平成 14 年度環境省請負委託事業

温暖化対策クリーン開発メカニズム事業調査

ﾌﾞﾙｶﾞﾘｱにおけるﾊﾞｲｵﾏｽ利用及び高効率ﾎﾞｲﾗｰの採用による地域暖房ｼｽﾃﾑの実証調査

報 告 書

平成１５年２月

社団法人　海外環境協力センター

ブルガリアにおけるバイオマス利用及び高効率ボイラーの採用による地域暖房システムの実証調査

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Ｉ．報告書要約（和文）

「ブルガリアにおけるバイオマス利用及び高効率ボイラーの採用による地域暖房システムの実証調査」要約

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ブルガリアにおけるバイオマス利用及び高効率ボイラーの採用による地域暖房システムの実証調査（報告書要約）

平成 15 年 2 月

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はじめに

本研究の主たる目的は、熱分解ボイラーなどの高性能ボイラーを利用して建物の集中暖房に廃材を使用する可能性と、この種のプロジェクトを共同実施（JI）プロジェクトとして実施する可能性を調査することにある。

ブルガリアの本プロジェクトは、次の理由により選択されたものである。

- ブルガリアは、1992 年のリオ会議以来、気候変動問題に大きな関心を示してきた。現在、同国は気候変動に対処すべく、国家政策を立案したところである。同国は 2002 年に京都議定書を批准した。
- ブルガリアは、気候変動の分野で国際協力を行う大きな余地がある（『第 3 回気候変動国別報告』によると、同国の二酸化炭素の排出量は、1988 年を基準年として 1999 年には 51％も減少した）。
- 共同実施プロジェクトは、また市場経済に遷移途上にあって困難に遭遇している国に外資を導入する手段であり、環境にやさしい技術をもたらす手段である。
- ブルガリアにおける山村地帯の失業率は 20％を超える。このプロジェクトの実施は、廃材の回収、加工、加工廃材供給、さらには暖房施設の設置、運転、維持で新しい雇用を創出する。

本研究のメンバー

(1) 社団法人海外環境協力センター（OECC）は、本調査の共同研究を目的として、中東欧環境センター（REC）及びブルガリアの NGO であるエネルギー効率性センター（EnEffect）との間でそれぞれ契約を結ぶ。

(2) REC は本調査において中東欧の環境保全推進の立場からブルガリアのカウンターパートに助言を与えるとともに、欧州において必要な調整を行なう。

(3) NGO の EnEffect（Center for Energy Efficiency）は、本研究を実施する幹事兼主契約者となり、以下の(4)および(5)の組織と協働してプロジェクトを調整・推進する。

(4) 民間企業のエネルギー研究所 Energy Institute 社は、いくつかの技術問題の評価と排出物削減の予測について専門家の立場から EnEffect に対し支援を行う。

(5) パイロット・プロジェクトは、ハスコヴォ市庁およびハスコヴォ市の ERATO Holding 社と協力して行うことになるため、EnEffect は本調査においてはそれら組織と協働して研究を行なう。

エネルギー効率性センター（非政府組織）　本研究実施の幹事兼主契約者。

1. ブルガリアの政策および制度的背景

1.1 気候変動に関する国家政策

ブルガリアは、気候変動に関する国際連合枠組条約（UN FCCC）を付属書 I 締約国として署名し、批准することにより、世界規模の気候変動について関心を示し、同条約による約束を果たそうとする政治的意志を示した。ブルガリアは、2002 年京都議定書を批准した。議定書におけるブルガリアの約束は、温室効果ガスの年間排出量を 2008 年から 2012 年の期間に、基準となる 1998 年に比べて 8%削減を達成するために適切な政策と対策を実施することにある。

ブルガリアは、温室効果ガスの排出削減のための特定政策と対策を含めて、気候変動に関する国家行動計画（NAPCC）を策定した。2000 年 6 月、ブルガリア政府はこの計画を採択した。2003 年 1 月以降、オランダ政府の支援のもとに、NCCAP の改訂が始まっている。

気候変動に対処するためのブルガリアの国家政策は、環境水問題省（MOEW）が立案、調整を行っている。同省は、温室効果ガスの年間排出量インベントリと国別報告を気候変動枠組条約事務局（Climate Secretariat）に提出することにも責任を負う。同省は、同国内では気候変動緩和政策および対策の推進力であり、京都議定書のフレキシブル・メカニズムへの同国の参加にも責任を負う。

MOEW が行う気候変動条約に関する活動を支援する機関が他に二つある。その一つとして気候変動に関する政府間委員会（IGCC）が、2000 年 7 月、NAPCC の実施期間中に省庁の事業を管理し、調整するために設立された。もう一つは共同実施プロジェクト運営委員会（Steering Committee for Joint Implementation Project）である。同委員会は、プロジェクト計画書に基づき、既往の共同実施プロジェクト国家基準に従い、共同実施プロジェクト案を審査する。

1.2 国のエネルギー政策および再生可能エネルギー資源の利用に関する国の政策

ブルガリアのエネルギー部門は、国家経済において大きな重要な地位を占めている。この部門の進展に関しては、国内エネルギー資源の限界、輸入エネルギー資源がブルガリアの貿易収支の全体的構造に占める大きなシェア、工業生産におけるエネルギー集約度の高さ、エネルギー資源生産に対する補助金などの問題がある。

この数年の特徴としては、この分野における企業再構築、民営化および自由化があげられる。一次エネルギー総消費量は、1985 年から 1988 年の期間は比較的安定していたが、この 10 年間で急減した。

ブルガリアは需要の 70%以上を輸入に依存しており、液体燃料と天然ガスはほぼ全量輸入している。エネルギー資源の国内生産は、総消費量の 1%に満たない。高カロリーの瀝青炭および無煙

炭も輸入している。

基本的な国産エネルギー資源は、「マリザ・イースト（Mariza East）」露天掘り炭鉱コンプレックスで産出される低カロリーの褐炭である。それで国内産電力の約 35%を賄う。

これらの前提条件のもとで、再生可能エネルギー資源（RES）の利用は、国のエネルギーバランスを形成するにあたり、有力な代替品となる。多くの研究によると、再生可能エネルギー資源の潜在的可能性は大きいと評価されている。しかし、その実績はなお低迷している。これまでのところ、もっとも開発が進んだのは、水力発電であった。再生可能エネルギー資源の潜在的利用についての難点は複雑で、技術的、法律的、地理的問題およびその他の問題をはらんでいる。その結果、ブルガリアのエネルギーバランスに占める再生可能エネルギー資源のシェア（水力発電を除く）は、これまでのところ 0.4%に過ぎない。

このような状況のため、再生可能エネルギー資源国家プログラム（National Programme for Renewable Energy Sources, NPRES）を開始することになったが、このプログラムはまだ政府の承認するところとなっていない。再生可能エネルギー資源が市場に大規模に参入する時期は、今のところ不明である。これまで実施されたいくつかのプログラムは、もっぱら外国の資金に依存してきた。しかしながら、この方向への取り組みは着実に進展しており、具体的プロジェクトの実施に関わる事実上の障害は何も存在しない。

1.3　国としての共同実施政策、制度的インフラストラクチャー、手続き

政府は、京都メカニズムである共同実施（JI）と国際的排出権取引に経済的技術的および専門的支援が得られる可能性を見込んでいるとともに、温室効果ガス緩和対策の共同資金調達及び資金調達の好機と見ている。これらのメカニズムはブルガリアでも温室効果ガス排出削減政策から経済的利益を引き出す可能性をもたらしている。

ブルガリアでは共同実施班（JI Unit）が、オランダ政府の支援を得て 2000 年に創設された。JI Unit は環境水問題省の直接の監督下にある。

共同実施プロジェクトの選択基準が、作成され、承認された。それらは主にブルガリアとオランダ間の合意書に関連するものであり、現在より多くの当事者の関心を抱かせるために改訂作業中である。共同実施プロジェクトとしての温室効果ガス排出削減プロジェクトの基本的要件は、実現可能性、透明性、単純性、予見可能性である。

プロジェクトが満たすべきこれらの一般的要件に加えて、プロジェクト案は次のような基準に従って評価される。

- プロジェクト承認の要件：　共同実施プロジェクトの基本的要件を満たさないプロジェクトの提案を排除することを目的とする。特に、根拠の十分なベースラインのシナリオと、プロ

ジェクト実施における実際の排出削減量の予測値を示すこと

- 一般的な評価指標：　ホスト国が設定した優先順位に当該プロジェクトが合致すること
- プロジェクト評価にあたっての環境指標：　本プロジェクトがベースラインシナリオに関連して環境を改善するものであること。すなわち、天然資源を経済的かつ有効に利用し、その他の地域的局所的環境指標に悪影響をもたらすものであってはならない。
- 社会的、資金的、経済的指標
- 専門的・技術的指標

2000 年に、ブルガリア政府とオランダ政府は排出削減獲得テンダーERUPT に基づき、共同実施プロジェクトのための合意書に調印し、排出量の削減を二国間で分割した。再生可能エネルギーの利用を目的とするプロジェクトを主体として、6 件のブルガリアのプロジェクトが最初の 2 回の入札に付せられた。残念ながら、いずれも成功しなかった。オランダ政府は、6 件のプロジェクトを全て承認しなかった。第 3 回の入札は 2002 年 10 月 25 日から 2003 年 1 月 30 日まで行われた。いくつかの案がこの入札に提出されると期待されている。

京都議定書の第 6 条に基づくその他の共同実施プログラムには、世界銀行のプロトタイプ炭素基金（Prototype Carbon Fund, PCF）がある。ブルガリアと PCF 受託者である欧州復興開発銀行間のホスト国協定は、2002 年 11 月 14 日に締結された。

1.4　温室効果ガス排出インベントリと将来予測

ブルガリアは、UNFCCC 締約国が承認した温室効果ガスのインベントリ作成法を用いて、排出源別温室効果ガス排出とシンク別吸収量のインベントリを開発し、定期的に更新している。

インベントリは、ブルガリアにおける UNFCCC 基準年である 1988 年に始まっている。これは主な温室効果ガスである二酸化炭素（CO2）、メタン（CH4）、亜酸化窒素（N2O）、温室効果ガスの先駆物質（窒素酸化物、一酸化炭素、NMVOCs）、二酸化硫黄（SO2）の排出を対象としている。ハイドロフルオロカーボン（HFC）とパーフルオロカーボン（PFC）の排出は、これらのガスについてのブルガリアの基準年である 1995 年に始まった研究で検討されている。これらの排出量は、『IPCC 改訂ガイドライン』1996 年版に従い再計算されている。

二酸化炭素の排出量は、IPCC ガイドラインで推奨されている二つの方法（トップダウン・アプローチとボトムアップ・アプローチ）を用いて推定する。ブルガリアにおける部門別の二酸化炭素排出量の 1998 年と 1990-1999 年の期間における全体的推定値を部門別に表 1 に示す。エネルギー関連の事業活動は、ブルガリアにおいて温室効果ガスの最大の排出源である。その活動とは化石燃料の燃焼、生産、燃料の輸送、貯蔵および流通から成る。

表 1. ﾌﾞﾙｶﾞﾘｱにおける燃料燃焼による CO_2 の分野別排出量 (Gg)

	1988	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
ｴﾈﾙｷﾞｰ産業	37 823	39 664	37 626	34 127	34 632	31 574	32 246	31 286	31 487	27 600	26 322
製造業および建設業	35 756	19 890	12 051	9 694	10 752	11 984	14 582	14 010	13 968	11 401	9 488
運輸業	12 639	10 864	6 525	6 435	7 444	6 547	6 845	6 306	5 315	6 475	6 212
その他産業	7 612	5 381	4 086	4 612	4 117	3 325	2 621	3 238	2 678	2 989	2 491
産業以外	1 666	1 006	882	196	733	810	315	261	112	49	0

出典: GHG National Inventory, 1999

第 1 次約束期間である 2008 年から 2012 年までの排出予測値の分析によれば、ブルガリアにおける経済効率化の急速な上昇のためすでにとっている対策がなければ、京都議定書上の義務を満たすことができなくなることになる。もし対策をとらなければ、この期間に、排出量は京都議定書の目標を 18%超過するはずである。すでにとった対策で、ブルガリアが約束を果たすことが保証できるであろう。さらに、排出量取引という大きな可能性が出現している。「対策をとった場合の」シナリオでは、この可能性は、毎年二酸化炭素相当 1100 万トン以上と予測される。対策を追加実施すると、排出量取引の可能性は、約 2000 万トンに達するであろう。

ブルガリアにはさらに大きな排出量削減の可能性がある。しかしながら、投資不足のため実現ができない。ただし、製造業および建設業での共同実施プロジェクトを実行すれば、さらなる二酸化炭素排出削減が可能となろう。

2. 化石燃料の代替品としての廃材バイオマスの利用

2.1　廃材バイオマス利用のメリット

木材ブリケットや廃材の利用は、液体燃料と電力の消費節減を生む。エネルギー媒体の節約は、温室効果を生ずる主な汚染物質（二酸化炭素（CO2）、メタン（CH4）、亜酸化窒素（N2O））をはじめとする大気中への有害排出物の減少につながる。バイオマスの燃焼に伴う排出物はゼロと仮定するが、それはこれらが森林バイオマスの成長期間中に吸収した排出物の量と同じと考えられるからである。

廃材利用は、地域暖房ネットワークが発達していない地域でも効果的である。木材や木材ブリケットを燃やす小型ボイラー（10～100KW）は、現在電力、石炭、残渣油を使用している公共社会住宅、一般家庭の集中暖房でも利用できる。

電力、石炭、残渣油の価格が比較的高く、エネルギーの利用を制限せざるを得ないため、住宅や公共建築物内の暖房の快適性はきわめて低い水準にある。集中暖房に比較的安価な廃材を導入すると、公共建築物（学校、病院等）の暖房の快適性は高まる。間接的ながら、これは住民の健康や医療費支出によい影響を与える。

廃材利用は、廃材処理所やブリケット製造所での廃材回収を促進する。その結果、管理森林の健全性は顕著に改善し、森林の老朽廃材や埋立地からのメタン排出量は減少する。埋立地への持ち込み量も減少し、埋立地の寿命も伸びる。

廃材を利用することにより、失業率がきわめて高い地域において廃材回収、加工、加工廃材供給、暖房施設の設置、運転、維持の分野で、新しい雇用を創出する。ブルガリアの山村の失業率はきわめて高い。

2.2 資源：　ブルガリアの森林と木材バイオマスの現状

農林省（Ministry of Agriculture and Forests、国家森林局 （National Forestry Board)）が提供する 1996-2000 年のデータによると、森林面積は、388 万ヘクタールないし 391 万ヘクタールと比較的安定的な幅にあった。ブルガリアの国土にしめる森林面積は 31.7%ないし 34%である。この面積のうち 86.6%ないし 86.8%から森林が伐採され、336

万ヘクタールから 340 万ヘクタールへとわずかながら増加傾向にある。落葉樹林の比率は 67%である。この傾向は、伐採したが再植林されない森林面積が減ったこと、また実際の皆伐が減ったことのためである。最近の国全体の森林調査（2000 年）によると、森林保有量は、乾燥ベースで 5 億 2610 万立法メートルである。

森林と森林地の返還手続きが終わった後、森林の 80%強が国有林として残り、8～9%が民間所有に移行し、その残余は自治体、教会、学校、協同組合の資産となるものと思われる。

このような傾向は、ブルガリアがエネルギー製造に用いるため安定的な森林バイオマスを生産してきたことを示している。バイオマスの量は、一般に気象上の条件の影響を受けることがきわめて少なく、また年による変動も少ない。

森林資源は増加基調が続いている。森林バイオマスには、継続的増加傾向が見られる。最近では 1370 万立方メートルに達した。年間計画伐採量は、材木の需要が急減しているため、達成できない。計画伐採量と実際の伐採量の乖離が増加し、樹木の通常の新陳代謝に差し支えが出ている。

エネルギー生産のための森林バイオマスの利用は、利用する技術によるところが大きい。ブルガリアの場合、枝、潅木、挽き屑、その他木材処理の残渣が、まったく利用されていなかった。1985 年から 1991 年の期間に生産された薪、残材、くずの量は、160 万ないし 240 万立方メートルである。

これから数年間に伐採しうる雑木林や低木林からの木材バイオマスは大量となる。この 15 年で 7000 万立方メートル、すなわち年間 400 万立方メートルを超えるであろう。木材 400 万立方メートルのエネルギーは、9,445 ギガワットアワーとなる。針葉樹を間伐すれば、工業用木材や材木の量を増加することができる。これらの量は年間 280 万立方メートルに達する。利用されないのに伐採されて森林に放置されている廃材は、年間 120 万立方メートルを超える。立木の処理および針葉樹の間伐による廃材、雑木林や低木林からの木材バイオマスの切り出しは、毎年合計 700 万立方メートル以上で、これをエネルギーに換算すると 1100 ギガカロリーとなる。

廃材利用による潜在的なエネルギーの増加率の実践的な可能性はきわめて高い。

ブルガリアにおける木材の平均年間伐採量は 600～700 万立方メートルである。同時に、立木の増加は年間 1200 万立方メートルに達する。1999 年には、伐採した木の残りは 200 万立方メートルで、うち 100 万立方メートルは薪として使用したが、100 万立方メートルの廃材（細かい屑）が利用されなかった。伐採後の残りと材木加工工場から出る屑をこれに付け加えると、かなりの廃材が出たことになる。廃材燃焼ボイラーは市街地の大気質を改善する。それは、二酸化硫黄やダストの排出を伴わないためである。

2.3　プロジェクト実施の優先地域

ブルガリアには、国の行政区画に一致して 28 の地方営林局がある。年間計画伐採量は、それらに次のように割り当てられている。

表 2. 地域別木材収穫量配分計画

地域	木材穫量計画地域別シェア	立木伐採収穫量計画値	廃木材生産量計画値	廃木材生産量実績値	廃木材含有エネルギ量
	%	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**

廃材量が 5 万立方メートルを越す地域がブルガリアには 17 ある。製材工場から出る廃材を上記の数字に加えると、膨大な量の廃材が出てくることになる。残念ながら製材の需要が減少したため、上記の計画は通常達成できない。実際の伐採量は平均で予定の 20%ほど少ない。これが森林では利用可能な廃材が予定より少ない理由である。

廃材利用プログラムは、十分な廃材が出されている地方に適応したものでなくてはならない。当該地域においては製材の生産が減少してもそれをカバーする廃材の補充がなくてはならない。上

