent national forest inventory (year 2000) estimated the total volume of the forest at 526.1 million solid cubic meters.

After the process for restitution of forests and forested land was finished, it is expected that more than 80% of the forest will remain state-owned, 8-9% will go into private hands and the rest will become property of the municipalities, the Church, schools and cooperatives.

The trends indicate that Bulgaria has produced ***a stable amount of forest biomass*** that could be utilized for energy purposes. The amount of biomass was generally very little influenced by the meteorological conditions, and varied insignificantly from year to year.

The increasing tendency of the *wood reserve* is kept. A constantly increasing increment of the forest biomass is observed. Recently it reached 13.7 mln m^3. The planned annual cut cannot be fulfilled due to the sharp decrease of the demand for timber wood. The increasing discrepancy between the planned and real cuts is leading to disturbance of the normal turnover of the forest trees.

The utilization of the forest biomass for energy generation depends to a great extent on the technologies used. In the case of Bulgaria, very often greater part of the branches, bushes, sawdust and some other residues from the wood processing is not used at all. The amount of firewood, brushwood and litter produced during the period 1985 – 1991 varies between 1600 and 2400 thousand cubic meters.

There exists significant quantity of *wood biomass from the coppice and low-stem forests* that could be envisaged to be harvested in the next years. It could reach about 70 million m^3 within 15 years, or more than 4 million m^3 per year. The energy equivalent of 4 million m^3 wood is about 9445 GWh. Additional quantities of *technological timber and woods* could be obtained also through thinning in the conifer stands. These quantities could be 2.8 million m^3 /year. There is more than 1.2 million m^3 biomass annually left in these forests from the cuttings that is not used. The wood wastes from the processing standing wood and from the thinning in the conifer stands and the cut of wood biomass from the coppice and low-stem forests could total at more than 7 million m^3 /year with energy content of 11 millions GCal.

The practical possibility to increase the percentage of the potential energy through utilization of wood wastes is very high.

The average annual harvesting of wood in Bulgaria is about 6-7 millions m^3. At the same time the wood stands growth is of 12 millions m^3 annually. In the 1999 the residue of the harvested wood was 2 million m^3, half of which was used as fuel and about 1 million m^3 waste wood (lopping) was not utilized. Adding the amounts left after cutting and the wastes from wood processing plants to the above figures, a significant amount of waste wood is obtained. The utilization of waste wood combustion boilers will improve towns' ambient air quality, because they have no SO_2 and dust emissions.

2.3. Priority regions for the implementation of the project

Bulgaria has 28 regional forest administrations, coinsiding with the administrative regions in the country. The annual planned quantity of wood harvesting is allocated between them as follows:

Table 2. Allocation of the planned wood harvesting by region

Region	Planned share of the region[1]	Planned harvested wood per root[2]	Waste wood – planned[3]	Waste wood – realization[4]	Waste wood energy content
	%	1000 solid m^3	1000 solid m^3	1000 solid m^3	Gcal
Blagoevgrad	9,36	627	188	151	240829
Pazardzhik	8,63	578	174	139	222135
Sofia	7,44	498	149	120	191354
Bourgas	6,81	456	137	109	175126
Smolian	6,10	409	123	98	156883
Lovech	4,99	335	100	80	128510
Stara Zagora	4,59	307	92	74	118061
Plovdiv	4,41	295	89	71	113334
Varna	3,93	263	79	63	101015
Kiustendil	3,77	253	76	61	97025
Sliven	3,65	245	73	59	93992
V. Tarnovo	3,30	221	66	53	85029
Haskovo	3,08	206	62	50	79262
Shumen	2,96	198	59	48	76082
Silistra	2,86	192	58	46	73662
Kardzhali	2,59	174	52	42	66751
Gabrovo	2,58	173	52	41	66394
Montana	2,34	157	47	38	60149
Vidin	2,28	153	46	37	58778
Targovishte	2,24	150	45	36	57629
Razgrad	2,18	146	44	35	56153
Pernik	2,01	135	40	32	51736
Rouse	1,73	116	35	28	44605
Vratza	1,68	112	34	27	43178
Pleven	1,59	107	32	26	41008
Dobrich	1,58	106	32	25	40669
Iambol	0,90	60	18	14	23143
Sofia - city	0,40	27	8	6	10307
Total	**100**	**6700**	**2010**	**1608**	**2572800**