に示した表は、効率的な生産廃材処理所が必要とする 3 万立方メートル以上の廃材資源を 17 の地域が確保できることを示している。それらの地域とは、Blagoevgrad, Pazardzhik, Sofia, Bourgas, Smolian, Lovech, Stara Zagora, Plovdiv, Varna, Kiustendil, Sliven, Veliko Tarnovo, Haskovo, Shumen, Silistra, Kardjali, Gabrovo である。

2.4　バイオマスからの熱生産技術

一般的に、バイオマスから熱を得るには、直接燃焼と熱分解（ガス化）の二つの方法がある。

直接燃焼は、もっとも一般的な技術である。通常、家庭でも、普通のストーブ、タイルストーブ、暖炉、壁つき暖炉、マントルピース、それに特殊ボイラーで使用されている。燃焼効率は、ストーブやマントルピースで 40%ないし 50%、特殊ボイラーで 75%ないし 85%%と幅がある。

木材はクリーン度では一級の燃料であるが、直接燃焼技術は排出物を比較的多く出す。一酸化炭素、微粒子、有機炭素化合物の排出量レベルは比較的高く、それを減らすためには特別な対策を施さなくてはならない。通常のストーブ、暖炉、壁掛け暖炉、マントルピースなどによる暖房で小さな町を暖める場合、大気質上の限界は冬季には守られていないのが通常である。集中暖房や地域暖房がこの問題を解決する。

ある種の燃焼ボイラーは廃材バイオマス（木材、廃材、木材ブリケット、ペレット、挽き屑、チップなど）を利用でき、燃焼効率も運転プロセスも高効率である。この種のボイラーの出力は 10～1000kW と幅がきわめて広い。

熱分解は、酸素やその他の化学物質がないところでおきる有機物の熱分解作用である。この分解は、一連の複雑な化学反応ならびに熱および重量の移転のプロセスを経て行われる。熱分解は、ガス化および燃焼プロセスの中の一段階である。物質の熱分解は 250℃以上から約 500℃で始まるが、反応の程度は反応器の中に残渣が滞留する時間で決まる。反応器は特殊ボイラーの中に統合できる。木材バイオマスは酸素濃度が薄い特殊チャンバーで熱せられる。バイオマスから出る有機物質は、すべてガス化され、特殊チャンバーから排出される。ガスは燃焼チャンバーにある一つまたはいくつかのバーナーに送られる。ボイラーの効率はボイラーの出力により 80%ないし 90%である。熱分解ボイラーの効率は、10%ないし 15%ほど直接燃焼ボイラーの効率より高い。二酸化炭素、微粒子、有機炭素化合物の排出レベルは無視しうるほどで、それを減らすための特別の対策は必要ない。

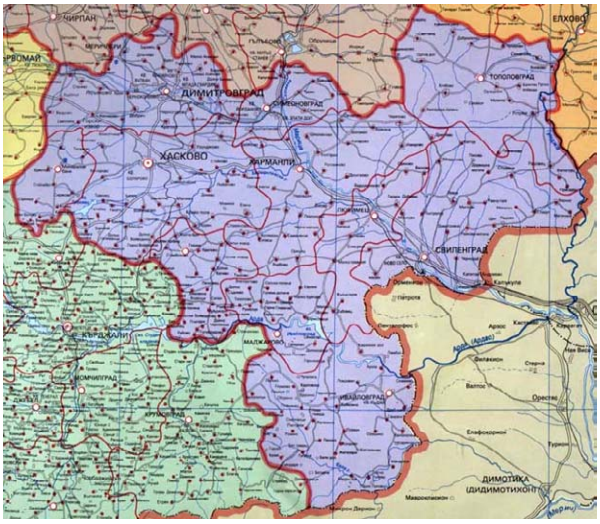
小規模の熱分解ボイラーは、どの町でも家屋の集中暖房で使用可能であり、あらゆる大気質の規制に対応できる。熱分解ボイラーの価格は、固形燃料を利用する通常のボイラーの価格よりも 50%ないし 100%高い。ERATO ホールディング JSC ハスコヴォ（ERATO Holding JsC Haskovo）は種々のボイラーを製造ないし販売しているが、それらは固形燃料（固形木材、木材ブリケット、木材ペレット）を燃やすための熱分解プロセスを応用している。それらの出力は 10～100kW である。

3. 建築物の集中暖房装置供給において廃材バイオマスを利用するパイロットプロジェクト、およびそれらに共同実施を適用する可能性

3.1　選択した技術実施のための優先分野と実施場所

高能率ボイラーを使用して集中暖房の熱を発生する廃材利用の可能性を評価するために、ハスコヴォ市でパイロットプロジェクトを実施する。ハスコヴォは典型的なブルガリアの町で、木材資源の利用可能性に関しては国内でも平均的な位置にある。同市は平均廃材発生量が高い南ブルガリアのハスコヴォ地域にある。同市の中心は、ソフィアから 234 キロほどの距離にある。

Physical Map of Haskovo Region



Administrative Map of Haskovo Region

同市の総面積は 740 平方キロメートルある。同市内には 15,503 ヘクタールの森林があり、それらは主として落葉樹林である。地形は北端では平らで、南端には丘陵がある。同市にはハルマンリスカ川(Harmanliyska)が貫流している。

同市には 37 の居住地がある。そのうちの一つがハスコヴォ市である。人口は 100,124 人で、その 79.9％は市街地に、21.1％は田園地帯に居住している。(1999)

同市の年間電力支出額は約 840,000 レフ、燃料暖房支出額は 660,000 レフである。

ハスコヴォは、都市エネルギ効率化ネットワーク（Municipal Energy Efficiency Network）のメンバーで、都市エネルギ効率化室（Municipal Energy Efficiency Office）を持ち、主な市施設のエネルギー消費のデータベースを構築している。2001 年にはこれらの施設で 11,457MWH のエネルギーを消費した。その主な内訳は、暖房用ナフサ 48.83%、電力 31.93%、天然ガス 14.56%であった。

2 つの学校校舎と市役所をハスコヴォ市の実証例として選択する。これら 3 つのサイトは、次の理由で選ばれた。

i) 公的に所有されている。
ii) この地方では最大の社会施設である。
iii) 校舎はネットワークの全市町村にとってもっとも優先度の高い目標グループであり、ハスコヴォ市エネルギー効率化プログラムでも第一順位になっている。
iv) これらのサイトから得るフィージビリティ・スタディの結果は、比較分析と反復のための適切なデータを提供することになる。

3.2 プロジェクトのアプローチ

これら校舎 2 つと市役所の建物は、暖房用軽油（Light Heating Oil, LHO）焚きの個別ボイラーで暖房している。ボイラーはそれぞれ 1961 年、1978 年、1995 年、1970 年に設置されたものである。新しいボイラーだけが良好な状態に維持され、その他は時代遅れで非効率である。

このプロジェクトでは、Vassil Levski と Kiril-i-Methodiy の両校とハスコヴォ市庁舎で, 既存のボイラーを燃料自動調節装置つきの近代的な高効率バイオマス燃料ボイラーで置き換え、燃料を産業・公共利用 LHO からバイオマスに転換することを予定している。工業用・商業用の LHO は、180℃～380℃で蒸留して得る中間的蒸留油である。その排出率は、メガワットあたり二酸化炭素 268.2kg 相当である。

必要とする機器は、この 3 か所の建物をエネルギー診断した結果決定した。そのために、建物の現在の維持状況、建物内システム、エネルギー消費機器を詳しく調査し検討した。また建物ごとのコンピューター化モデルを開発し、エネルギー収支を作成した。それぞれの建物の運転スケジュールによって、暖房シーズンにおける室内気候の諸変数に関わる通常の基準を維持することが、初期条件としてそれぞれの建物のコンピューター化モデルで与えられた。エネルギー診断を基礎として、ボイラーをバイオマス燃料機

器に取り替える可能性の評価を行った。

3.3 ハスコヴォにおけるプロジェクトのベースラインシナリオ

選択するベースラインシナリオはプロジェクト固有のものであり、当該プロジェクトを実施しないとした場合に発生するはずの同様な状況をシミュレートする。ベースラインシナリオでの前提は、ブルガリアの他の町における同様なプロジェクトでの経験に基づいている。それらはシステムを機能させるための対策に関する限り、参考例として考慮できる。

ベースラインシナリオは、次のようないくつかの原則にも妥当な考慮を払う。

i) 費用最小オプションの選択：これは、生産の低下および失業の増大による歳入減少のため、通貨庁の事情もあり市財政が極端に苦しくなったことから、当国では市の発案プロジェクトにもっぱら適用される原則である。

ii) 建物の暖房上の快適性基準要件を満たすこと：　建物内に暖房上の快適性を提供するために市の担当部局が決定する必須的要件である。現状では、基準要件よりやや低めに温度を維持することにより、エネルギー消費に若干の制限を課している。しかしながら,これらは健康上のリスク、学校における学習プロセスの効率低下、建物内居住者の満足度低下のために、受け入れることはできない。

iii) 当国において最も普及した技術を使用すること

簡単に言うと､ベースラインシナリオは､この種の機器にとってはもっとも安価な燃料であるLHOの継続利用、既存ボイラーが更なる使用に耐え得るならばそれらの修理維持、陳腐化したボイラーの新しい同種のボイラーとの交換を念頭においている。

このパイロットプロジェクトのサイト 3 箇所のベースラインシナリオは、サイトで行ったエネルギー診断を基礎として作成した。それぞれのフィージビリティ・スタディの結果として、各サイトの LHO の必要量ならびに機器の交換費、修復費およびその維持費を示す。

それぞれの必要とする燃料の量と温室効果ガス排出量

コンピューター化モデルの手法を応用して、建物に必要な熱産出量を計算して、基準となる要件の達成のために暖房に必要な量を定める。得た値は、各建物の実際の運転負荷サイクルに従い、修正（減少）する。修正値は、それぞれのサイトのエネルギー収支で入力値として代入する。ボイラー注入口での必要エネルギー値を得るために、発熱時のエネルギー転換効率と各建物の損失を考慮に入れる。

3 つのサイトについての結果は、建物の暖房に必要なエネルギーの削減値とボイラー注入口での必要エネルギーを含め、次のとおりである。

Vassil Leviski 学校　516.3MWh／年、すなわち LHO44.7 トン（45,486 レフ）
市庁舎　392.7MWh／年、すなわち LHO 34 トン（34,597 レフ）
Kiril-i-Methodiy 学校　157.3MWh／年、すなわち LHO 13.62 トン（13,858 レフ）

このベースラインは、LHO がブルガリアのメーカー、ブルガス（Burgas）所在の LUKOIL Bulgaria Ltd.が一手に供給することを前提としている。この燃料は、ブルガスからハスコヴォまで容量 22 立方メートルのタンクをつけたディーゼルエンジントラックで運搬する。サイトで燃料を燃焼する間、燃料そのものからの排出の他、ボイラーと暖房システムの運転に必要なバーナー、ポンプ、ファンの電力消費量を考慮に入れなくてはならない。

ベースラインシナリオでの排出物は、燃焼チャンバーでの燃料消費、電力消費、ハスコヴォまでの燃料の道路輸送に要する燃料消費で、全部で二酸化炭素換算 4,563.7 トンとなる。

機器の交換、修復、維持に必要な費用

サイトのエネルギー診断によると、Vassil Leviski 学校と市庁舎の機器の保守状態は悪く、それらは事実上それらの技術的資源を消費し尽くしていて、これ以上適正な運用にほとんど耐えられない。既存の機器をこれから 15 年間にわたり維持、修理、再生するための費用を、ベースラインシナリオで考慮した。15 年間に要するこれらの費用は、104,290 レフになる。

3.4 プロジェクトの実施

エネルギー費用および温室効果ガスを削減する対策

『ブルガリアで建物の集中暖房に廃材を利用するプロジェクト』の目的に従い、これら 3 つの市の建物でのパイロットプロジェクトでは、第一次的手段として、LHO で運転している既存のボイラーを近代的で高能率のバイオマス燃料ボイラーに交換することを検討する。この更新案の目的は、燃料切り替えにより温室効果ガスの顕著な低減を達成し、LHO のコストに比べればきわめて安い廃材利用熱によって市が負担するエネルギーコストを大幅に節減することにある。実際には、LHO から廃材バイオマスへの燃料切り替えは、燃料の燃焼に伴う温室効果ガスの排出を停止することにもなる。

Vassil Leviski 学校

このプロジェクトは、現在利用している燃料（LHO）を木材バイオマス（廃材、チップ、削り屑、木材チップ等）に切り替えることを予定する。このために、既存の LHO 焚きボイラーは、バイオマス燃料を使用する小型の温水式ボイラー2 台（総出力 700kW、2x350kW、自動燃料注入装置つき）に更新する必要がある。屋内の暖房システムを蒸気式から温水式に改造する必要もある。このサイトには、原料の取り扱い作業に便利なプラットフォームと燃料備蓄に必要なスペースが整

っている。後者はボイラーハウスに隣接して建設できる。必要な廃木片バイオマスの年間消費量は、約 146 トンである。

ハスコヴォ市庁舎

このプロジェクトは、現在利用している燃料（LHO）を木材ブリケットに切り替えることを予定する。このために、既存の LHO 焚きボイラーは、バイオマス燃料を使用する小型の温水式ボイラーATMOS DC 100 型（定格出力 99kW、ERATO ホールディング JSC ハスコヴォ製）2 台に更新する必要がある。ボイラーは熱分解蒸留の原理で稼動し、プロセスを全自動管理して高燃焼効率（最高 89%）を実現する。蒸気式暖房システムから温水式暖房システムに改造する必要もある。ハスコヴォの ERATO 資源会社（Erato Resource Company）が提案するバイオマスの配送予約システムをこのサイトで用いる。庁舎の需要を賄う木材ブリケットの年間消費量は、約 63 トンである。

Kiril-i-Metodiy *学校*

このプロジェクトは、現在利用している LHO を木材ブリケットに切り替えることを予定する。このために、既存の LHO 焚きボイラーは、バイオマス燃料を使用する小型の温水式ボイラーATMOS DC 100 型（定格出力 99kW、ERATO ホールディング JSC ハスコヴォ製）3 台に交換する必要がある。ボイラーは熱分解蒸留の原理で稼動し、プロセスを全自動管理して高燃焼効率（最高 89%）を実現する。このサイトには燃料備蓄の適当な場所がない。それがバイオマス配送予約システムを使用する理由である。校舎の需要を賄う木材ブリケットの年間消費量は、約 29 トンである。

プロジェクト投資額

表 3 は、サイトごとにプロジェクト稼動の費用を示す。配送費用と建設費と据え付け費用には、5%の予備費を見込んでいる。

ERATO ホールディング JsC ハスコヴォが見積もった価格を用いて計算した対策案のコストを基礎として、プロジェクトの実施に要する投資額は 272,300 レフと決定した。

表 3. プロジェクト・コスト

アクティヴィティ	金額(レフ)
Vassil Levski 小学校	193 784
Administrative building of Haskovo 市役所	36 265
Kiril-i-Metodiy 小学校	28 240
小計	258 289
雑費（計画, プロジェクト管理, その他）	1 100
投資額計	259 389
Incidental expenses 5% of investment costs	12 911
総合計	**272 300**

推定節約額

このプロジェクトでは、安価な燃料への切り替えにより相当のコスト節減を図ることができる。Vassil Levski 学校と市庁舎では蒸気暖房システムから温水暖房システムに切り替えるので、熱損失が減少し、さらなる節約の余地が生ずる。この計算では、LUCKOIL Neftochim が 2003 年 1 月に発表した LHO 価格（1 トン 1,017.6 レフ）を使用した。ブリケットと廃材の価格は、ERATO ホールディング JSC の見積もりの中に記載された価格で、1MWh あたりブリケットは 34.8 レフ、廃材は 11.8 レフである。

表 4.　年間節約費用

サイト	節約額　レフ/**year**
Vassil Levski 小学校	40 370
Administrative building of Haskovo 市役所	22 672
Kiril-i-Metodiy 小学校	8 394
Total	**71 436**

環境上のメリット

一般に再生可能エネルギー源を利用するプロジェクト、ことに木材ブリケットや廃材を利用するプロジェクトの重要な結果は、温室効果を生む二酸化炭素（CO2）、メタン（CH4）,亜酸化窒素（N2O）など、大気圏内に排出する温室効果ガスを削減することにある。

『ハスコヴォ市の市施設内で建物の集中暖房に廃材を利用するパイロットプロジェクト』の実施の結果、大気圏内に排出する温室効果ガスの削減量は、二酸化炭素換算 4,430 トンとなる。

LHO からの排出は、環境水問題省が承認した『電力部門、工業、商業の室内暖房プロセスから生ずる排出物の割合を定める方法』（ソフィア、2000 年）を利用して計算した。バイオマス燃焼の結果、達成する排出物削減のそれぞれの計算は、『気候変動第 2 回国別報告』（ソフィア、1998 年 4 月）の作成過程で適用された方法によった。『1996 年改訂国別温室効果ガスインベントリ IPPC ガイドライン』も使用した。

排出物のベースラインおよびベースライン計算に含まれるアクティヴィティは、
- ボイラーが使用する暖房用軽油（LHO）の配送
- サイトで使用する LHO の燃焼
- ボイラーが消費する電力消費

である。

プロジェクト実施後の排出物の計算に含まれるアクティヴィティは、

● 3つのプロジェクトサイトの需要を満たす木材ブリケットの生産、
● 道路輸送による木材ブリケットと廃材の配送
● 木材ブリケットと廃材の燃焼
● 新しい木材燃料ボイラーの電力消費

である。

このようにして、大部分が合理的にプロジェクトアクティヴィティに帰着し、プロジェクト実施主体の管理下にある共同実施プロジェクト案から生ずる温室効果ガス排出量は、すべて次に記すプロジェクト範囲内に収まる。