Source: Ministry of Agriculture and Forestry, 2000

There are 17 regions in the country with average waste wood generation of more than 50 000 m^3. Adding the amounts of wastes from wood processing plants to the above figures, a significant amount of waste wood is obtained. Unfortunately due to the reduced demand for timber, the above

[1] Planned share of the region –the share of the planned wood harvest that is expected to come for a given region
[2] Planned harvested wood per root –the volume of wood that is to be harvested from standing trees
[3] Planned waste wood –the expected volume of waste wood
[4] Realized waste wood –the actual volume of waste wood produced

plan is regularly not fulfilled. The actual cut is on average on 20% less than scheduled. That is why the available waste wood at the forests is lower than scheduled.

A waste wood utilization program should be oriented to the regions that produce sufficient quantity of waste wood. There should be enough waste wood reserves that would cover possible reductions of the timber production in the region. The 17 regions mentioned have waste wood reserves ensuring more than the necessary 30 000 m^3 for an efficient waste wood processing site. These are the following regions: Blagoevgrad, Pazardzhik, Sofia, Bourgas, Smolian, Lovech, Stara Zagora, Plovdiv, Varna, Kiustendil, Sliven, Veliko Tarnovo, Haskovo, Shumen, Silistra, Kardjali and Gabrovo.

2.4. Technologies for heat production from biomass

In general, there are two technologies for heat generation from biomass: direct combustion and pyrolysis (gasification).

The ***direct combustion*** is the most popular technology. It is usually applied in the household regular stoves, tile stoves, fireplaces, chimneypieces and in special boilers. The combustion efficiency varies from 40 –50% for stoves to 75%-85% for special boilers.

Despite of the fact that wood is one of the cleanest fuels, the direct combustion technology is relatively high emitting one. The emission level of CO, particulate mater and organic carbon compounds is relatively high and special measures are needed to reduce it. The ambient air quality limits are usually not observed in the winter if a small town is heated through local space heating by regular stoves, tile stoves, fireplaces, chimney-pieces and mantle-pieces.

Some of the direct combustion boilers can utilize waste wood biomass (wood, waste wood, wood briquettes and pellets, shavings, chips, etc.) and ensure high efficiency of the combustion and operation process. The capacity of this type of boilers vary widely - from 10 to1000 kW.

The ***pyrolysis process*** can be described as the thermal decomposition of organic material in the absence of oxygen or other chemical reagent. This decomposition proceeds through a complex series of chemical reactions and processes of heat and mass transfer. Pyrolysis is a step in the gasification and combustion processes. The pyrolysis of a material begins around 250ºC and its over at about 500ºC, although reaction extent depends on residence time of the residue in the reactor. It can be integrated in a special boiler. The wood biomass is heated in a chamber with low oxygen content. The entire organic matter from the biomass is gasified and evacuated from the chamber. The gas is supplied to one or more burners in a combustion chamber. The efficiency of the boiler varies between 80 and 90%, depending on the capacity of the boiler. The efficiency of pyrolysis boilers is 10 to 15% higher than the efficiency of direct combustion boilers. The emission level of CO, particulate mater and organic carbon compounds is negligible and no special measures are needed to reduce it.

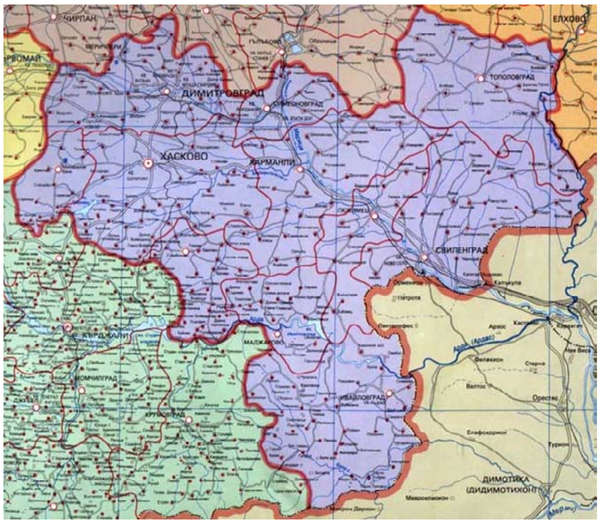
Small-scale pyrolysis boilers could be used for centralized heating of the houses in every town, meeting all the ambient air quality requirements. The price of pyrolysis boilers is 50 to 100% higher than the price of a regular boiler for solid fuel combustion. Several models of the boilers produced or offered by ERATO Holding JsC Haskovo are using the pyrolysis process for burning solid fuel – solid wood, wood briquettes or wooden pellets. Their capacity varies from 10 to 100 kW.