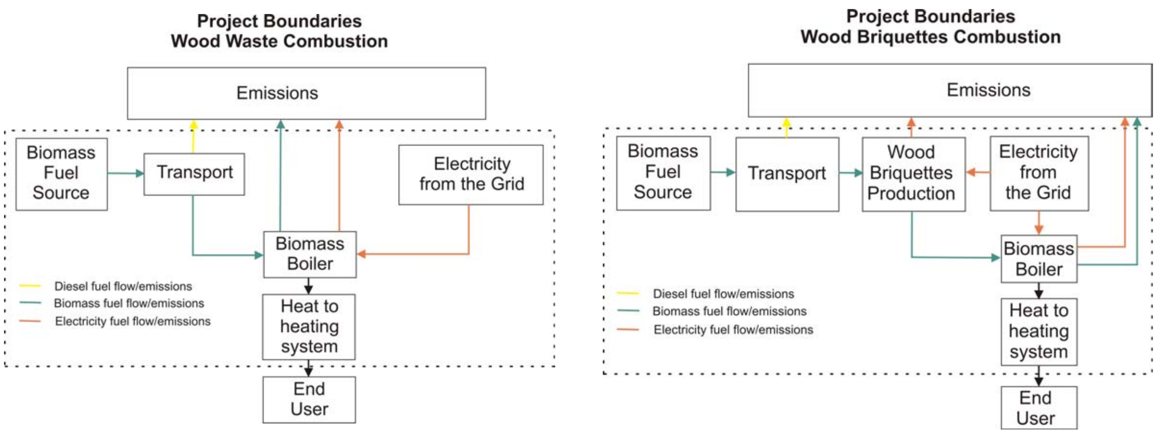


Fig. 1. Project boundaries

ベースラインとＪＩシナリオとの比較を、CO2 換算 GHG 発生量について行なったのが下表である。ＪＩによるＧＨＧ削減効果は 301.2 － 11.0 ＝ 290.2 ton-CO2 換算／年となる。

CO2 換算 GHG の年間排出量（ton）

	ベースライン		ＪＩシナリオ	
燃料燃焼に伴う排出	ＬＨＯ燃焼	286	メタン発生	1.411
電力消費に伴う排出	ボイラ用電力	13.6	ブリケット製造	2.4
			ボイラ用電力	7.5
運搬に伴う排出	ＬＨＯの運搬	1.6	廃木材、ブリケット運搬	0.251
合　計		301.2		11.02

このプロジェクトでの温室効果ガスやその他の有害汚染物質の減少は、主な燃料の切り替えと電力の節約の結果である。バイオマス燃焼による排出はゼロと仮定するが、それは森林バイオマスの成長期間中に吸収した排出物の量と同じと考えられるからである。

電力からの排出物は、発電施設の建設および開発計画に沿って推定する。毎年の特定温室効果ガスおよびその他の有害排出物は、長期的に発電のロードチャートの調達に参加する発電施設出力の予想構成に対応する。2006 年末には Kozloduy 原子力発電所の第 3 号機と第 4 号機は運転停止

すると仮定する。

二酸化炭素換算 1 トンあたりの排出量削減費用は、プロジェクト増加費用に比較すると、 50.26 レフ（25.70 ユーロ）である（ベースラインで避け得た投資保守費用は、当該プロジェクトの投資および保守費用から差し引く）。二酸化炭素換算 1 トンあたりの排出量削減費用は、プロジェクト投資費用に比較すると、62.36 レフ（31.88 ユーロ）である。

温室効果ガスの削減に加えてこのプロジェクトは、これまで LHO 燃焼で運転していたサイトにおいて、地域にとって深刻であった有害排出物の削減に貢献する。さらには、化石燃料発電所から排出される硫黄酸化物、窒素酸化物や塵埃もわずかな量であるが避けられる。

プロジェクト実施のタイムスケジュール

ハスコヴォ市の市施設で暖房にバイオマスを利用するパイロットプロジェクトは、2003 年の暖房を利用しない時期（4 月から 9 月まで）の 5 か月間で実施しうる。別個の据え付け工事チームを手配して、異なるサイトでの作業の間も若干の重複が可能となるように計らう。市庁舎と Kiril-i-Mehodiy 学校での熱分解ボイラーの据え付け工事は、Vassil Levski 学校でのボイラーの据え付け工事より 1 か月先行して開始する。主な工事は、建物内に人がいる率が低く、施工が容易な 7 月から 8 月にかけて予定する。3 箇所での建設工事と据え付け工事は、9 月 20 日までに終了し、暖房システムが引き取られて、9 月末には通常の運転を開始する。必要な資機材の購入ならびに解体および据え付け工事の下請け業者は、入札によって選定する。

プロジェクトの資金計画

資金計画では、182,100 レフをある金融機関から借り入れ、その他借入人であるハスコヴォ市から 90,200 レフの拠出を予定する。その他、市当局はプロジェクト実施期間中の金利を 3,559 レフ負担する。この結果、借入人の負担の割合は、総プロジェクト費用の 34%となる。

キャッシュフロー分析

主要財務指標（回収期間、内部収益率、純現在価値）は、利率を 15%、年間インフレ率を 4%という前提でプロジェクトのキャッシュフローを作って計算した。

名目利率	15%
実質利率	11.11%
純節約額による回収期間	3.33 Years
内部収益率	28.80%
純現在価値	276 840 BGL

これはプロジェクトの耐用年数が 15%という前提で計算してある。この期間内に、さらに維持修

理費として総額 51,150 レフが加わる。完全に償却した機器を交換せずに回避できた投資コストは、27,120 レフである。既存ボイラーの修理維持のために発生したが回避できたコストは、25,750 レフにのぼる。

上記のようなこのプロジェクトの財務指標に基づいて、このプロジェクトは十分に健全で安定的なキャッシュフローを生み出し、そのために予定投資額の借り入れの返済は保証しうるということができる。

このプロジェジェクトを共同実施プロジェクトとして実施するのであれば、第 1 次約束期間（2008－2012）内には、プロジェクトの収入として温室効果ガス削減の売却によるさらなる収入が見込める。この収入額は、当事者間で交渉して決める二酸化炭素 1 トンあたりの単価により変動する。それはプロジェクトの財務諸指標を改善する。それらの資金をプロジェクト実施主体である市当局が手にする正確な時期を知ることが特に必要となる。もっとも都合がよいオプションは、市当局がプロジェクトの開始に先立って当該額の少なくとも 50％を前払いの形で受領する取り決めである。それは、初期投資の負担を減らす。見積もり節約額を勘定に入れても、必要借入額の減少は期待できない。

リスクと感度分析

プロジェクト実施にまつわる 3 種のリスクを検討し、評価した。

● プロジェクトが完成しないリスク	予算を超過し、システムの稼動が遅れるリスクを評価する。
● 運営リスク	見積もった純節約額が、不適切なプロジェクト運営のために、その通りに実現しないリスクを検討する。
● 価格リスク	主として燃料価格に関するもの。

最悪ケースのシナリオでは、これらの予想されるリスクが同時に発生する影響を推定することになる。予算超過は、リスクウェイト 5％で組み込んである。稼動開始遅延のリスクとして 1 か月を見込む。運用の失敗と価格の変化による純節約額の減少は、リスクウェイト 10％で反映させてある。最悪ケースのシナリオは、上記のシナリオすべての組み合わせを検討するのに役立つ。

すべてのシナリオで、本プロジェクトの財務指標は、受け入れ可能な範囲にとどまる。

プロジェクトの感度分析では、プロジェクトの結果に影響し、技術的および経済的パラメーターに変化を与える 2 つの主な要因を検討する。すなわち、(1)LHO とバイオマスの価格の比率の変化。計算上の節約額の実現は、これにかかっている。(2)プロジェクト実施に投資する額の変化。分析によれば、本プロジェクトは、純現在価値と内部収益率が 50％の範囲で変化しても、利益が挙がる。

3.5　ブルガリアにおける本プロジェクトの反復可能性と持続可能性評価

この事前調査には、もしハスコヴォのパイロットプロジェクトが効率的であることが判明すれば、同様のプロジェクトを、地域暖房ネットワークが発達していない地域でも反復的に実施することが有望であると述べている。木材や木材ブリケットを燃やす小型ボイラーは、現在、電力、石炭、残渣油を利用している公共建築物や家庭の集中暖房に利用できる。このプロジェクトは、廃材の入手が可能で廃材をブリケットに国内で再加工できる 20 以上の（おそらく 24）地域で有効であろう。

パイロットプロジェクトの反復の実現性と可能性をさらに高めるため、都市エネルギー効率化ネットワーク EcoEnergy (Municipal Energy Efficiency Network EcoEnergy)の能力を基盤として活用した。EcoEnergy には全国から 39 の都市が加盟している。そのうち 23 都市は廃材生産の可能性が高い 14 地域に所在する（第 2 部に記載）。EcoEnergy の都市メンバーは、市施設とそれぞれの燃料別エネルギー消費についてのデータベース、建物内の暖房源と設置状況にかかるデータベースを開発した。残念ながら、この情報は、ソフトウェアがブルガリア語であるために、この報告には直接記載できない。いずれにせよ、プロジェクトチームはそれを入手しているので、ブルガリアの他の地域や都市でもこのプロジェクトを反復する可能性を説明するために、その抜粋を作成する。

液体燃料を使う個別ボイラーをもつ公共建物の数を調査するために、選別を行なう。これらの市町村で液体燃料を使う個別ボイラーをもつ建物は、435 棟ある。それらは現在、化石液体燃料から生産する 104,597MWh の熱エネルギーを使っている。エネルギー利用のベースラインは、これらの建物に標準的なレベルの暖房を提供するには、さらに多くのエネルギーが必要になることを考慮している。多くのエネルギー診断の結果、公共建築物内の温度は通常の労働条件を確保するに必要な温度よりも低いことが判明した。快適なレベルの温度を保つには、エネルギーをそれよりも約 20％多く消費する必要がある。これを考慮すると、435 棟の建物に必要なベースラインの年間エネルギーは、125,516MWh となる。

これらの建物の廃材バイオマスへの燃料切り替えプログラムにより、木材バイオマスから生産される 125,516MWh のエネルギーを利用することになる。パイロットプロジェクトで確認したとおり、このバイオマスのうち約 50％はブリケットの形、50％は廃材の形をとると仮定する。このプログラムにより削減される温室効果ガス排出量は、本プログラム実施の 15 年の期間内に,二酸化炭素換算約 502,104 トンとなる（表 6）。

表 5. ブルガリアの 23 市の公共建造物における石油燃焼ボイラのエネルギ消費

地域	市	ボイラ設置建物	現状の燃料使用量 MWh	ベースラインの年間燃料使用量 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**

表 6 ベースラインおよびＪＩシナリオのＧＨＧ排出量比較

. *ＧＨＧ*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

燃料価格の差による資金的な節約は、毎年 8,134,064 レフにのぼる。本プログラムの実施に必要な投資額は、約 1200 ないし 1500 万ドルである。

しかしながら、本プログラムは本研究に記載する都市に限るものではない。それらの都市が選択されたのは、それらが木材バイオマスを利用する可能性が高いことが実証された地域にあり、それらの建物に関するデータが揃っていたからである。他方、都市部における建物でこのようなプロジェクトの実施が成功すれば、民間会社や住宅部門も同様にバイオマスに燃料を切り替えようとして関心を深めるであろう。パイロットプロジェクトを開始し、その結果についての情報を普及し、広い層の消費者の意識を深めることが、きわめて大切である。

本プログラムの実施可能性と維持可能性は、次の 5 つの主要な要因による。

i)　木材資源の入手。

ii) 希望する形（木材、廃材、木材ブリケット、ペレット、削り屑、チップ等）で木材製品を回収し、加工し、配送する能力。
iii) 効率的な木材バイオマス燃焼ボイラーの生産能力。
iv) ボイラーの代金を支払う当初資金の調達。
v) 取引費用を低く抑えるようなプログラムの運営。

木材資源は、すでに第 2 部に述べたようにこの国では入手が容易である。それらはこのようなプログラム実施の最善の前提条件である。木材製品を回収し、加工し、配送する能力はある程度発達しているが、さらにこれを発達させなければ必要を満たすには十分でない。木材ブリケットやペレットを経済的な方法で処理する廃材処理所を設置すれば,この問題は解決する。これを市場に委ねることもできるし、関心をもつ当局が推進することもできる。そのような施設 1 箇所は、24 時間（3 交代）稼動すれば、乾燥ベースで最高 30,000 立方メートルの廃材を処理することができる。そのような処理所の建設費は、せいぜい 250,000 ユーロである。年間操業経費は 700,000 ユーロ程度である。

ブルガリアでは，高能率の木材バイオマス燃焼ボイラーの生産能力が高まりつつある。在来型のボイラーを製造しているメーカーは多く存在し，それらはこのような特殊ボイラーに生産をシフトできる。市場が発達すれば，生産にはよい刺激となる。その好例は ERATO 社で，同社はこの数年間に生産を増やしてきたが、今なおボイラーの種類を増やしながら生産を拡張中である。高能率の熱分解ボイラーの生産が拡大すれば，本プログラムは効率を大きく高めよう。他方、ボイラーの生産の増加が競争を高め，価格の低下をもたらすと可能性がある。

一都市が実施するパイロットプロジェクトは、共同実施プロジェクトとして容易に契約できる。それは当該施設の所有者が法人格をもっている自治体であるからである。いくつかの都市が連合してプログラムを実施する場合には、中継機関を設置することによって、取引コストを節約できる。中継機関の役割は、次のものが代行することができる。
i) 都市の間に特別に結成したコンソーシアムおよびプロジェクト実施機関の設立。
ii) コンソーシアムとしての都市エネルギー効率化ネットワーク、およびプロジェクト管理者としてのその事務局。
iii) 国家環境保護基金（環境保護活動管理会社 (Enterprise for Management of Activities for Environmental Protection) に最近改組）または国家環境信託基金 (National Eco Trust)。これらは双方とも国家基金である。国家環境基金を共同実施プロジェクトの中継機関として利用する例は、チェコ共和国にある。

おわりに
このプロジェクト案と拡張プログラムは、共同実施プロジェクトの基準を満たしている。これらの実施は、エネルギー生産における廃材バイオマスの利用と温室効果ガス排出削減のための事業に、種々の部門からさらに多くのパートナーの参加を得るよい機会となっている。

Ⅱ．報告書要約（英文）

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

Center for Energy Efficiency

EnEffect

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

Feasibility Study Summary

Sofia, February 2003

Content

Annexes

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.

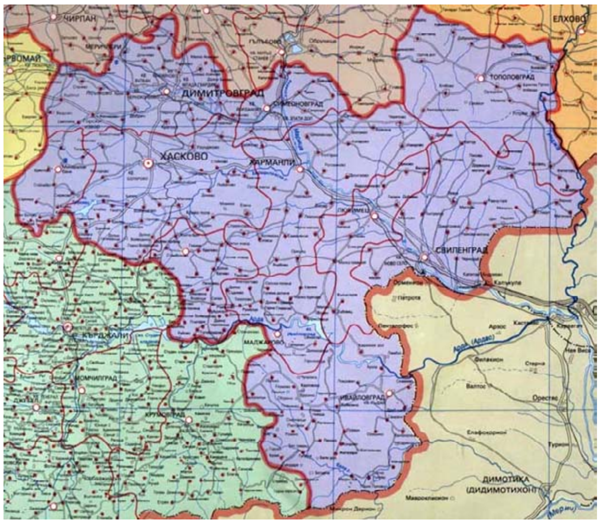
Small-scale pyrolysis boilers could be used for centralized heating of the houses in every town, meeting all the ambient air quality requirements. The price of pyrolysis boilers is 50 to 100% higher than the price of a regular boiler for solid fuel combustion. Several models of the boilers produced or 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.

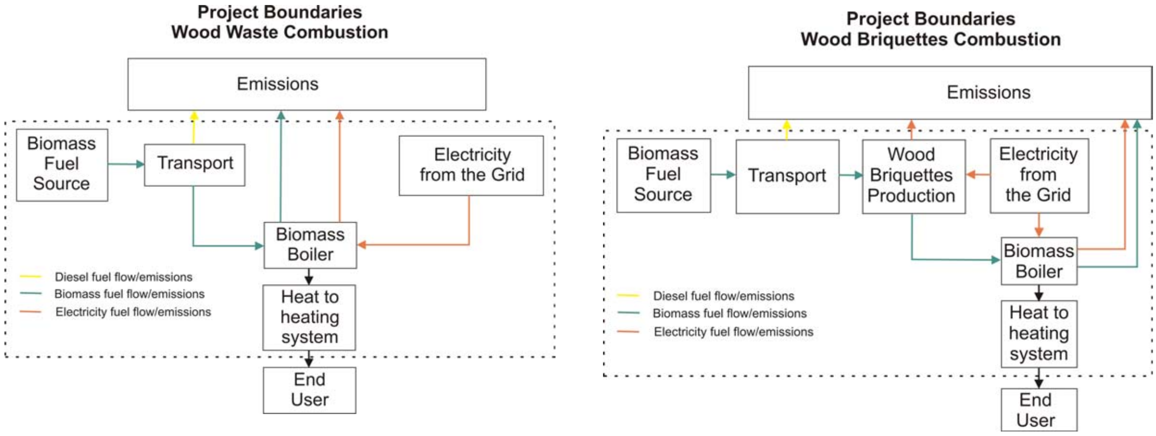


Fig. 1. Project boundaries

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.

Ⅲ．報告書（英文）

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

Center for Energy Efficiency EnEffect

Utilization of Waste Wood for Centralized Heat Supply to Buildings in Bulgaria as a Climate Mitigation Project in the Frame of Joint Implementation

Feasibility Study

Sofia, February 2003

Utilization of Waste Wood for Centralized Heat Supply to Buildings in Bulgaria as a Climate Mitigation Project in the Frame of Joint Implementation

Feasibility Study

Commissioned by:

Overseas Environmental Cooperation Center (OECC), Japan

Coordinating Agency:

Regional Environmental Center for Central and Eastern Europe, Hungary

Executing Agency:

Center for Energy Efficiency EnEffect, Sofia, Bulgaria

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Conversion of monetary units

1 EUR = 1.956 BGL (fixed)

1 USD = 1.825 BGL (as of 17 February 2003)

10 JPY = 0.152 BGL (as of 17 February 2003)

Introduction

Project objectives and approach

The main objective of this study is to assess the feasibility of waste wood utilization for centralized heat generation for space heating in Bulgaria as a climate mitigation project in the frame of Joint Implementation. The technical solution for the project is installation of highly efficient boilers, incl. pyrolysis boilers. The approach applied is by undertaking a cost-benefit analysis of a small-scale pilot project in average for the country conditions, and assessment of the replicability and sustainability of such actions in Bulgaria. An assessment of the potential of this type of projects as Joint Implementation projects is done. The study is based on desk research and on-the-site investigations.

The study was required by the Ministry of Environment of Japan and coordinated by the Overseas Environmental Cooperation Center (OECC), supported by the Regional Environmental Center for Central and Eastern Europe (REC). 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. 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.

Scope of the Feasibility Study

- The project is focusing at the use of waste wood biomass for heat energy production in municipalities in Bulgaria;
- Reduction of emission of carbon dioxide (CO_2) as the most important Greenhouse Gas (GHG) is the main target of the project;
- Other emission reductions from fossil fuel combustion and methane (CH_4) reduction from waste disposal are in the focus of the project as a side effect.

Counterparts for the study:

i) The Centre for Energy Efficiency EnEffect is the leader and main contractor for carrying out the study. EnEffect is a non-governmental organization, established in 1992 and working mainly in the area of demand-side energy efficiency. EnEffect has also developed capacity in climate change issues through the completion of a number of studies for the Regional Environmental Center for Central and Eastern Europe (REC) and the World Resources Institute (WRI), the Organisation for Economic Cooperation and Development (OECD), the government of the Netherlands, etc. EnEffect is the executing and implementing agency for the project "Energy Efficiency Strategy to Mitigate GHG Emissions. Energy Efficiency Demonstration Zone in the City of Gabrovo, Republic of Bulgaria", funded by the Global Environment Facility (GEF) through the United Nations Development Program (UNDP). EnEffect is acting as the Secretariat of the Bulgarian Municipal Energy Efficiency Network EcoEnergy, established in 1997. (More information is provided in Annex 1)

ii) The Energy Institute JSC provides expert support for the study in the assessment of the available resources of wood and wood waste in the country, in the technical issues concerning the technologies applied, and provided support for the estimation of emissions reductions. The Energy Institute is a joint-stock company dedicated to providing science and technology-based solutions in the field of energy, environmental protection and climate change. A unit within the Institute has been responsible for the preparation of the National Communications on Climate Change, as well as for the National Greenhouse Gases Inventories for the years 1988, 1990 – 1999. The unit has developed the National Action Plan on Climate Change approved by the Bulgarian government in 2000. (More information is provided in Annex 1)

iii) The Municipality of Haskovo is the owner of the pilot project facilities. Haskovo is a typical Bulgarian municipality with average for the country availability of wood resources. The Municipality of Haskovo comprises 37 human settlements, including one city – the city of Haskovo. It has a population of 100,124 inhabitants (More information is provided in Annex 2)

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

1. Policy and Institutional Background in the Country

1.2. Brief presentation of Bulgaria

Population (2002):	7.933 million
Population per sq. km:	71.84
Population growth:	-0.6%
Life expectancy:	72 years
Population below national poverty line:	12.8%
GDP per capita (2001):	US$ 1,669
GDP (2001):	US$ 13,553 million
GDP Growth (2001):	4%

Fig. 1. Location of Bulgaria in Europe

Bulgaria is located on the Balkan Peninsula, in the South Eastern part of Europe. The country borders on the Black Sea to the East, with the Republic of Romania to the North, with Greece and Turkey to the South, and with the Federal Republic of Yugoslavia and Republic of Macedonia to the West. The territory of Bulgaria is 110,993.6 km^2, the total length of the boundaries is 2,245 km, of these 52.6% land, 30.6% river and 16.8% sea.

The Bulgarian landscape is highly diverse. The vast lowlands of the Danube plains dominate the North and in the south there are highlands and elevated plains. Along the Black Sea coast there are 130 km of excellent vast beaches. The terrain of Bulgaria is diverse, the mountains are high and low, rocky and folded, deep valleys, shallow rivers and large planes.

Bulgaria has a moderate continental climate with average annual temperatures of 10.5°, with four seasons: spring, summer, fall and winter. There is a marked Mediterranean influence in the climate in the southern parts of the country.

The population of Bulgaria is 7,932,984 residents (March, 2001). About 69% live in the cities. The Bulgarian ethnic group represents 85.8% of the population. Other major ethnic groups are the Turks (9.7%) and Roma (3.4%).

Nine cities have a population above 100 thousand residents. The capital city Sofia has over one million of residents, followed by Plovdiv, Varna, Bourgas, Rousse, Stara Zagora, Pleven, Sliven and Dobrich. The average density of the population is 73.42 persons/km2. The country is divided into 28 regions and 262 municipalities.

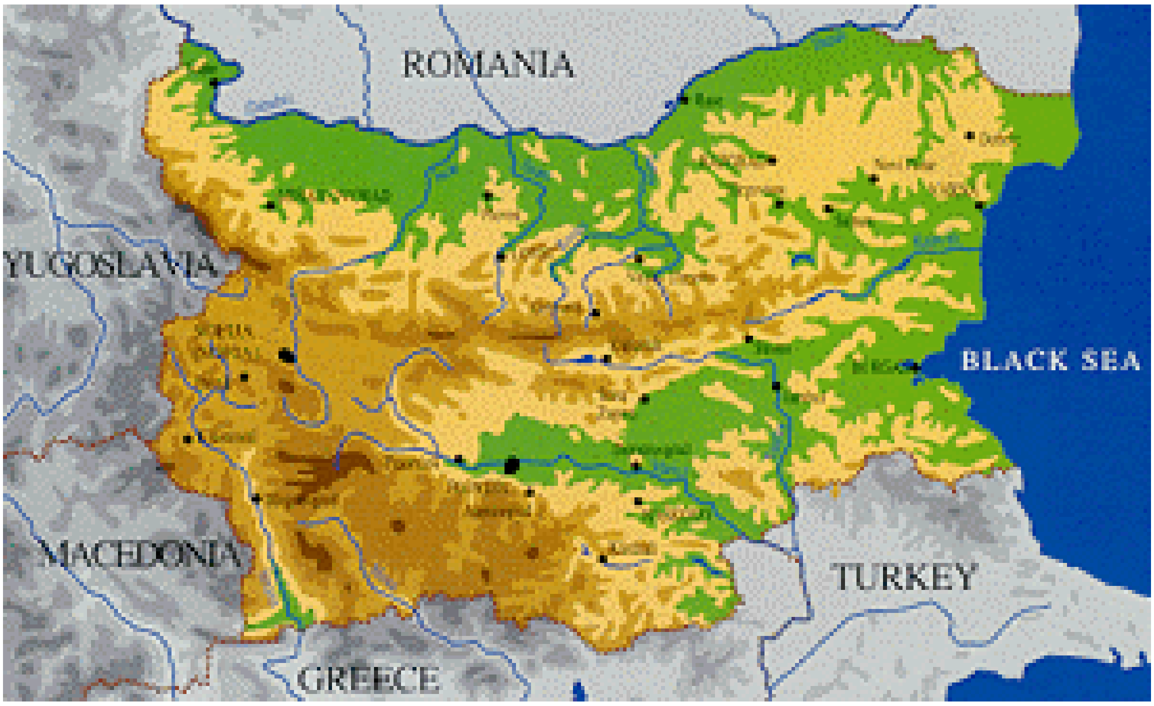


Fig. 2. Physical Map of Bulgaria

Soils are varied and of good quality. Bulgaria does not have large inland rivers, but has a relatively large number of unevenly distributed smaller rivers that spring from mountains and flow to the Danube, Black Sea and Aegean Sea. There are few natural lakes, even though there are no less than 260 high mountain lakes located in Rila and Pirin at 1900-2400 m altitude. A number of artificial reservoirs have been built. Bulgaria is one of the richest in mineral water resorts in Europe. The country possesses rich biodiversity, a good system of protected territories and a large number of biosphere reserves.

Bulgaria is a parliamentary republic. The Constitution is the supreme law of the country. The latest Constitution of the Republic of Bulgaria was adopted in July of 1991 and features all basic principles of modern constitutionalism. It provides for a multi-party parliamentary system and free elections on the basis of universal suffrage.

Bulgaria has made significant progress in its transition to a democratic society and functioning market economy, following a difficult start.

During 1997 Bulgaria experienced a large economic crisis, mainly caused by postponement of essential structural reforms of the Bulgarian economy. To help overcome the economic crisis and to stabilize the exchange rate of the Bulgarian Lev, a Currency Board was introduced effectively as of July 1st 1997. The Currency Board was proposed by the IMF and World Bank as an active attempt to curb down inflation, devaluation of the BGL and the run on the banking system. The Currency Board Arrangement was supported by a tight fiscal policy, strict incomes policy, and a broad agenda of structural reforms. Since the operation of this currency board the exchange rate stabilized. Currently the Lev is pegged to the Euro (1 € = 1.956 BGL).

Strong support by all political parties for Bulgaria's EU accession and NATO membership is effectively anchoring the direction of macroeconomic policies and structural reforms. The current economic policy measures and reforms are designed to help Bulgaria make substantial progress towards meeting the conditions for accession to the European Union. The goal of accession to the European Union should create momentum for structural reforms, which are essential for the development of the Bulgarian economy.

Important progress toward long-term macroeconomic stability has been achieved. Real GDP growth averaged about 4 percent per year in 1998-2001 and inflation has been contained to single digit levels. Poverty has declined by nearly two-thirds since 1997 to 12.8 percent in 2001, but remains more than double the pre-crisis level. Yet, unemployment remains high.

There have been major structural changes in the economy. The first generation of structural reforms have been implemented, with the private sector share of GDP reaching 63 percent and the share of private sector banks in the banking system increasing to 80 percent at end-2001.

Although Japan as a country is the biggest donor of grants for Bulgaria among the states of G-24, Japanese companies are somewhat reserved to invest in this country. According to data of the Ministry of Economic Affairs, the direct Japanese investments in Bulgaria for the period from 1992 till the third quarter of 2002 amounted to hardly USD 23.7 million and rank at the 19th place on the list of investors[1]. During the recent ten years there is a drop in the goods turnover between Bulgaria and Japan, which is currently almost the half of the volumes in 1989.

At its 18th session in 2002 the currently operating Bulgarian-Japanese Economic Committee recommended to Bulgaria to propose to Japan projects, which underline its advantages as compared to the other CEE countries. These are, among others, its outlet on the Black Sea, its closeness to the markets of the Black Sea states and the Middle East, the availability of three sea ports and airports, the unique climate. Agriculture and protection of the environment may be some of the priority spheres for Bulgaria. Processing of biomass, which is one of the most prospective energy sources, may become the basis for collaboration.

1.2. 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 to implement adequate policies and measures to achieve reduction of its annual 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 proposing, coordinating and implementing the activities aimed at meeting the obligations under the

[1] Source: Bulgarian Foreign Investment Agency

UNFCCC and the Kyoto Protocol. It is coordinating the national climate change policy and is representing the country and the government in the international negotiations. It is also 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 leading the application, control, update and adaptation of the NAPCC. It 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 and the Steering Committee for Joint Implementation projects.

The **Intergovernmental Commission on Climate** (IGCC) was established in July 2000 to control and coordinate the activities of ministries and agencies during the implementation of the NAPCC. Chairman of the Commission is a Deputy Minister of Environment and Water. Representatives of the Ministry of Economy, Ministry of Finance, Ministry of Justice, Ministry of Transportation and Communications, Ministry of Regional Development and Public Works, Ministry of Education and Science, Ministry of Foreign Affairs, Ministry of Agriculture and Forestry, the Executive Energy Efficiency Agency, Ministry of Energy and Energy Resources and the Privatisation Agency are members of the Commission.

The **Steering Committee** (SC) for Joint Implementation projects is an evaluation body for Article 6 projects (CDM and JI). It consists of representatives from the Ministry of Economy, Ministry of Finance, Ministry of Regional Development and Public Works, Ministry of Agriculture and Forestry, the Executive Energy Efficiency Agency, Foreign Investments Agency, Technical University, Ministry of Energy and Energy Resources and Ministry of Environment and Water. Chair person of the Committee is the Deputy Minister of Environment and Water.

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. If necessary, additional expert opinions and statements from the relevant ministries and organizations are requested. These activities are free of charge. The Steering Committee takes a decision to advice the Minister of the Environment and Water to issue or not a Letter of Approval for each particular proposal.

1.3. 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 **Ministry for Energy and Energy Resources (MEER)** takes care of the policy development in the energy supply and energy efficiency, of the energy transformation, transmission and distribution systems, penetration of policy decisions. The **State Energy**

Regulatory Commission is responsible for the state regulation in energy. The **Energy Efficiency Agency (EEA)** is an executive agency attached to the Minister of Energy, taking overall responsibility for the policy formulation in the field of energy efficiency and renewable energy sources.

The total primary energy consumption for the period 1985 – 1999 (which was relatively steady for the period of 1985 – 1988) underwent steep decrease in the last decade. The same is valid for the energy consumption.

Bulgaria has limited domestic energy resources and imports over 70% of the energy carriers demanded. Almost all liquid fuels and natural gas are imported. 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 always 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. In the meantime the energy intensity of the Gross Domestic Product (GDP) is 2 – 5 times higher than that in the European Union member states, which is accompanied by excessive use on energy resources, higher pollution to the environment and big dependence on energy imports.

This situation led to initialising a **National Programme for Renewable Energy Sources** (NPRES) to be implemented during the period 2003 - 2010. The elaboration of the programme started in 2000 by the National Energy Efficiency Agency in accordance with the Energy and Energy Efficiency Law. The elaboration and coordination of the Programme was held with the participation of all the Ministries and Agencies as well as the Regional Administrations. The branch and regional programmes for RES presented are included in the programme. Currently, it is under discussion by the government. The draft NPRES includes the following energy sources:

- Solar (thermal boiler and heating installations);
- Solar (photo solar installations for electricity);
- Wind (ground and other installations);
- MHPP (micro and small Hydro Power Plants with capacity up to 10 MW);
- Geothermal energy for heating and electricity;
- Biomass (agricultural, wood, industrial and household);
- Biogas (from landfills).

The NPRES comprises concrete investment projects and project proposals for large-scale use of RES. The primary and the secondary set of projects for NPRES (as of July, 2002) consist of about 1000 real investment projects and project proposals.

A special attention is paid to the biomass, which constitutes a considerable RES share. The biomass utilization is an issue with rather practical achievements in the EU countries. Within the commenced Campaign for large-scale market introduction of RES (2000 – 2005) to the Green Book for Energy Strategy of EU, the utilization of biomass forms a large share of RES.

The main laws pertaining to public relations with respect to promotion of the use of renewable energy sources are the Energy and Energy Efficiency Act and the Forests Act. The provisions of the Energy and Energy Efficiency Act provide some incentives for the use of renewable energy sources, synthesized in the following:

(1) The energy transmission or distribution companies may purchase heat and power generated from renewable energy sources, provided:

- A mandatory obligation to purchase heat and power from RES is incorporated in the license of the energy transmission or respectively distribution company;
- In the process of distribution of the electricity load the operator of the transmission network shall give priority to power generation plants, which use renewable energy sources.

(2) The activities to increase energy efficiency and promote the use of renewable energy sources shall be supported through implementation of projects under programmes at the national, sectoral, regional and local/municipal levels.

(3) Opportunity is provided for active collaboration in technology transfer and the exchange of knowledge and experience in the field of energy efficiency and the use of RES through expert assistance.

(4) The Energy Efficiency Agency is obliged to keep an information system on energy efficiency and the use of RES.

(5) The Ministers and the top officials of other institutions, the regional governors and mayors are authorized, within their respective sphere of competence, to conduct a policy and work out drafts for legal acts, aligned with the legislation of the European Union for promotion of the use of renewable energy sources with the aim to reduce the energy intensity of the Gross Domestic Product, as well as to implement energy efficiency programmes involving the use of renewable energy sources.

(6) The Ministries and other governmental institutions, the regional administrations and the municipal authorities in municipalities with a population above 100,000 inhabitants are obliged to set up specialized administrative structures, which will be assigned the task to work out proposals for formulation and implementation of policies and measures for encouragement of the use of renewable energy sources in the respective public or economic sector, region or municipality, or to assign these functions to existing administrative structures.

(7) In compliance with their sphere of competence the branch ministries should allocate funds from additional sources of financing for funding the projects of the regional and municipal programmes for energy efficiency improvement and promotion of the use of renewable energy sources.

(8) The budget of every municipality should envisage funding for the costs of drafting and implementation of municipal programmes for energy efficiency improvement and promotion of the use of renewable energy sources.

(9) The Ministry of Energy and Energy Resources and the Energy Efficiency Agency are assigned also the responsibility to launch training at different levels in how to identify, evaluate, prepare, finance and manage investment projects for the utilization of renewable energy sources.

The application of the Forests Act also provides for incentives for the use of renewable energy sources. It contains a requirement for reforestation and aforestation to increase the forests stock, one of the specifically recommended means to that effect being plating of intensive crops of rapidly growing species for production of wood and biomass.

At the same time some important barriers exist which hamper the utilization of renewable energy sources:

- To date there is neither a National Strategy nor a National Plan on the utilization of RES approved in the country.
- The required by-laws for application of the regulatory framework for effective promotion of the utilization of renewable energy sources are not in place as yet.
- The energy sector reform with respect to privatization and the abilities of transmission or distribution companies to purchase heat and power produced from renewable energy sources is delayed.
- The system for raising public awareness on the use of renewable energy sources is not adequately developed as yet.
- No national funds for support to projects related to the utilization of renewable energy sources have been set up as yet.
- No use is made of the full range of economic tools, which may be used to promote the use of RES, for instance tax reductions etc.

According to the data published in the final report of the PHARE[2] project *Technical and Economic Evaluation of Renewable Energy Sources in Bulgaria* (1995-1998) the potential for biomass utilization in Bulgaria is assessed as follows:

- 21434 GWh/year biomass from agricultural solid waste
- 133 GWh/year paper waste biomass
- 668 GWh biomass from fuel wood (waste wood is not accounted)
- 147 GWh/year liquid agricultural waste biomass

Currently, this potential is not well utilized. As for the biomass, there are installations for heat generation and co-generation from wood waste with gross installed capacity of 963 MW. There are still no working installations for energy generation from agricultural waste (solid and liquid). A single attempt to utilize straw in a small district heating company failed due to economic reasons.

In the NPRES for the period 2003 - 2010 25 projects for biomass utilization installations are included. The required investments total USD 374.3 million. The aggregated heat capacity is 249.5 MW and the heat energy produced per year is estimated at 1497 GWh.

2 PHARE (Poland Hungary Assistance for Reconstruction of the Economy) A programme of the European Commission initially directed to Poland and Hungary and later extended to all candidate countries.

As a conclusion, the actual start of large-scale market penetration of RES is still pending. The 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.