3. Pilot projects for utilization of waste wood biomass for centralized heat supply to buildings and their JI potential

3.1. Priority sectors and sites for the implementation of the selected technology

In order to assess the feasibility of waste wood utilization for centralized heat generation for space heating using high-efficient boilers a pilot project is developed for the municipality of Haskovo. Haskovo is a typical Bulgarian municipality with average for the country availability of wood resources. The Municipality is situated on the area of Haskovo Region in Southern Bulgaria, one of the regions with high average waste wood generation. The municipal center is situated at a distance of 234 km from the capital.

Physical Map of Haskovo Region



Administrative Map of Haskovo Region

The total area of the Municipality is 740 km^2. There are 15,503 ha forest areas on the area of the Municipality, predominantly deciduous species. The relief is plain (in the northern end) and hilly (in the southern end). The area of the Municipality is crossed by the river Harmanliyska.

The Municipality of Haskovo comprises 37 human settlements, including one city – the city of Haskovo. It has a population of 100,124 inhabitants, including 78.9% urban population and 21.1% rural population (1999).

The annual expenditure of the municipality for electricity amounts to approximately BGL 840,000 and that for fuels and heat – to BGL 660,000.

Haskovo is a member of the Municipal Energy Efficiency Network, and as such it has a Municipal Energy Efficiency Office and has developed an information database for energy consumption of major municipal facilities. In 2001 these facilities have consumed 11 457 MWh of energy, mainly heating naphtha (48.83%), electricity (31.93%) and natural gas (14.56%).

Two school buildings and the municipal administration building are selected as a demonstration example in the municipality of Haskovo. Those three sites are selected on the grounds that:

i) they are in public ownership,

ii) they are among the largest social sites in the area,

iii) the school buildings represent the priority target group for all municipalities in the Network and are included as first priority in the Haskovo Municipal Energy Efficiency Program,

iv) the results of the FS obtained from these sites can provide the fertile ground for comparative analysis and replication.

3.2. Project approach

The school buildings and the municipal building are heated with local boilers on Light Heating Oil. The boilers were respectively installed in 1961, 1978, 1995, and 1970. Only the new boiler is in good condition, the others are obsolete and inefficient.

The project envisages fuel shift from Light Heating Oil for industrial and public use (LHO) to biomass in the schools *Vassil Levski* and *Kiril-i-Methodiy* and in the administrative building of the Municipality of Haskovo through replacement of the existing boilers with modern highly efficient biomass-fueled boilers with automatic control of the combustion process. Light Heating Oil for industrial and commercial uses is a medium distillate oil primarily distilling between 180 and 380 degrees Celsius with emission factor 268.2 kg CO_2 eqv./MWh.

The required pieces of equipment have been determined as a result of the energy audit, conducted on the three sites. It comprised a detailed survey and assessment of the current state-of-repair of the buildings, the in-house systems and energy consuming equipment. Computerized models of the buildings have been developed and energy balance sheets have been worked out for each building. Maintaining of the norm requirements for the parameters of indoor climate during the heating season, depending on the schedule of operation of the respective building, have been laid down in the computerized models of the individual buildings as a starting condition. On the basis of the energy audit an assessment of the possibility for replacement of the boilers by biomass-fueled units was made.

3.3. Baseline scenario for the project in Haskovo

The selected baseline scenario is project specific and is simulating a likely situation that would have occurred without the project. The assumptions in the baseline scenario are based on experience with similar projects in other municipalities in Bulgaria, which can be considered as reference as far as the undertaken measures to keep the systems working are concerned.

The baseline scenario takes also due account of several principles:

i) Selection of least cost option – a principle, which is applied solely for municipal initiatives in this country because of the exclusively limited municipal resources under the conditions of a Currency Board and diminished budget revenue due to the drop in production and the high unemployment.

ii) Achievement of the norm requirements for heat comfort in buildings – a mandatory requirement, determined by the regulatory responsibility of the municipality to provide heat comfort in its sites. Under the current circumstances certain restraints are imposed on energy consumption through maintaining temperatures below the norm requirements. This is, however, unacceptable because of the health risks, diminished work ability, low effectiveness of the learning process in schools and the lack of satisfaction of building residents.

iii) Application of the most available technologies in the country.

Shortly, the baseline scenario envisages further use of Light Heating Oil as the cheapest oil fuel for this type of equipment, repair and maintenance of the existing boilers, wherever their further utilization is possible, and replacement of obsolete boilers with new ones of the same type.

The baseline scenario for the three sites of the pilot project has been formulated on the basis of the energy audit performed in the sites. At an outcome of the studies, the necessary quantity of fuel (LHO) for each of the sites and the required costs for replacement or rehabilitation of the equipment and its maintenance are indicated.

Required quantity of fuel and related GHG emissions respectively

By means of computerized modeling, the required heat output for the buildings has been calculated and the required quantity of heat for space heating with attainment of the norm requirements has been determined. The obtained value is corrected (reduced) according to the real duty cycle of operation of each building. The corrected value is incorporated as an input value in the energy balance sheet of each site. The efficiency of energy conversion of the fuel during heat generation and the losses for each of the buildings is taken into account to produce the value of the required energy at the boiler inlet.

The results for the three sites, including the reduced value of the energy required for space heating of the buildings and the required energy at the boiler inlets are as follows:

Vassil Levski School	516.3 MWh/year or 44.7 tonnes LHO (BGL 45,486)
Administrative building	392.7 MWh/year or 34 tonnes/year LHO (BGL 34,597)
Kiril-i-Methodiy School	157.3 MWh/year or 13.62 tonnes/year LHO (BGL 13,858)

The baseline contains the assumption that the Light Heating Oil is delivered by the only Bulgarian manufacturer LUKOIL Bulgaria Ltd. located in Burgas. The fuel is transported from Burgas to Haskovo by oil tanks of $22m^3$ capacity, mounted on trucks driven by diesel engine. During combustion of the fuel on the sites, besides the emissions from the fuel itself, account is taken also of the relevant electricity consumption for burners, pumps and fans, required for the operation of the boiler and the space heating system.

All emissions under the baseline scenario, generated by fuel consumption in the combustion chambers, by electricity consumption and by the transportation of the fuel by road to Haskovo, amount to 4,563.7 tonnes CO_2 eqv.

Required costs for replacement, rehabilitation and maintenance of the equipment

According to the energy audit of the sites, the state of repair of the equipment in *Vassil Levski* School and the administrative building of the Municipality is poor and they have practically exhausted their technical resource and would hardly be fit for proper operation much longer. All costs for maintenance, repair and rehabilitation with the aim to ensure operation of the existing equipment in the course of 15 years are considered in the baseline scenario. The total amount of these funds within this time span is BGL 104290.

3.4. Project Intervention

Measures to reduce energy costs and GHG emissions

In compliance with the objectives of the project *Utilization of Waste Wood for Centralized Heat Supply to Buildings in Bulgaria*, the pilot project in the three municipal buildings envisage as a primary measure replacement of the existing boilers running on Light Heating Oil (LHO) by modern and highly efficient biomass-fueled boilers. The aim of the proposed replacement is to achieve significant savings of GHG emissions as a consequence of the fuel shift, as well as considerable reduction of the energy costs of the municipality thanks to the much lower price of heat generated from wood waste biomass as compared to that of LHO. In practical terms, the fuel shift from LHO to wood waste biomass eliminates the GHG emissions produced by fuel combustion.

Vassil Levski School

The project envisages shift from the currently used fuel - Light Heating Oil (LHO) – to wood biomass (wood waste and chips, sawdust, wood pellets etc.). To this end the existing LHO-fueled boilers have to be replaced by two compact biomass-fueled water heating boilers of a total capacity up to 700 kW (2 x 350 kW) and equipped with a system for automatic fuel charging. It is necessary to perform reconstruction of the in-house space heating system from steam-based to water-based operation. The site has a convenient platform for materials handling operations and the required space for a fuel storage yard, which will be constructed next to the boiler house. The required annual consumption of solid-fraction biomass is about 146 t.

Administrative building of Haskovo Municipality

The project envisages fuel shift from the currently used Light Heating Oil (LHO) to wood briquettes. To this end the existing LHO-fueled steam boiler should be replaced by two compact biomass-fueled water heating boilers ATMOS DC 100, rated capacity 99 kW, manufactured by ERATO Holding JsC-Haskovo. The boilers operate under the principle of pyrolysis distillation, which provides high efficiency of combustion (up to 89%) with fully automatic control of the process. Reconstruction of the space heating system from steam-based to water-based one will be necessary. The subscription system for delivery of biomass, proposed by the Erato Resource Company, Haskovo, will be used for this site. The annual consumption of wood briquettes to meet the building demand is about 63 t.