Bulgaria lacks a systematic experience and practice with utilization of biomass. There is an urgent need for development of a national strategy to boost the effective and environmentally friendly heat generation and cogeneration from biomass. In this regard, the country can make use of the experience gained in the Czech Republic, Slovak Republic, Germany, Austria, Denmark and the Netherlands. These countries encourage the manufacturing of biomass-utilization systems and the production of biomass fuel through economic and financial schemes and preferences.

1.4. 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 mechanism set also options for economic benefits from the GHG mitigation policy in the country.

The areas of potential JI projects in Bulgaria are:

- *Energy supply*: renewable energy (e.g. wind mills); biomass (heat and/or electricity generation); cogeneration; improving energy efficiency by replacing existing equipment (installing new efficient one, new water pumps etc.); minimisation of transport and distribution losses (e.g. update pump stations for gas transport); fuel switch (e.g. switch the fuel for a boiler from coal to biomass).
- *Energy demand:* replacement of existing 'household equipment' (such as installing 100 000 energy efficient light bulbs in low-income households); improvement of energy efficiency of existing production equipment.
- *Transport:* more efficient engines for transport (e.g. replacing old diesel trains by modern diesel trains); mode shift (e.g. from plane to train); fuel switch (e.g. public transport buses fueled by natural gas).
- *Waste management*: capture of landfill methane emissions; utilization of waste and wastewater emissions.
- *Forestry:* Afforestation and reforestation.

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. The Unit's staff perform the provision of expertise in relation to the Prototype Carbon Fund (PCF), Emission Reduction Unit Procurement Tender (ERUPT) and other relevant programs of the countries with which Bulgaria has signed Memoranda or Agreements on JI cooperation.

The main task of the Unit is to evaluate the project proposals submitted, and advise the Bulgarian Ministry of Environment and Water. The JI Unit assists in the development of project selection criteria and coordinates the Joint Implementation activities with the Ministry. A significant part of JI Unit's responsibility is the promotion of relevant JI schemes and creation of awareness on Joint Implementation in general. The purpose is to increase the quality and the quantity of future Bulgarian projects implemented under the Joint Implementation mechanism.

Criteria for JI projects selection have been developed and approved by the JI Steering Committee. 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.

1.5. Experience in the country with JI projects

Bulgarian government has already started some Joint Implementation initiatives. However, the opportunities provided in the pilot phase were not sufficiently used. The experience of the government with Activities Implemented Jointly was very limited (only one project was implemented under this mechanism in Bulgaria).

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:

- "Cascade SHPP, Iskar, Community Svoge" - small hydro power plants;
- Reduction of Greenhouse Gases by Gasification of the Towns of Veliko Tarnovo, Gorna Oryahovitsa and Lyaskovets - gasification of municipal, industrial and residential buildings;
- Energy Saving Measures and Biomass Burning - fuel switch from heavy fuel to agricultural (straw) biomass in pulp and paper factory in Noth Bulgaria;
- "Landfill Gas Extraction and Utilisation in Bulgaria" - methane extraction&utilisation from existing landfills;

- Windpark Kaliakra No1 - power generation through wind utilisation;
- Forestry Project for CO2 Sequestration – afforestation.

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 PCF is intended to invest in projects that will produce significant amount of greenhouse gas emission reductions that could be registered with the United Nations Framework Convention on Climate Change (UNFCCC) for the purposes of the Kyoto Protocol. To increase the likelihood that the reductions will be recognized by the Parties to the UNFCCC, independent experts will follow validation, verification and certification procedures that respond to UNFCCC rules as they develop. By handling the business of reducing emissions, the PCF will develop a major knowledge base. The PCF will maximize the value of its experience by collecting, analysing, and disseminating information and knowledge to NGOs, governments, private sector interests, and any other stakeholders involved in the climate change negotiations.

PCF resources will be provided by both the public and private sectors. The PCF aims to demonstrate how insights and experience from both sectors can be pooled to mobilize additional resources for sustainable development and address global environmental concerns. The active participation of both sectors ensures that the PCF will operate efficiently and in accordance with the Kyoto Protocol while serving the interests of World Bank client countries. The Host Country Agreement between Bulgaria and the EBRD as a Trustee of the Prototype Carbon Fund was signed on 14 November 2002.

A Memorandum of Understanding for realisation of JI projects with Austria was signed on 02.09.2002 and is expected to be ratified by the end of February 2003. Memoranda of Understanding with Switzerland, Denmark and other countries are under preparation.

2. Inventory of and projections for the GHG emissions

Bulgaria has been successful until now in meeting reporting requirements as an Annex I Party to the United Nations Framework Convention on Climate Change. 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). Although SO_2 is not officially recognized as GHG gas, it has a profound effect on the climate, thus the IPCC has included it in the methodology (IPCC Revised Guidelines 1996) for preparation of national inventories. 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.

2.1. CO_2 emissions

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.

The major part of energy in Bulgaria is produced through combustion of fossil fuels (Figure 3). In this process, CO_2 is emitted together with small quantities of other GHG. For the recent decade, fossil fuel combustion accounts for 60-70% of the global anthropogenic CO_2 emissions. Emissions from fuel combustion are reported in some categories as represented:

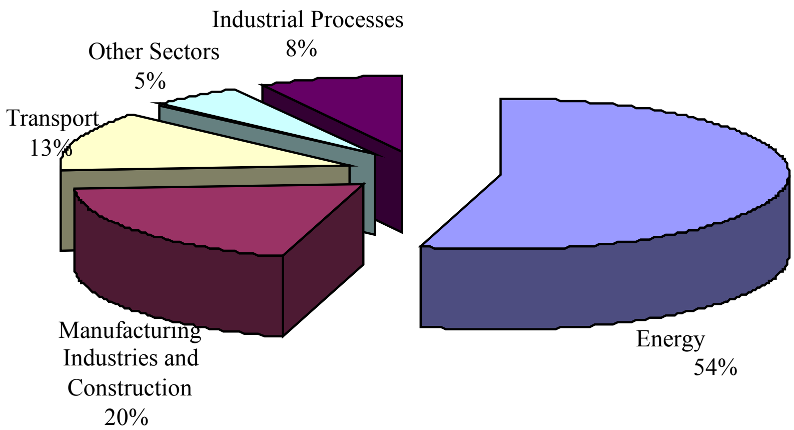
- Energy industries
- Manufacturing industries and construction
- Transport
- Other sectors (Commercial, Residential, Agriculture and Forestry)
- Other

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

Fig. 3. CO_2 emissions by IPCC-defined sectors in 1999



Source: 3rd National Communication on Climate Change, 2002

Information about CO2 emissions by types of fuel source is provided for the commercial, residential, and agriculture and forestry sectors. The information about the commercial sector (Table 2) includes the fuels used in public buildings such as schools, hospitals, office, etc.

Table 2. CO_2 emissions by fuels in Commercial sector,Gg

Fuel	1997	1998	1999	2000
Natural Gas	27.02	2.34	37.51	28.64
Gas Oil	0.04	211.85	270.88	225.34
Residual Fuel Oil	6.27	57.76	93.07	58.68
Anthracite	1.16	0.00	0.00	0.00
Black Coal	5.11	0.00	0.00	0.30
Brown Coal	1.46	8.03	80.59	6.69
Lignite	1.92	0.00	11.69	2.21
Coke	0.00	0.00	0.01	0.02
Wood[3]	8.59	103.34	56.36	40.07
Coal Briquettes	2.17	8.40	6.70	5.30
LPG	0.00	0.00	2.31	2.50
Total	45.14	288.38	502.76	329.68

Source: GHG National Inventory, 1999

3 The emissions from wood combustion (row “wood”) are not accounted for in the row “Total”

The analysis of the table shows that the main CO_2 emission sources are the gas oil, residual fuel oil and wood. The emissions from natural gas, brown coal and coal briquettes are smaller. During the last two years liquified petroleum gas (LPG) is being used, which also leads to CO_2 emission. One of the peculiarities is the fall of the natural gas emissions in 1998 in comparison to the rest of the years in this period. That is due to the sudden rise of the prices and the changing delivery conditions during this period. Another peculiarity is the sudden increase of the brown coal emissions in 1999 which is compensated by nearly double decrease of wood consumption compared to that of the previous year. This can be explained by commencing the process of changing the property in this sector in which the prices influence to a greater extent the orientation to a certain kind of fuel.

Hereby, and in the other tables, CO_2 emissions from wood combustion are not taken into consideration in the aggregate emissions in accordance to the requirements of the 1966 IPCC Revised Guidelines.

Table 3 displays the CO_2 emissions for the Residential sector. The main sources of CO_2 emissions from the households are the Coal Briquettes, wood, brown coal and lignite. Considerably smaller quantities of LPG and gas oil are burned, which emitted ten times less CO_2 emissions than the above mentioned basic emission sources. During the last two years the Settlement Natural gas supply program was started as a result of which there are, though small, emissions from natural gas combustion. During the period is spotted stable trend towards decreasing the coal consumption at the expense of the increased wood consumption. This is a result from the price policy held by the state and removal of the subsidies from coal and briquettes, which led to increased timbering for energy use.

The greatest share of the CO_2 emissions is due to Coal Briquettes combustion. They have high relative share (over 70% of the CO_2 regardless the emissions from wood combustion), though during the last two years of the period a stable decrease was noticed. As a whole, the aggregated emissions of the sector (without wood combustion emissions) have decreased by 48.3% at the end of the period compared to the beginning, while the wood combustion emissions have almost tripled.

Table 3. CO_2 emissions by fuels in Residential sector, Gg

Fuel	**1997**	**1998**	**1999**	**2000**
Natural Gas	0.00	0.00	0.22	0.45
Kerosene	0.00	0.00	0.00	0.00
Gas Oil	0.45	18.41	15.55	12.47
Residual Fuel Oil	0.00	0.00	0.00	0.00
Anthracite	0.00	0.00	0.00	0.00
Black Coal	0.00	0.00	0.00	0.00
Brown Coal	454.92	392.34	351.33	211.37
Lignite	180.38	124.75	115.70	98.94
Coke	0.00	0.00	0.00	0.00
Wood[4]	742.32	1475.57	1478.92	2075.56
Coal Briquettes	1762.82	1984.90	1274.00	1001.00
LPG	233.77	23.53	37.75	37.69
Total	2632.34	2543.92	1794.56	1361.91

Source: GHG National Inventory, 1999

4 The emissions from wood combustion (row "wood") are not accounted for in the row "Total"

Table 4 displays the CO_2 emissions from the Agriculture and Forestry sectors. The main CO_2 emission sources in the Agriculture and Forestry sectors are the liquid fuels (LPG, diesel oil, and avia gasoline). They have shown considerable increase during the last two years of the period - just as the wood combustion emissions have. The consumption of natural gas also shows a trend toward increase despite the fluctuations in 1997 and 1999.

Table 4. CO_2 emissions by fuels in Agriculture and Forestry sector,Gg

Fuel	1997	1998	1999	2000
Natural Gas	0.00	46.78	13.34	30.14
Kerosene	0.00	0.00	0.00	0.00
Gas Oil	0.00	60.67	32.41	38.72
Residual Fuel Oil	19.88	44.89	68.25	56.30
Anthracite	0.03	0.00	0.01	0.00
Black Coal	0.09	0.00	0.30	0.20
Brown Coal	0.12	0.00	2.01	0.67
Lignite	0.00	0.00	1.21	0.77
Coke	0.00	0.00	0.00	0.00
Wood[5]	21.52	4.15	46.59	60.31
Coal briquettes	4.20	4.20	3.00	3.70
Avia Gasoline	0.62	0.00	0.07	0.00
LPG	0.05	0.00	1.25	3.00
Dizel Oil	0.00	0.00	72.19	70.98
Motor Gasoline	0.00	0.00	0.00	0.00
Total	24.98	156.54	194.04	204.49

Source: GHG National Inventory, 1999

2.2. Emissions of methane (CH_4)

Although the emissions of CH_4 are less than CO_2 emissions, their inventory (Table 5) is important, given the high Global Warming Potential (GWP) of this gas - 21 times the GWP for CO_2. Wastes are the most important source of methane, and the main portion is emitted by landfills (Figure 4).

The second important source is the coal mining and the production of oil and natural gas. More than 77.7% of the coal in Bulgaria is extracted through open-pit mining. The fugitive methane emissions per unit production in open coal mines are 15 times less than in the underground mines. Therefore the overall emissions from coal production are comparatively small, i.e. 5-8% from the total emissions.

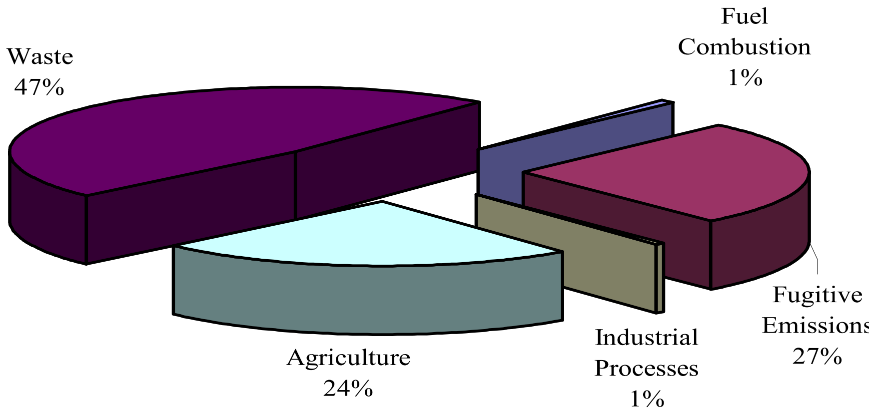
Table 5. CH_4 Emissions by IPCC-defined sectors (Gg)

	1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Fuel Combustion	8.26	7.18	5.63	4.66	5.41	4.97	5.32	4.66	5.03	3.96	4.08
2. Fugitive Emissions	258.59	252.46	216.21	204.73	196.41	192.31	219.66	220.59	182.04	171.49	128.81
3. Industrial Processes	2.79	3.27	2.36	2.23	2.61	3.40	3.72	3.47	3.71	2.83	2.50
4. Agriculture	272.88	257.38	232.79	189.50	147.45	123.44	118.68	112.43	106.51	113.72	114.34
5. Waste	791.25	889.30	896.33	845.92	769.55	493.88	540.31	486.01	406.26	362.26	232.56

Source: GHG National Inventory, 1999

5 The emissions from wood combustion (row “wood”) are not accounted for in the row “Total”

Fig. 4. CH_4 Emissions in Bulgaria by IPCC-defined sectors in 1999



Source: 3rd National Communication on Climate Change, 2002

CH_4 emissions from landfill waste

The waste wood from the wood processing is disposed in landfills. For this reason, the emissions from landfills are analysed below.

Significant amount of the annual global methane produced and released into the atmosphere is a by-product of the anaerobic decomposition of man-made wastes. Two major sources of this type of methane production are landfills and wastewater treatment. Here will focus only on the landfills, where significant part of the wood waste from wood processing is disposed. Unfortunately the disposed wood waste is not accounted as separate position.

The two main types of waste management practices of concern for CH_4 emissions are open dumping, which is generally practised in small villages, and sanitary land-filling, generally practised in urban areas. Waste management practice, some physical factors (moisture, temperature, pH) and waste composition influence CH_4 generation.

In Bulgaria, municipal solid waste (MSW) deposited in landfills is the largest source of CH_4 emissions. In the landfills, the quantity of oxygen dissolved in the buried solid waste is very small or completely missing. Methane and carbon dioxide are emitted as a result of the anaerobic decomposition of the wastes.

In 1999, the number of the waste sites supervised by municipal authorities was 567. Of them 124 are controlled landfills. At the wastes landfilled there are 2193584 t and the population that landfills there represents 54% of the total population. The total population linked to landfills is 6 353 134, i.e. about 77% of the national population. About 99% of the urban population is included in this number and about 33% of rural population.

Available data at the moment indicates that disposal is the only way of municipal waste treatment at present. With few exceptions, the landfills do not comply with the new requirements. The most common practice for waste treatment is the soil cover, which is typical for about 85% of the landfill wastes. Disposal in landfills is the most commonly applied method for industrial waste treatment. Over 99% of the amount of waste deposited is concentrated in landfills, owned by the enterprises and the rest is deposited in the urban landfills together with municipal waste. The data for last decades shows a tendency of decrease in the waste generation, which is even more characteristic for the organic wastes.

2.3. GHG emission projections

Background

The projections reported here are developed in the 3rd National Communication. Following the instructions from the Conference of the Parties to the Climate Convention, three scenarios for GHG emission projections until 2015 were developed, analysed and compared:

- "**without measures**" scenario (No M)
- "**with measures"** scenario (M)
- "**with additional measures"** scenario (Add M)

The "**without measures**" scenario is based on the assumption for intensive economic development with emphasis on energy intensive technologies and limited application of energy efficiency improvement measures in industry and agriculture. In both household and services sectors there are no special measures envisaged to improve energy efficiency. This scenario was originally developed in 1994 (before Bulgaria ratified the UNFCCC) for the preparation of the First National Communication. It was considered "business-as-usual" scenario, nonetheless it is not a "frozen efficiency" such. It incorporates all of the governmental policies and measures that have been adopted before 1994, thus making it more "likely-to-be" scenario. GHG projections for the scenario have been based on a limited number of emission sources, reflecting the actual IPCC Inventory Guidelines for that period.

Present IPCC guidelines cover bigger number of emission sources, so the "**with measures**" and "**with additional measures**" scenarios include them. Furthermore, after 1994 the Global Warming Potential (GWP) factors have been changed. To assure comparability between the three scenarios, based on the forecasted in 1994 macroeconomic indicators, production volumes, activity data and the new GWP factors, the emissions forecast in "**without measures**" scenario have been revised. The procedure for this revision is similar to the procedure for recalculation of GHG inventories used during preparation of 1999 GHG inventories.

The "**with measures"** projection encompasses currently implemented and adopted policies and measures, and those measures that are given in the energy sector. It envisages a growth rate of electricity demand by 26% for the period 2000-2015. This scenario projects relevant measures in the energy sector, while the rest of the sectors rely on separate measures without implementation of in-depth programs.

This scenario encompasses measures for entire rehabilitation of old units and improved environmental performance. GHG emissions mitigation could be expected due to the introduction of renewable energy sources (including Hydro Power), safe operation of NPP units after rehabilitation, and expansion of heat generation units in Sofia.

This projection integrates the assumption for increase in annual electricity export from 4200 up to 8000 GWh for the period after 2005.