Kiril-i-Metodiy School

The project envisages fuel shift from Light Heating Oil (LHO) to wood briquettes. To this end the existing LHO-fueled water heating boiler will be replaced by three compact biomass-fueled water heating boilers ATMOS DC 100, rated capacity 99kW each and total capacity up to 300 kW, manufactured by ERATO Holding JsC Haskovo. The boilers operate on the principle of pyrolysis distillation with high efficiency of combustion (up to 89%) and fully automatic control of the process. The site does not have a suitable site for fuel storage and that's why a subscription system for delivery of biomass will be used. The annual consumption of wood briquettes to meet the building demand is about 29 t.

Value of project investments

Table 3.1 shows the costs for implementation of the different project activities, broken down by sites, with a 5% reserve on delivery costs and the costs of construction and assembly works.

The required investments of 272300 BGL for implementation of the project have been determined on the basis of calculations of the costs of the proposed measures using the prices quoted by ERATO Holding JsC Haskovo.

Table 3. Project costs

Activity	Total BGL
Vassil Levski School	193 784
Administrative building of Haskovo Municipality	36 265
Kiril-i-Metodiy School	28 240
Investment costs TOTAL	258 289
Miscellaneous – planning, project management, acceptance of sites upon completion	1 100
Investments total	259 389
Incidental expenses 5% of investment costs	12 911
GRAND TOTAL:	**272 300**

Estimated savings

The project generates considerable cost savings as a result of the shift to a cheaper fuel. Additional savings are produced by the reduction of heat losses in the space heating systems of *Vassil Levski* School and the administrative building of the municipality as a result of their reconstruction from steam-based to water-based systems. The calculations have used the price of LHO announced by LUCKOIL *Neftochim* by January 2003 (BGL 1017.6/tonne). The prices of briquettes and bulk waste wood are those offered in the quotation of ERATO Holding JsC: 34.8 BGL/MWh for briquettes and 11.8 BGL/MWh for waste wood.

Table 4. Summary of the estimated annual savings

Site	Savings, BGL/year
Vassil Levski School	40 370
Administrative building of Haskovo Municipality	22 672
Kiril-i-Metodiy School	8 394
Total	**71 436**

Environmental benefits

An important result of the projects for use of renewable energy sources in general, and the use of wood briquettes and waste wood in particular, is the reduction of GHG emissions in the atmosphere, including some of the major pollutants causing the greenhouse effect – carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

As a consequence of the implementation of the pilot project *Use of Waste Wood Biomass for Space Heating in Municipal Sites in the City of Haskovo* savings of GHG emissions in the atmosphere to the amount of **4430.3 tonnes CO_2eqv** will be achieved.

The emissions from LHO combustion are calculated using the Methodology for Determination of the Rate of Emissions from Combustion Processes in the Power Sector, Industry and Space Heating in the Communal Sector, endorsed by the Ministry of the Environment and Water, Sofia 2000. The specific calculations of the achieved emission reductions as a result of biomass combustion have been carried out under the methodology, applied in the course of working out of the Second National Communication on Climate Change, Sofia, April 1998. Additional emission factors, contained in the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories are used as well.

The activities that are included in the emission baseline and baseline calculations are:

- Delivery of Light Heating Oil (LHO) used by the boilers;
- Combustion of LHO in the boilers on the sites;
- Electricity consumption by the boilers.

The activities included in the emission calculations for the project intervention are:

- Wood briquettes production to cover the demand of the 3 project sites;
- Wood briquettes & wood waste delivery by road transport;
- Wood briquettes & wood waste combustion;
- New wood-fueled boilers electricity consumption.

In this way all GHG emissions from the proposed JI project that are significant and reasonably attributable to the project activity, and also are under control of the project owner/developer are included in the project boundary.

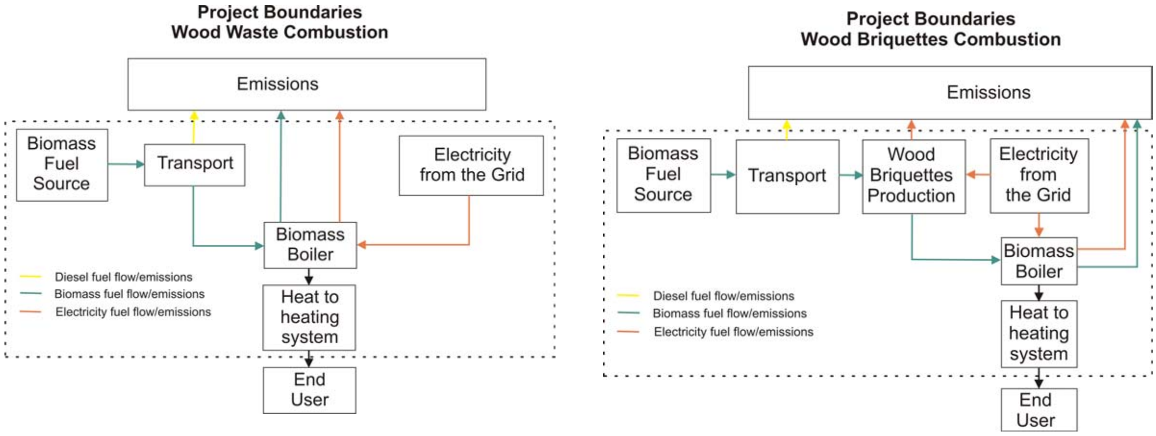


Fig. 1. Project boundaries

The main reduction of GHG emissions and other harmful pollutants for this project are as a result of the replacement of the main fuel and electricity savings. The emissions related to the combustion of biomass are assumed to be zero, because these are considered to be the same as the amount of emissions sequestered during the growth of the forestry biomass.

The estimates for the emissions from electricity are in compliance with the plans for construction and development of the power generation capacities. The calculations of the specific GHG and other harmful emissions by years correspond to the forecast composition of the generation capacities, that in the long-term horizon will participate in the procurement of the load chart of electricity generation. An assumption is made that at the end of the year 2006 Units 3 and 4 in the Kozloduy Nuclear Power Plant would be decommissioned.

The costs for emissions reduction of 1t CO2eqv, compared to the project incremental cost (the avoided investment and maintenance costs in the baseline are subtracted from the investment and maintenance costs for the project) is BGL 50.26/tonne (25.70Euro). The costs for emissions reduction of 1t CO2eqv are BGL 62.36/tonne (31.88 Euro), compared to the project investment cost.

Besides reduction of GHG emissions, the project leads also to reduction of harmful emissions of local importance for the sites previously fueled by LHO combustion. In addition, sulphur oxide, nitrogen oxide and dust emissions from the fossil-fuels-fired power generation plants will also be avoided, although in negligible quantities.

Time schedule of project implementation

The pilot project for use of biomass for space heating in municipal sites in the city of Haskovo may be implemented within a period of 5 months during the 2003 off-heating season (from April till September). Separate assembly work teams are envisaged, so that a certain overlapping will be possible during the time of work on the different sites. The installation of the pyrolysis boilers in the administrative building and in *Kiril-i-Metodiy* School will start a month earlier than the installation of the boiler in *Vassil Levski* School because of the shorter delivery time. The main activities are planned for the months July and August, when the rate of human presence in the buildings is lower and hence the implementation process will be facilitated. The construction and assembly works in the three sites will be finished by September 20 and systems will be accepted and commissioned into regular operation at the end of September. The purchase of the required equipment and materials, as well as the selection of the subcontractor for the dismounting and installation works will be effected by tender.

Financial plan of the project

The Financial Plan envisages loan capital to the amount of BGL 182100, lent by a creditor, and equity contribution of the borrower, the Municipality of Haskovo, to the amount of BGL 90,200. In addition, the Municipality will bear the costs of interest during project implementation, to the amount of BGL 3559. Thus the total contribution of the borrower to project financing accounts for 34% of the total project costs.

Cashflow analysis

The major financial indicators (Payback Period, Internal Rate of Return, Net Present Value) have been calculated from the project cashflow at 15% Interest Rate and 4% annual inflation rate.

Nominal interest rate	15	%
Real interest rate	11.11	%
Payback period by net savings	3.33	Years
Internal Rate of Return	28.80	%
Net Present Value	276 840	BGL

The calculations are based on economic lift cycle of 15 years. An additional amount of a total of BGL 51150 has been envisaged for maintenance and repair during that period. The avoided investment costs for replacement of the entirely worn-out equipment is BGL 27120. The avoided costs, which would have been spent for repair and maintenance of the existing boilers, amount to BGL 25750.