The "**with additional measures"** scenario comprises planned policies and measures for GHG mitigation. While in the "**with measures**" scenario the measures are more generally referring to environmentally friendly development, this scenario is more concentrated on the specific GHG mitigation measures and policies in the power sector. It is based on the same key macroeconomic characteristics.

CO_2 from the Energy Sector

The "**with measures**" scenario compared to the "**without measures**" scenarios indicates a tendency for decrease of the emissions for the period 1995-2015 that results in 22-30% lower emissions. The decrease is due to the restructuring of the industrial and power sectors. A significant delay in the rehabilitation of old capacities and introduction of new units in electricity sector is observed. On the other hand the energy demand for the "**with measures**" scenario is lower by 23-43% in the period 2000-2015 compared to the "**without measures**" scenario.

The scenario "**with additional measures**" covers the planned measures for development and commissioning of power units, decrease of electricity export and increased use of renewables. Both the "**with additional measures**" and "**with measures**" scenarios use one and the same projection for final energy demand. As a result the final CO_2 emissions for the "**with additional measures**" scenario are 6-8% lower.

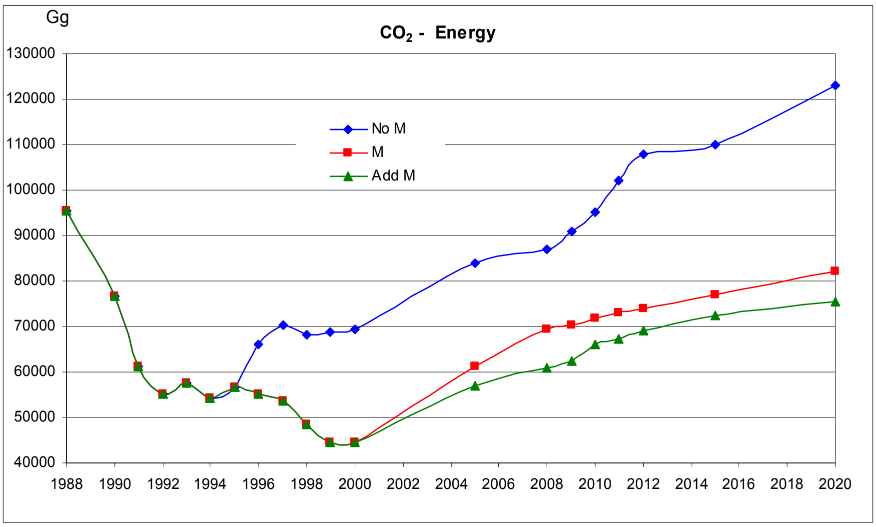


Fig. 5. CO_2 emissions projections from energy (Gg)

Source: 3rd National Communication on Climate Change, 2002

Overall CO_2 projected emissions

Analysis of the overall ***projected emissions*** in Bulgaria (Figure 6) 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. However, the implementation of these additional measures would depend on whether or not Bulgaria will comply with the requirement from the European Union for early termination of the operation of two units in the Kozloduy Nuclear Power Plant.

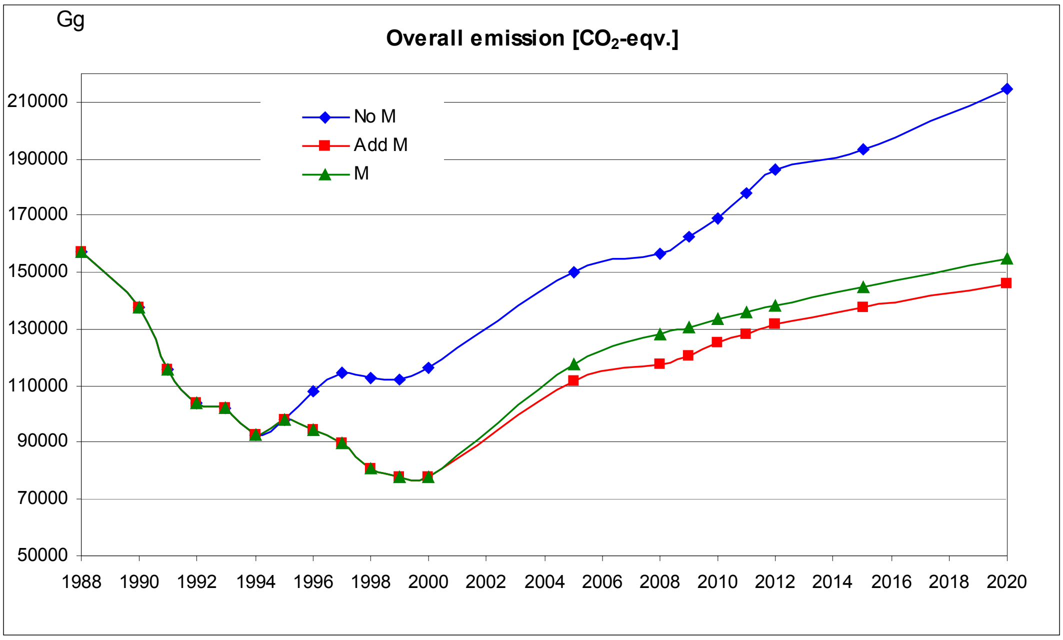


Fig. 6. Overall GHG emissions projections, CO_2 eqv., Gg

Source: 3rd National Communication on Climate Change, 2002

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 eventually lead to additional emission reduction in the amount of 10-15 million tons CO2-equivalent.

The forecasts for the CO_2 emissions of the services, residential and agricultural sectors are shown in Table 6. These are the sectors in which biomass for heating can be used.

Table 6. CO2 emissions forecast for services, residential and agriculture sectors (Gg CO2)

Year	Services	Residential	Agriculture
2003	363	1342	206
2004	407	1320	207
2005	468	1303	209
2006	476	1324	210
2007	484	1345	211
2008	493	1368	215
2009	502	1382	218
2010	511	1397	222
2011	510	1454	225
2012	510	1515	228
2013	509	1581	231
2014	509	1648	235
2015	508	1720	238

Source: Background materials for the Third National Communication on Climate Change, 2002

3. Utilization of waste wood biomass as an alternative to fossil fuels

3.1. Advantages of the utilization of waste wood biomass as an alternative to fossil fuels

The use of wood briquettes and waste wood results in savings in coal, 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 (CO_2), methane (CH_4) and nitrous oxide (N_2O). The CO_2 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.

3.2. Experience in the country for the utilization of waste wood biomass for energy production

General experience

The main share of wood used for energy generation in Bulgaria consists of logs for burning in regular manually-operated stoves with horizontal grates. Usually the logs are burned together with coal, or separately. In the past years modern boilers for wood burning with high efficiency coefficient were getting imported in the country.

The design works during the 80-ies were related to waste utilization (barks and saw-dust) from the wood processing, paper and cellulose industries, as well as residual hydrolyzed wood-wool from the production of forage, for meeting the energy demands of the factories in which this waste is produced.

In 1981 an inquiry about the available waste in the wood-processing enterprises in Bulgaria was completed. The volume of the waste wood (chips, shavings and barks) was estimated, along with the energy needs of the wood-processing factories. On this basis the construction of installations with different capacity and type that can demonstrate the existing opportunities for utilization of wood waste was proposed. A certain part of these proposals were realized and thus the first steps were made in utilising the non-classical wood waste for energy purposes (mainly bark, hydrolyzed wood-wool, etc.). Below are short descriptions of some of the installations.

Oven for bark combustion

The oven was installed in 1982 at a wood-processing enterprise in the town of Chepelare (Southern Bulgaria, Rodopa Mountain), as component to a steam boiler that provides for the factory's heat demand for drying furnaces and heating. Softwood barks with high humidity without preliminary preparation are used as fuel. It is a cylindrical chamber with inner diameter 2000 mm. The cone-shaped fire grate is fixed. Both fuel and air are placed in the centre of the grate from below, and the fuel feeding is by mechanical transporters. The furnace gases flow into flame-tubular boiler with capacity 2.5t steam per hour (steam pressure 1.3 MPa).

Industrial steam boiler for bark combustion

The Π-shaped boiler consists of cylindrical oven (diameter 2500 mm and total surface of the fire-grate 4.9m²), insulated burn-away chamber, evaporator and air heater.

The capacity is 6.5 t steam per hour under pressure of 1.3 MPa. The steam is used for technological purposes and for heating. The furnace chamber construction is similar to that of the oven described above. The fire grate is fixed and cone-shaped. The fuel – bark fragments with size 40-50 mm – is introduced from below via mechanical transporters. The rotations of the transporter can be altered, thus regulating the steam quantity.

The efficiency coefficient is 80% with combustion heat of the rinds – 1.74 MWh/t. The boiler is in operation since 1982 in a wood-processing enterprise in the town of Devin.

The Bulgarian company "ERATO Holding" located in Haskovo has produced and sold since the beginning of 2002 numerous appliances utilizing biomass as fuel with total name-plate capacity of 70 MW. More than 3500 households and companies in Bulgaria have chosen to use the economic and environmentally friendly fuel from biomass. ERATO is the first Bulgarian company to offer complex solutions utilizing biomass. These solutions range from extraction and production of biomass to manufacturing and marketing of biomass-utilization systems.

Implemented and current projects

Project on biomass district heating (DH) plant is in the stage of planning in the municipality of Razlog as a joint initiative with PIRINHART - paper and cellulose manufacturer. The project envisages installing a biomass (wood residues) boiler to provide 30% of the produced heat to the enterprise, and the rest for district heating of the nearby town of Razlog. The project plans to introduce new structure of the energy consumption in the area of Razlog:

- Substituted by biomass expensive fuel oil, presently used for the heating of large public buildings in the centre of Razlog (3 000 - 4 000 tonnes per annum);
- Decreased consumption of heavy fuel oil with high sulphur and carbon content by industrial plants by about 8 000 - 10 000 tonnes per year, due to the production of process steam from biomass;
- Decreased municipal expenses for the public building heating.

The expected environmental impacts from the project are:

- Reduced CO_2 emissions by 20-30% due to the combustion of biomass instead of fossil fuels.
- Reduced SO_x emissions by 700 - 1000 tonnes due to the substitution by biomass of 8 000 - 10 000 tonnes heavy fuel oil per year (with sulphur content 3,5%).
- Reduced NO_x emissions resulting from decommissioning of 25 - 30 local boilers in the centre of Razlog with annual fuel oil consumption of 3 000 - 4 000 tonnes.
- Decreased spreading of dust and gases from uncontrolled deposits of wood waste (occurring mainly in the summer period).

The expected total approximate investment amounts to 25,0 MUSD. The calculated payback period of the project investments is about 6 years.

Furthermore, there is a PHARE and ECOS OUVERTURE project including partner municipalities from Bulgaria (Apriltsi), Greece, and Austria (Furt, Triesting). The project started in 1998 and plans to install a biomass boiler (wood residues) by the end of 2002 for district heating benefiting municipalities in Bulgaria and Greece. Other similar demo projects have also been accomplished in the past, still without a follow up due to economic impediments.

The Prototype Carbon Fund of the World Bank has initiated a fuel switch project in Svilosa AD in the city of Svishtov in 2001. The main elements of the project include installation of a biomass-fuelled boiler, with nominal thermal output capacity of 13 MW, which will consume as fuel all the fresh woody wastes produced by the company over the crediting lifetime of the project, and eventually all of the historical, stockpiled waste. The biomass boiler has been sized at 13MW to ensure that in the case of the planned expansion the entire wood waste from current production plus additional wood waste on stock can be burnt. The biomass boiler heat output will reduce the amount of process heat demanded from the coal-fired CHP system, thereby reducing the quantity of coal consumed. This will lead to a reduction in CO2 emissions as a result of reduced coal consumption. This will also lead to a reduction in CH4 emissions as a result of (1) consuming part of the wastes from the stockpile and preventing further methanogenesis from the quantity consumed; and

(2) consuming all fresh waste arising, and therefore, totally eliminating methane production from this waste stream[6].

The small amount of realized projects and the lack of information about the results that can be achieved act as a barrier to the implementation of wood biomass projects in the country.

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

Forest resource area

The total area of the Bulgarian forests from 1955 till 1990 has been a relatively stable value that varies from 3.5 to 3.77 mln. ha, with a trend for gradual increase. According to data provided by the Ministry of Agriculture and Forests (the National Forestry Board) the ***forest resource area*** for the 1996-2000 period 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 this. This tendency is due to the reduced areas with cut and not recovered forests, and reduced actual uprooting.

1.6 million ha of new forests were created mainly on eroded forest and abandoned agriculture land. The afforestation activities have reached a considerable scale of up to 80 000 Ha per annum during the sixties of the last century.

The average age of the Bulgarian forests is 49 years. About 55% of the forests are young, about 30% are of age between 40 and 80 years, and 9.2% are older than 100 years. The recent national forest inventory (year 2000) estimated the total volume of the forest at 526 million solid cubic meters.

Ownership of forests

The ratio of state to non-state owned forests is 85.2% to 14.8% (8.1% of these forests belong to private owners). Since the adoption of the Forest Restitution Act in 1997, decisions for the restitution of 534 213 ha were taken. The private ownership of individuals is 51.95% of this amount, municipalities own 43.07%, schools – 0.82%, religious entities – 3.26%, cooperative and trade organizations – 0.06%, and others – 0.84%.

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 rest will become property of the municipalities, the Church, schools and cooperatives.

The forest protection and management is a priority of the Ministry of Agriculture and Forest. The National Forestry Board carries the operational responsibilities for management of the forests. There are 16 regional forest boards in the country. The Haskovo region is situated on the territory of the Kurdjali Regional Forestry Board. It incorporates the following state forest administrations (forestries): Svilengrad, Topolovgrad, Ivajlovgrad, Harmanly and Haskovo.

[6] Biomass Technology Group (BTG) BV, "CH4 emissions from biomass stockpiles in Bulgaria", BTG, Enschede, Netherlands, 2002

Types of forests

As a result of the climate change adaptation policy of the country the recent trends in the ***types of forests*** are as follows:

- Coniferous forests – decrease of their tentative share over the 1996-2000 period from 34.8% to 32.8%.
- Deciduous forests have increased their tentative share over the period from 65.2 to 67.2%.

The trends in the forest type distribution are expected to be kept despite the change in the ownership. After the restitution, an increased interest for afforestation of low-productive agricultural, mountain and eroded lands is observed, as well as creation of species for intensive wood production. The state will support the initiative of private owners offering co-financing under one accession program of the European Union – Special Accession Program for Agriculture and Rural Development (SAPARD), and also using legislative instruments.

In 2000 the total area of ***protected and recreational forests*** or forests in protected areas according to Article 5, Paragraph 2 of the Forestry Act was 1.33 mln ha or 34.1% of the forest area, including:

- 1.04 mln ha of protected and recreational forests;
- 294 thousands ha of forests in protected areas;
- 119.2 thousands ha of National Parks.

In 2000 two new National Parks were established - “Rila Monastery” and “Persina”. Thus the area of the national parks reached 237,610 ha, 159,185 ha of which belong to the forestry reserve. Protected areas are 103 with total area of 159,185.1 ha, 14,967 ha of which belong to the forestry reserve. Nature landmarks are 426 covering 23,153.3 ha, 9,080 ha of them being forest reserves.

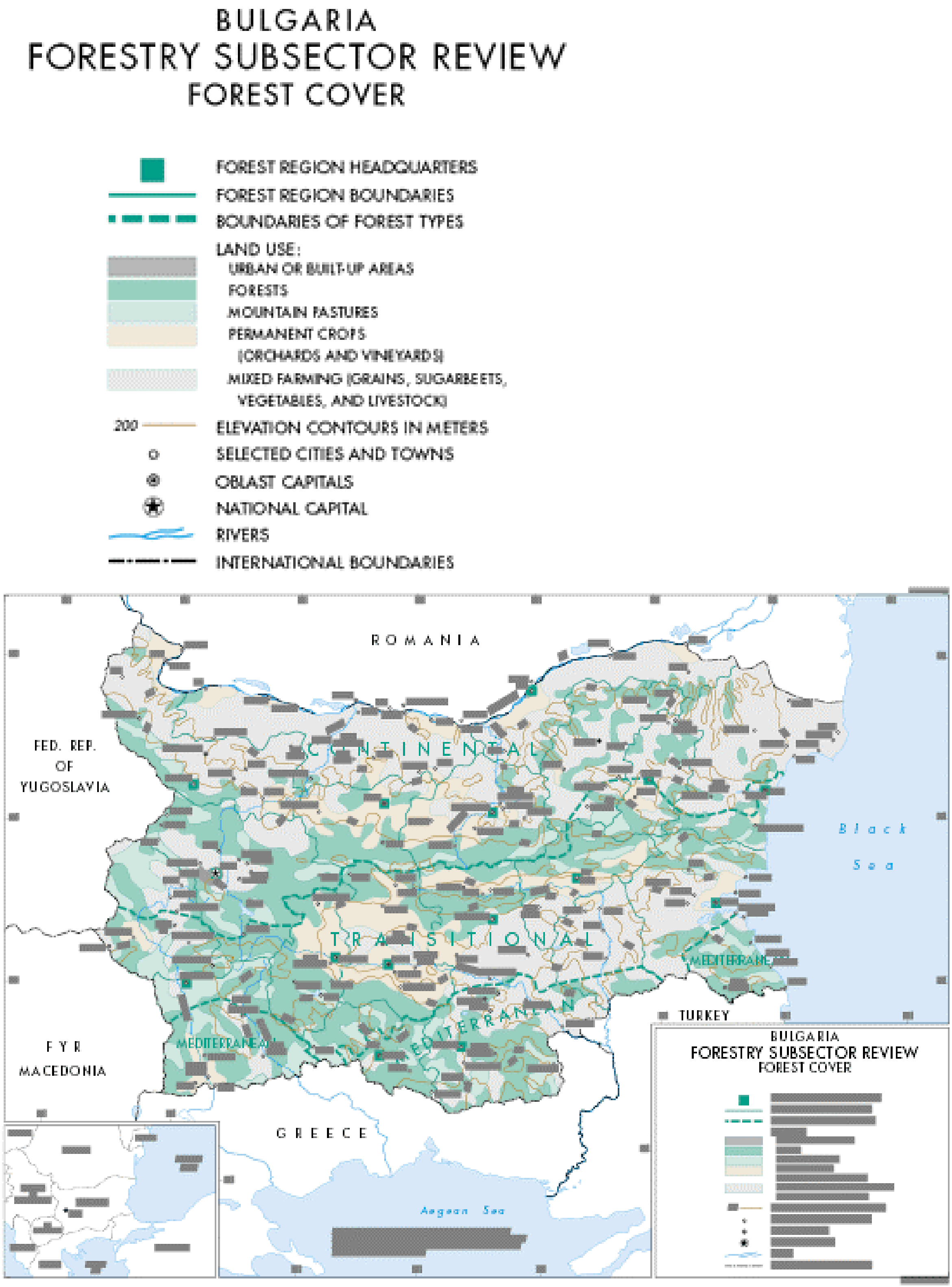
The increasing tendency of the ***wood reserve*** is kept. The total volume of wood in Bulgarian forests has reached 526.1 million m^3, while in 1995 it had been 456.7 million m^3.

Table 7. Comparative Table of Bulgarian Forests Trends 1990 - 2000

Characteristics	1990	1995	1996	1997	1998	1999	2000
1. Total area, million ha	3.77	3.77	3.88	3.88	3.899	3.894	3.914
2. Afforested area, million ha	3.26	3.26	3.36	3.35	3.37	3.37	3.398
3. Protected forests, %	30.90	39.80	n.a.	n.a.	n.a.	34	34.10
4. Mean increment, million m^3	10.97	12.35	n.a.	n.a.	n.a.	n.a.	13.69
5. Cut (planned), million m^3	6.37	6.24	6.54	6.16	6.65	6.80	6.81
6. Cut (actual), million m^3	4.68	4.76	5.87	5.35	5.49	5.18	4.63
7. Total volume, million m^3	396.00	456.70	n.a.	n.a.	n.a.	n.a.	526.10

Source: Third National Communication on Climate Change, 2002

Fig. 7. Map of Bulgarian forest resources



Source: The World Bank website

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 disturbance of the normal turnover of the forest trees.

These 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 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 7.4 TWh. The utilization of wood biomass in these forests is a major problem for Bulgarian forests management, and the solution of this problem has been postponed during the decades (transfer to longer rotations, etc.). As a result, unfavourable age structure is obtained, which leads to the potential loses of increment growth and some other unfavourable results, some of which are recently occurring - diseases, wiltings, fires, disorder of wood stands, losses of regeneration potential, etc. Realisation in the part of the 70 million m^3 coppice harvest could lead to achievement of positive results like improvement of the general status of the wood stands and supplement of enormous quantities of renewable energy sources.

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. Measures, like thinning, in its turn would lead to the increase of the annual increment by 1.6 to 1.8 fold in treated forest stands.

There is more than 1.2 million m^3 biomass annually left in these forests from the cuttings that is not used. It can be also said that considerable part (about 20%) of the produced wood is lost in the process of logging. The wood in laying conditions crops is about 80% of the production of standing crops. The share of firewood, brushwood and foliage takes around 40% of the production of standing crops; and timber takes between 38 and 43% of the total wood production. The firewood production varies between 30 and 35% of the total wood production. An average annual production of wood wastes is about 25 – 30% of the processed standing wood, or about 1.2 – 1.5 million m^3 /year.

The practical possibility to increase the percentage of the potential energy through utilization of wood wastes is about 25 – 30% of the processed standing wood, or about 1.2 – 1.5 million m^3 /year of the wood wastes.

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 13 TWh.

Improving Forest Management

A valuable project to improve forestry management was developed for funding by the World Bank. It is believed that the outcomes of the project can influence positively the stimulation of waste wood utilization for energy generation. For this reason, a short summary of the mentioned project is provided below.

The project aims to address the most important issues in the forestry sector which are of national significance from the environmental, economic and social point of view. These include the preparation of a national forest strategy and policy that would provide the basis and guidelines for the sector's development. One of the project objectives is the restructuring of the forestry administration, using as an example successfully functioning models in West Europe. Fire fighting is an important project element which includes a modern forecasting system, vehicles, equipment and reforestation of lands damaged by fires. The stimulation of more effective marketing of wood products will be provided for through the establishment of a Business Centre and pilot certification schemes. Assistance will be rendered to private forest owners so they can associate, take proper care of their forests and use them fully. Proper forestry activities, such as thinning, which have been neglected in the past decade, will be supported by the project. Activities in the biodiversity conservation field are also envisaged including in coordination with other donors and would comprise training, seminars, preparation of strategy, procurement of equipment, restoration of critical habitats.

Developing conditions to allow greater utilization of wood biomass fuels is also included in the project. Utilization of wood biomass fuel is a priority because forests are overstocked with small diameter trees and not sufficiently thinned resulting in stands more susceptible to abiotic (fire, wind, snow and drought) and biotic (insects, diseases) damages. In addition, post-harvest wood waste is often left in the forest, increasing significantly the risk of fires during drought years. Including projects promoting the switch from fossil fuels to wood from thinning operations would have a double impact since municipal central heating is a major expenditure for municipalities, and simultaneously a market would be created for the wood thinned out of forest which has been regarded as a cost item and thus neglected.

The main benefits of the project are expected to be that the project will contribute to the sustainable management of Bulgaria's forests and forest land resources to maximize their economic and environmental potential. The restructuring of the forest management will ensure the necessary financing for proper forestry activities. The effective fighting and prevention of forest fires is crucial in not allowing environmental damages and financial losses to the state and to forest owners. The project will provide for enhancing returns from forestry activities and increase of employment in rural mountain regions.

3.4. Priority regions for the implementation of the project

Distribution of wood production in the country

The share of forestry in the Gross Domestic Product is about 0.5%. The National Forestry Administration is planning the annual harvesting of wood. During the last few years in Bulgaria the planned figure is about 6.7 millions m^3. Unfortunately, as mentioned above, the real harvesting is far below the plan and recently does not reach 5 millions m^3. At the same time the wood stands growth is increasing steadily, reaching the figure of 13.7 millions m^3 annually. The annual planned quantity of wood harvesting is allocated between the 28 regional forest administrations as follows:

Table 8. Allocation of the planned wood harvesting by region

Region	Planned share of the region[7]	Planned harvested wood per root[8]	Waste wood – planned[9]	Waste wood – realization[10]	Waste wood energy content
	%	1000 solid m^3	1000 solid m^3	1000 solid m^3	MWh
Blagoevgrad	9,36	627	188	151	280034
Pazardzhik	8,63	578	174	139	258297
Sofia	7,44	498	149	120	222505
Bourgas	6,81	456	137	109	203635
Smolian	6,10	409	123	98	182422
Lovech	4,99	335	100	80	149430
Stara Zagora	4,59	307	92	74	137280
Plovdiv	4,41	295	89	71	131784
Varna	3,93	263	79	63	117459
Kiustendil	3,77	253	76	61	112820
Sliven	3,65	245	73	59	109293
V. Tarnovo	3,30	221	66	53	98871
Haskovo	3,08	206	62	50	92165
Shumen	2,96	198	59	48	88467
Silistra	2,86	192	58	46	85653
Kardzhali	2,59	174	52	42	77617
Gabrovo	2,58	173	52	41	77202
Montana	2,34	157	47	38	69941
Vidin	2,28	153	46	37	68347
Targovishte	2,24	150	45	36	67010
Razgrad	2,18	146	44	35	65294
Pernik	2,01	135	40	32	60158
Rouse	1,73	116	35	28	51866
Vratza	1,68	112	34	27	50207
Pleven	1,59	107	32	26	47684
Dobrich	1,58	106	32	25	47290
Iambol	0,90	60	18	14	26910
Sofia – city	0,40	27	8	6	11985
Total	**100**	**6700**	**2010**	**1608**	**2991627**

Source: Ministry of Agriculture and Forestry, 2000

There are 17 regions in the country with average waste wood generation of more than 40 000 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 plan is regularly not fulfilled. The actual cut is on average on 20%

[7] Planned share of the region –the share of the planned wood harvest that is expected to come for a given region
[8] Planned harvested wood per root –the volume of wood that is to be harvested from standing trees
[9] Planned waste wood –the expected volume of waste wood
[10] Realized waste wood –the actual volume of waste wood produced

less than scheduled. That is why the available waste wood at the forests is lower than scheduled.

The average heat value of the dry fire wood and briquettes is 3.72 MWh/t. Given the fact that the specific weight of dry wood is 0.5 t/m3, the total heat content of the waste wood is about 2.99 million MWh. An average Bulgarian family needs 20 MWh for space heating to ensure normal comfort, according to the district heating norms. Having in mind the better possibilities to control the heating regulation and the improved heat insulation of the houses, the 20 MWh norm could be reduced down to 10 to 15 MWh per household. Assuming an average efficiency of waste wood transformation into heat energy of about 70%, the number of families supplied with heat produced by waste wood could reach 140000 - 200000.

In the presence of favorable conditions (availability of resources, good wood harvesting organization, transportation and enough workforce), a waste wood processing site could process 30 000 m^3 wood briquettes and pellets per year in economically feasible manner. This conclusion has been drawn from studies in the European Union, which have shown among other things that it is only feasible to collect waste wood in a distance of not more than 50 km from the waste wood-processing site.

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 above shown table shows that there are 17 regions with 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. The program could be scheduled for these regions, and be further extended to the other 10 regions, in which the quantity of waste wood is not sufficient now, if the waste wood production would increase in the future. The usage of about 30 000 m^3 of the waste wood in any of these 17 regions in Bulgaria will not disturb the fuel wood balance and would create certainty of the waste wood delivery.

The pilot region Haskovo delivers about 50 000 m^3 of waste wood (year 2000) and is a good example. Efficient equipment for processing of waste wood into briquettes and pellets as well as boilers for wood utilization is produced there. The unemployment rate in the region is very high and the pilot project will create new jobs in waste wood collection, transportation, processing and the supply of the consumers.

3.5. Technologies for heat production from biomass

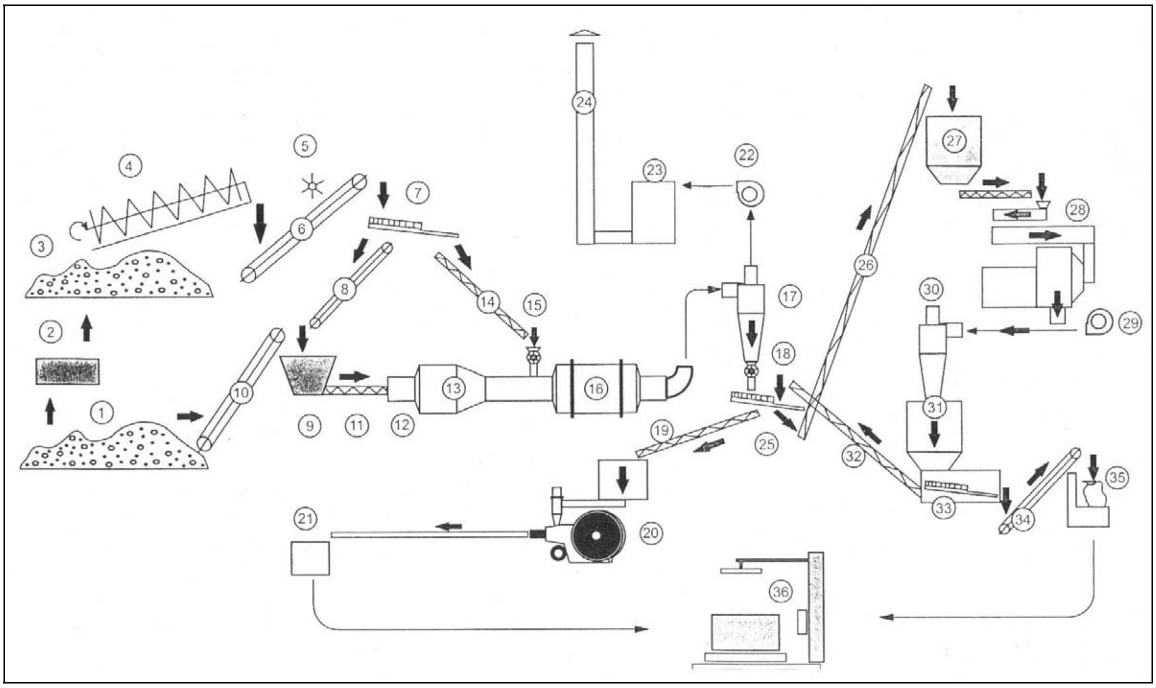
3.5.1. Available technologies in the country for waste wood processing

The calorific value of wood depends most of all on its humidity. The higher the humidity is, the lower the caloricity is thus making it more difficult to organize the burning process. Technically-achievable optimal humidity of the wood varies between 15 and 35%, with the average value of 30%. This humidity can be achieved by storing the wood for a period of 1 year in dry, well-ventilated place. One kilo of such wood has calorific value of 2.9 – 3.14 kWh/kg, and the weight of 1 solid cubic meter is 600 kilos.

Burning of wood with humidity 30-35% decreases the power and efficiency of the boiler. If the wood is kept under shed for 2 years, it could reach humidity level of 15-20%, which would significantly improve the wood parameters. This technology for storage and drying can be difficult to apply to wood waste of the type brushwood, branches and chips.

To create conditions for utilization of the waste wood, a technology for production of pellets and briquettes has been developed. Calorific value of the wood pellets and briquettes is 5.46 kWh/kg, with humidity value of 7% and weight of 1600 kg per 1 solid cubic meter. These parameters of the pellets and briquettes allow for better possibilities for transport and storage, not to mention the high burning efficiency that can be achieved.

Fig. 8. Scheme of waste wood processing facility



Source: Erato Holding, Bulgaria

Figure 8 shows simple diagram of the technological process for production of pellets and briquettes on specialized site, where waste wood is transported to. The waste wood comes for the felling sites (1) and from the wood-processing factories (3). After the gross waste wood is grinded in the hammer mill (2), it gets mixed up with wood chips and is transported (5) for processing. The coarse part of the waste wood is separated by sieve (7), mixed with the main stream of waste wood (1 and 10), moved trough bunker (9) and doser (11), fed to the burning chamber (12) and the die chamber (13). The hot flue gases from the die chamber are directed to the drum drier (16), where the fine and wet grinded waste wood enters trough mechanic transporter and a doser valve. The dry material is separated from the flue gases by means of cyclone separator (17) and is split up in two fractions – fine (27) which is used for pellet production in the pellet machine (28); and rough (19) for production of briquettes in briquette machine (20) after additional processing and transportation (19, 26 and 34) the pellets (35) and briquettes (21) are packed and readied for transportation.

Before being packed, the pellets are separated from the small fragments by means of cyclon separator (30). The separator receives air stream from a fan (29). The pellets are then cooled down in a bunker (31), while the small fragments are directed for secondary processing by means of transporter (32 and 33). A flue gas fan (22) moves the flue gases to filtering chamber (23), after which they are released into the air.

Portion of the dry material can be taken from (25) and transported for burning in special medium-power boilers utilizing automatic feeding of waste wood. These automated boilers with thermal power of several hundred kW to several MW can be used for heating medium-sized office buildings, schools, hospitals and other public buildings.

The facility for production of pellets and briquettes is usually sited in the middle of wood-harvesting area, so that the cost of transporting the waste wood is lower. 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, including:

- Supply with 30 000 solid cubic meters of waste wood at 17 Euro per cubic meter (including the transportation of up to 70 km) – this equals to 510 000 Euros.
- Processing of wood – 70 000 Euros.
- Others.

This estimation reveals that the cost price of the briquettes appears to be lower than the one of the dry wood, as long as the whole process is well organized. These costs would allow for a briquettes price of 55 Euros per ton. Crucial factor for this price of the briquettes is the transportation and distribution cost. At the moment, the price at which the briquettes with 5.46 kWh /kg are sold (80 Euros per ton) is about 30% higher compared to the price of dry wood with calorific value of 3.14 kWh/kg (35 Euros per ton), if calorific value is taken into account. Undoubtedly, the briquettes are easier to transport and store, which can justify their higher price.

This analysis shows that the local authorities in Bulgaria would be interested to have production of pellets and briquettes as long as there is a need of 15 000 – 17 000 tons of pellets and briquettes, or 80 mln kWh/year of thermal energy for heating the public buildings by means of boilers for direct combustion and pyrolysis boilers. This energy would be sufficient to heat 50-90 medium-size public buildings, which would be possible for a few neighbour municipalities.

Currently there is no special Bulgarian legislation concerning biomass installations. In the energy law and regulations renewables are addressed rather generally. On one side this is positive because there are no legal barriers to the introduction of such installations, but on the other – there are no incentives for this either.

In the heart of the biomass utilization boiler is the burning process. It is the oldest known thermo-chemical transformation of the biomass. Depending on the thermal power, the purpose of the boiler, the type of fuel used and the possible fuel combination there are two types of applications that use biofuel:

- Application with interrupted and dosed fuel feeding. The fuel is in the form of short logs, long logs, wooden and straw briquettes and pellets, small and big straw bales.
- Application with uninterrupted fuel feeding. The fuel is in the form of grinded or chopped straw, wood slivers, wooden and straw briquettes and pellets, and waste wood – chips, shavings, grinded or non-grinded bark.

In the **developed countries** like Sweden, Germany, Denmark and a few others the energy generation from biomass has achieved a significant technological progress and utilization. The biomass boilers with mechanical fuel feeding design that are predominantly used in the developed countries for central heating of small and medium-size buildings feature these components:

- Heat exchanger for warm water, hot water or steam with the corresponding equipment and fittings.
- Burning chamber with fixed or movable grill and air fans.
- Control system, which ensures the regulation of the burning process and the output water's temperature.
- Mechanical or hydraulic fuel feeding device.
- Intermediate bunker placed before the feeding device.
- Main stock-place with supplying mechanism – mechanical or hydraulic.
- Mechanism for mechanical separation of the hard bits from the ashes.
- Flue gases fan and stack.

The control system of the boiler makes it possible to regulate or supervise:

- The power of the boiler.
- The fuel feeding.
- The monitoring and alert system.
- The protection of the electric motors.
- The die away regime of exploitation.

The main regulated parameter is the output water's temperature. Other regulated parameters are:

- The pressure in the burning chamber – it is regulated by means of changing the revolutions of the flue gases fan.
- The temperature in the burning chamber – it is regulated by means of changing the revolutions of the fans for primary and secondary air stream according to pre-set levels.

Emissions and emission limits for the biomass boilers

When the burning of the biomass takes place in the temperature range of 800 – 1100 degrees Celsius and is accompanied by good supply of air in a spacious chamber, the resulting emissions are very low. The CO content is often in the range 50 – 250 mg/m3, the SO_2 content is negligible, and the NOx content reaches half of the permissible value.