On the basis of the financial parameters of the project, as reviewed above, one may declare that the project will generate a sufficiently strong and stable cashflow, which allows guaranteed servicing of a loan to the amount of investments envisaged.

If the project is implemented as a Joint Implementation project, there will be additional revenue to the project cashflow during the years of the First Commitment Period (2008 – 2012) – revenue from the sale of GHG emission reductions. The amount of this revenue will depend on the price of 1t CO2eqv, negotiated between the Parties. This additional revenue will improve the economic indicators of the project. It is particularly important to know the exact time when these funds will be made available to the project owner – the Municipality. The most favorable option will be the one, which provides that the Municipality could receive at least 50% of the value of the transaction prior to project start (advanced payment). It will help diminish the burden of initial investments. Bearing in mind the amount of the estimated savings, no diminishing of the required loan money may be expected.

Risk and sensitivity analysis

Three main groups of risks related to project implementation have been studies and evaluated:

- Risk of non-completion of the project – evaluating the risks of exceeding the budget and delayed commissioning of the system;
- Operational risk - reviewing the probability that the estimated net savings may not be achieved to the same level because of unadequite operation;
- Price risk - mainly with respect to the ratio of fuel prices.

Under the worst case scenario the simultaneous impact of all envisaged risks is evaluated. Exceeding of the budget is incorporated with a risk weight of 5%. The risk of delayed commissioning is assumed to be 1 month. Diminishing of the net savings due to operational failures and price changes is reflected by a risk weight of 10%. The worst case scenario serves to test the combination of all scenarios mentioned above.

In all scenarios the financial indicators of the project remain in acceptable limits.

The sensitivity analysis of the project reviews the two main factors, which may affect the results of it and change the technical and economic parameters. These are: (1) change in the ratio between the prices of LHO and biomass, on which achievement of the calculated level of savings depends; and (2) project implementation with a different amount of investments. The analysis snows that the project remains profitable in conditions of the NPV and IRR changing with 50%.

3.5. Assessment of the project's replicability and sustainability in Bulgaria

The preliminary study envisaged that if the pilot projects in Haskovo prove to be efficient, the project will be further replicated in the regions with good potential, where district heating network are not developed. Small scale boilers burning wood and wooden briquettes could be installed for centralized heating of public houses and households, currently using electricity, coal and residual oil. Potentially the project is good for replication for more than 20 (presumably 24) regions with waste wood availability and potential for waste wood reprocessing into briquettes around he country.

In order to make the study for the replication of the pilot projects more realistic and feasible, the potential of the Municipal Energy Efficiency Network EcoEnergy was used as a basis. EcoEnergy involves 39 municipalities-members from all parts of the country. 23 of them belong to the 14 regions with high potential for waste wood production (listed in Part 2). The municipalities-members of EcoEnergy have developed an information database for their municipal facilities and the respective energy consumption by fuel types, as well as information about heating sources and installations in the buildings. Unfortunately, this information cannot be directly provided to this report as the software is in Bulgarian language. Anyway, as it is available to the project team, an extract is done to illustrate the replication potential of the project in other regions and municipalities in the country.

A selection is done to identify the number of public buildings with local boilers using liquid fuels. The buildings with local boilers on liquid fuels in these municipalities amount to 435. They are currently using 104597 MWh heat energy, produced from fossil liquid fuels. The baseline for energy use considers the need for more energy in order to provide the necessary normative level of heating to the buildings. It was proved by a number of energy audits that the temperatures in the public buildings are lower that needed to assure for normal working conditions. The amount of additional energy to provide for this comfort levels is about 20% higher that the current energy use. Considering this, the baseline annual energy needed for the 435 buildings amounts to 125516 MWh.

Table 5. Energy consumption in public buildings with local boilers using oil fuels in 23 municipalities in Bulgaria

Region	Municipality	Buildings with boilers	Current annual fuel use MWh	Baseline annual fuel use MWh
Blagoevgrad	Blagoevgrad	35	22319	26783
	Razlog	10	2330	2796
Pazardzhik	Pazardzhik	12	1321	1585
Sofia	Slivnitza	4	345	414
	Botevgrad	6	2212	2654
Bourgas	Bourgas	35	9575	11490
	Aitos	12	1583	1900
Lovech	Lovech	6	695	834
	Troyan	11	43	52
Stara Zagora	Stara Zagora	21	2935	3522
	Kazanluk	3	293	352
Plovdiv	Karlovo	24	9683	11620
Varna	Varna	37	9669	11603
Sliven	Sliven	26	4166	4999
	Kotel	4	609	731
V. Tarnovo	V. Tarnovo	31	4472	5366
	G. Oryahovitsa	20	1970	2364
	Svishtov	21	4107	4928
Haskovo	Haskovo	32	4360	5232
Silistra	Silistra	27	13473	16168
Kardzhali	Kardzhali	33	5916	7099
Gabrovo	Gabrovo	22	2278	2734
	Sevlievo	3	243	292
	Total:	**435**	**104597**	**125516**

A programme for fuel switch of these buildings to waste wood biomass would lead to the utilization of 125516 MWh energy produced from wood biomass. We assume, as identified in the pilot project, that about 50% of this biomass would be in the form of briquettes and 50% - in wood waste. The reductions of GHG emissions as a result of this programme will amount to about 502104 t of $CO_{2eqv.}$ for 15 years lifetime of the programme. (Table 6)

Table 6. GHGs emission reductions

Emissions		Baseline	JI scenario	Emissions reduction
CO_2	tonnes	475768	0	475768
CH_4	tonnes	9,4	135,6	- 109,3
N_2O	tonnes	94,1	0	94,1
$CO_{2eqv.}$	tonnes	504951	2846,7	502104,3

The financial savings from the difference in fuel prices would amount to 8134064 BGL/year. The investments needed for implementation of the programme would amount to about 12-15 mln USD.

However, the programme might not be limited to the municipalities included in this study. They were selected because they belong to regions with proven high potential for wood biomass and because data are available for their buildings. On the other hand, successful implementation of such projects in municipal buildings would increase the interest of private companies and the residential sector to initiate similar fuel switch to biomass. It is very important to start with the implementation of a pilot project and to disseminate the information about its results and increase awareness of a wide range of consumers.

The feasibility and sustainability of the programme depend on 5 main factors:

i) Availability of wood resources;

ii) Capacity for collection, processing and delivery of wood products in the desired form (wood, waste wood, wood briquettes and pellets, shavings, chips, etc.) in the quantity needed;

iii) Capacity for production of efficient wood biomass fired boilers;

iv) Availability of initial investments to cover the prices of boilers;

v) Management of the programme to assure for low transaction costs.

The wood resources, as already presented in Part 2, are available in the country and they are the best prerequisite for the implementation of such a programme. Although the capacity for collection, processing and delivery of wood products is developed to some extend, it will not be enough to satisfy the needs if not further developed. Establishing waste wood processing sites, which could process wood briquettes and pellets in economically feasible manner, can resolve the problem. This can be either left to the market, or stimulated by the interested public authorities. One such facility is capable of processing up to 30 000 solid cubic meters of waste wood when working 24 hours (3 working shifts). The infrastructure price of such fully operational facility is no higher than 250 000 Euros. The operational expenditures of the facility can reach up to 700 000 Euros per year.

The capacity for production of efficient wood biomass fired boilers is developing in the country. There are a number of companies producing traditional boilers, which can shift to the production of these specialized boilers. The developed market would be a good incentive for this. A good example is the ERATO company which has developed such a production during the last few years and is further expanding its production in quantity and nomenclature. The efficiency of the programme would substantially increase if the production of pyrolysis boilers with higher capacity were enlarged. On the other hand, the increased production of boilers would create competition and would probably lead to reduction of prices.

The pilot project for one municipality can be easily contracted as JI project as the owner of the facilities is one legal entity – the municipality. Entering into a programme for greater number of municipalities, an intermediary would save transaction costs. The role of such intermediary can be played by:

i) Specially established consortia among the municipalities and establishment of a project implementation unit;

ii) The Municipal Energy Efficiency Network as a consortia and its Secretariat as project manager;

iii) The National Environment Protection Fund (recently transformed into an Enterprise for Management of Activities for Environmental Protection) or the National Eco Trust Fund – they are both state funds. There is an example of using a state environment fund as an intermediary for a JI project is the Czech Republic.

Conclusion

The proposed project and the wider peogramme answer the criteria for JI projects. Their implementation would be a good step to further involvement of more partners from different sectors in activities for utilization of waste wood biomass for energy production, and respective reductions of GHG emissions.