The average values of the emissions coming from the regular pyrolysis boilers, calculated considering 11% (volumetric) content of oxygen in the flue gases, are:

- CO – 650mg/Nm3
- NOx – 259 mg/Nm3
- C – 50 mg/Nm3
- Particulates – 150 mg/Nm3

3.5.2. Technology with pyrolysis boiler

In general, there are two technologies for heat generation from biomass:

- Direct combustion.
- 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 and pieces to 80% for special boilers.

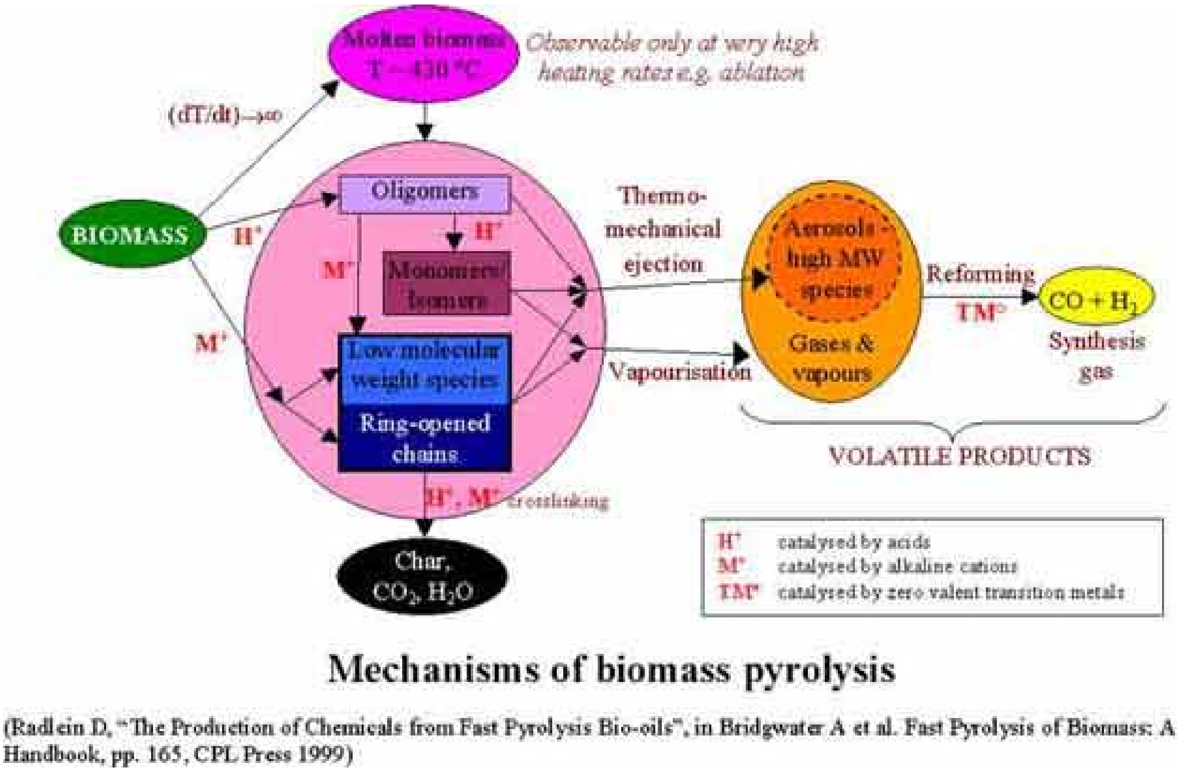
Despite of the fact that wood is one of the cleanest fuels, the direct combustion technology is relatively high emitting one. The emission level of CO, particulate mater and organic carbon compounds is relatively high and special measures are needed to reduce it. The ambient air quality limits are usually 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. Central or district heating could solve the problem.

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.

Figure 9 shows the mechanism of the biomass pyrolysis process.

Fig. 9. Scheme of the biomass pyrolysis process



There are different pyrolysis processes depending on the physical conditions on which the reaction is carried out. So, factors as heating rate, residence time, pressure, etc, greatly influence product distribution. The table below gives some highlights on this issue:

Table 9. Products of the pyrolysis

PYROLYSIS	RESIDENCE TIME	HEATING RATE	PRESURE BAR	TEMPERATURE °C MAX.	MAIN PRODUCT
Carbonization	Hours-days	Very Low	1	400	Solid
Conventional	5-30 min	Low	1	600	Gas liq. and solid
Fast	0.5-5 sec.	Very High	1	650	Liquid
Flah-Liquid	< 1 sec.	High	1	< 650	Liquid
Flash-gas	< 1 sed.	High	1	> 650	Gas
Ultra	< 0.5 sed.	Very High	1	1000	Gas
Vacuum	2-30 sec.	Medium	< 0,1	400	Liquid

Source: Swedish Biomass Association

Primary products obtained from pyrolysis are:

- Gases: mainly composed of CO, CO_2, CH_4, C_2H_6 and small amounts of other light hydrocarbons.
- Liquids: composed of a huge amount of different chemicals as ketones, organic acids, aromatic compounds, and heavier fractions.
- Solids: the solid product of the pyrolysis is a carbonaceous residue, called char, which can be used as a fuel or to obtain active carbon.

Production of (biomass burning) boilers in Bulgaria

Although not so well disseminated as in the developed countries, the technology for energy generation from biomass is steadily introduced and spread out in Bulgaria. Nowadays several Bulgarian companies produce appliances for energy use of wood. Some brief data about these companies is provided below.

Kotlostroene Ltd, Sofia - The company is specialized in the production of boilers for liquid fuels. Special orders for wood-burning boilers of up to 2 MW capacity can be fulfilled too.

Promishlena energetika 97, Pazardjik - The company produces the following devices for wood utilization:

- Boilers for wood and low-caloricity coal type “Trakia” with capacity 250 – 350 kW
- Ovens for steam boilers with productivity 2.5 and 6.5 t per hour for burning bark.

Promishlena energetika, Vratza Ltd, producing the following types of wood-burning boilers:

- Boiler KB – 150 with a capacity of 150 kW for wood waste
- Boiler KOT – 350 with 350 kW capacity for wood waste

Racho Kovacha Ltd, Gabrovo - Producer of boilers with capacity of 62, 80, 150, 215 kW for wood and low-caloricity coal.

ERATO Holding, Haskovo

The company produces and imports great variety of boilers for wood combustion with high efficiency coefficient under license from the Czech company “Viadrus” with rated power of up to 100 kW. In 2000, the company sold 410 units of pyrolysis boilers and in 2001 – 742 units. The gross thermal power of the pyrolysis boilers sold during these two years is 39 MW.

Furthermore, the company produces under license mobile grinding machine for chips with the following specifications:

- Productivity – $4m^3$ wood per hour.
- Thickness of the grinded wood – up to 120mm.
- Power of the motor – 60 kW.

- Dimensions of the chips – 30-60mm.
- Operating personnel – 2 people.

Promishlena energetika – Varna Ltd

The company produces these types of boilers:

- Steel water-heating boilers utilizing solid fuel such as wood, waste wood, wood briquettes and pellets, shavings, chips, etc.
  - Type KOK with rated power of 17, 35, 55 and 100 kW
  - Type KBT with rated power of 55, 290, 580 and 870 kW
- Steam low pressure boilers utilizing wood and wood waste type KPT with steam generating capacity of 400, 650 and 1000 kg/hour.
- Water heating boiler with rated power of 49 kW utilizing biomass.
- Ovens for steam boilers with capacity of up to 12 t/hour utilizing wood chips.

MZ Razlog JSC

The company produces these types of boilers utilizing wood or wood waste as fuel:

- Water-heating boiler model KTvG with rated power 30, 50 and 75 kW.
- Water-heating boiler type KB with rated power in the range 50 – 800 kW, with automatic feeding mechanism licensed from the German company Fellner GmbH.

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. The simple payback period (if only the efficiency is considered) for pyrolysis boiler, compared to a regular one if both fueled by wooden briquettes or pellets is less than 2 years.

Several models of the boilers produced or offered by ERATO are using the pyrolysis process for burning solid fuel – solid wood, wood briquettes or wooden pellets. Technical information about the models produced (Atmos Kombi, Atmos and Ling) are provided in Annex 2. The technical specifications for two boilers that incorporate the pyrolysis process for burning solid fuel can be seen in the following tables below:

Table 10. Steel Boiler Dakon DOR

Model	**Fuel**	**Fuel Consumption** [kg/h]	**Traction** [Pa]	**Working Pressure** [MPa]	**Water Temperature** input/output	**Water Capacity** [Liter]	**Power** [kW]	**Weight** [kg]	**Efficiency** (coke) [%]
DOR 12	Brown coal or wood	3,2	12-14	0,2	70 / 90	47	6-12	158	78-84
DOR 16		4,7	16-18	0,2	70 / 90	46	8-16	166	74-78
DOR 20		6,0	20	0,2	70 / 90	56	6-20	200	74-78
DO R24		3,2-7,6	22-26	0,2	70 / 90	57	12-24	215	74-78
DOR 25M		7,9	26	0,2	70 / 90	63	8-25	232	74-78
DOR 32		3,9-8,4	25-32	0,2	70 / 90	64	16-32	240	74-78
DOR 32D		8,4	26-32	0,2	70 / 90	64	1-28	240	74-78
DOR 45D		14	26-36	0,2	70 / 90	73	36-45	320	74-78

Source: Erato Holding

Table 11. Boiler Atmos

Model	Power [kW]	Burning Chamber Capacity [dm3]	Efficiency [%]	Max Fuel Length [mm]	Fuel Consumption [kg/h]	Fuel Consumption per season [m3]	Fuel	Weight [kg]
DC18S	10-20	66	80-89	350	3,8	15	Dry wood or briquettes	243
DC22S	10-22	100	80-89	550	5,6	18		275
DC25S	12-25	100	80-89	550	6,5	21		280
DC25GS	12-25	130	80-89	550	6,3	21		380
DC32S	14-32	140	80-89	550	7,2	29		320
DC32GS	14-32	130	80-89	550	7,2	29		380
DC40GS	20-40	170	80-89	550	10	35		433
DC50S	25-48	180	80-89	750	13	45		380
DC80	35-70	180	80-89	750	18	70		450
DC100	50-99	400	82-90	750	26	85		780

Source: Erato Holding

The information provided with the feasibility study can stimulate opportunities for technology transfer from other manufacturers, including Japan, as well. This would be an advantage for the country for implementing more advanced technologies, and it would also influence positively the competitiveness on the national market.

3.6. Consumer Market

3.6.1. Consumer potential

The growing energy prices on international level and at the same time experiencing decreasing household incomes in the country, the locally priced biomass from forest and agriculture residues shows a growing demand: the consumption of wood biomass has more than doubled over the past years. Firewood became an important fuel source for households (nearly 2 million m^3 per year) with special significance for the people living in rural areas (32% of the population). According to official data, biomass already contributes 3,7% (4757 GWh) to the national final energy supply and has the immediate potential to contribute up to 5% to the current 238 460 GWh national total energy requirements.

The growing demand for biomass increased the prices of these fuels and generated commercial developments in these fields. Assessments show that there is a tremendous scope to utilize wood, wood waste, wood energy crops and agricultural waste not only for heating in small, inefficient household and industrial units, as occurring today, but in modern, highly efficient systems such as small district heating plants.

Surveys in different towns and villages show that the use of wood and agricultural solid waste by households is remarkably high and thus present a considerable potential for small-scale biomass plants for dwellings (< 100 kW). E.g. a survey for the Lovech (Northern Bulgaria) and the Haskovo region (Southern Bulgaria)[11] quotes that 81% of the households in the Lovech region use wood for heating purposes. The average household

11 See PHARE Technical and Economic Assessment of RES in Bulgaria, BG 9307-03-L001, 1997.

wood consumption is about 5 m³ per household and year. These figures may be representative for Bulgaria, so that previous estimates for biomass consumption should be higher. This indicates that more than 4.7 million volumetric m³ (2 million t) per annum are presently used for household energy purposes in rural areas.

Recent developments in local wood briquettes and pellets production represent a renewable fuel source at competitive price compared to other fossil energy sources (e.g. black coal). There are small and middle size enterprises for wood briquette and pellet ting. The prices of the biomass briquettes is from 52 to 100 USD/t compared to 50 USD/t for broadleaves wood, 70 to 80 USD/t coal and 60 to 80 USD/t coal briquettes. However, wood briquettes and pellets are currently not yet popular for local households and manufacturers are therefore exporting their products.

3.6.2. Main possible consumers

The table displays the wood consumption in the commercial (incl. municipalities and services), residential and agriculture and forestry sectors. These sectors are where the main wood consumption occurs.

Table 12. Wood consumption by the commercial, residential and agriculture/forestry sectors, 1997-2000

Year	Commercial		Residential		Agriculture&Forestry		Total	
	Solid m³	GWh	Solid m³	GWh	Solid m³	GWh	Solid m³	GWh
1997	21750	24	1880300	2089	54550	61	1956600	2174
1998	251750	291	3737500	4153	10500	12	3999750	4456
1999	150018	159	3936920	4163	124127	131	4211065	4452
2000	106685	113	5525199	5842	160546	170	5792430	6124

All in all, during the period there is a stable increase of the wood quantities in the three sectors. This increase, measured in solid m³, is almost tripled at the end of the period. A stable raising trend is recorded only in the residential sector while in the other two sectors there are some fluctuations in 1997 and 1998.

Municipalities are an important possible consumer of the technology for utilizing wood waste biomass for energy production. Municipal authorities in Bulgaria are facing substantial difficulties to provide the energy needed for the municipal sector buildings. The reasons for this are different, but the rising energy prices and the budget shortages are some of the most important. As a result, the comfort in the municipal buildings is low, which results in low efficiency of the respective activities, health problems, etc.

Information from the energy database of the Municipal Energy Efficiency Network EcoEnergy shows that more than 42% of the energy consumption in municipal buildings is based on heat production from liquid fuels (See Table 13). This type of fuel results in environmental problems and high energy costs.

Table13. Consumption of energy by type of fuels in municipalities from EcoEnergy

Annual consumption of energy, produced by type of fuel	**2000**		**2001**	
	MWh/year	% of total energy consumption	MWh/year	% of total energy consumption
Liquid fuels	129 324	43,25	102 337	42,24
Wood	6768	2,26	4564	1,88
Coal	5894	1,97	5148	2,12
District heating	57125	19,10	35056	14,47
Natural gas	22365	7,48	25055	10,34
Propane-Butane	1340	0,45	423	0,17
Electricity	76222	25,49	69698	28,77
Annual energy consumption total	**299 038**	**100,00**	**242 282**	**100,00**

Source: Energy Database of the Municipal Energy Efficiency Network EcoEnergy

Country forecasts for individual and centralized district heating and gas supply of the ***households*** show that the number of households with individual heating (where probably biomass fuel would be mostly used) will remain the largest user group (more than 55%) compared to district heating and natural gas supply. District heating systems are not expected to expand further their capacities and networks because they face substantial problems with disconnection from the grid because of the rise of prices and the structural reforms in the economy; the share of gas supply will increase but this will not affect small towns and villages, which are the biggest wood biomass consumers in practice. A substantial barrier to the introduction of any new heating technology to the household sector is the fact that 92% of the homes are owned by their occupants, which means numerous partners in any initiative. There are no big house owners, nor building owners associations. At the same time, the income of the population in the country is very low and the purchase power respectively does not allow big private investments.

The ***services sector***, especially tourist complexes situated in the mountain regions of the country, is another consumer group that is already interested in the energy production from wood biomass. There are a number of boilers installed in such tourist regions.

A barrier to the wider application of these technologies in the services sector (usually small and medium sized enterprises and companies) is the relatively high (about 15%) interest on bank loans. On the other side, long-term loans are rarely allowed by the banking institutions in the country.

3.6.3. Prices and accessibility of prices of energy produced with waste wood biomass

Prices of firewood

During the 2002 – 2003 heating season the state forestry departments will provide 1 650 000 m^3 of firewood. About 40–42 % of this volume is designated for distribution among low-income families at a symbolic price. Thus the real amount available on the market will be about 1 million m^3 of firewood. It comes in different quality and price levels. Firewood of sizes 300 – 1000 mm is the most expensive (BGL 100/t) or about BGL 45/m^3.

The state forestry departments sell firewood at the price of BGL 30-35/m^3 or about BGL 70/t. That price is close to the price of waste wood from the wood processing enterprises. The reason for this is due to the fact that the larger portion of the firewood yield is the product of sanitary felling in forests. It consists mainly of bent or rotting trees and branches, which have no other economic value. One may assume that the firewood sold by the forestry departments is biomass, which in origin is the closest to the waste wood from wood processing industries. It may, therefore, be used as a substitute in case of shortage of waste wood for energy production.

Waste wood from timber logging and wood processing is a residue product, which is regarded rather as industrial waste than as fuel for energy generation. When it is piled in larger quantities on the area of the storage yards of wood processing enterprises, quite often they are interested in offering it for sale at rather symbolical price with the aim to clear up the platform. Small sawmills, for instance, offer waste wood chips and shavings at the price of BGL 20 per truckload.

Calculations have shown that a quantity of approximately 5 m^3 can be loaded on a truck of the most common model and make used in Bulgaria (ZIL 130, load capacity 6 t and platform capacity of the standard version 5 m^3). Bearing in mind that the specific volume weight of a bulk load of biomass in the form of dry twigs and splinters is about 270 kg/ m^3 (the specific volume weight of biofuels ranges from 40 kg/ m^3 for the lightest fuel to about 500 kg/m3 for briquettes and pellets, loaded in random bulk state), then the price of BGL per truckload refers most probably for biomass in the form of dry twigs and splinters, stored outdoors and featuring about 45% humidity and 3.14 MWh/t heat imported by the fuel. A truck without a supra structure on the platform is able to transport a load of about 5 m^3 biomass (1.35t), which may produce 2,96 MWh of heat. This price seems realistic, taking into account the fact that ERATO offers biomass of the same type at the price of BGL 35/t including delivery within the city boundaries, where the company has a store, i.e. handling and transportation costs are calculated in the price.

It should further be taken into account that these price levels for waste wood from wood processing enterprises have been determined under conditions of excessively shrunk and irregular consumption. Higher consumption of biomass of this kind has natural limitations in terms of the quantity of processed primary wood, of which it is a technological waste. In case real consumption grows beyond the available quantities of waste wood, the shortage shall have to be compensated by a more expensive fuel, for instance firewood, price BGL 70 – 100/t and heat imported by the fuel 4.58 MWh/t.

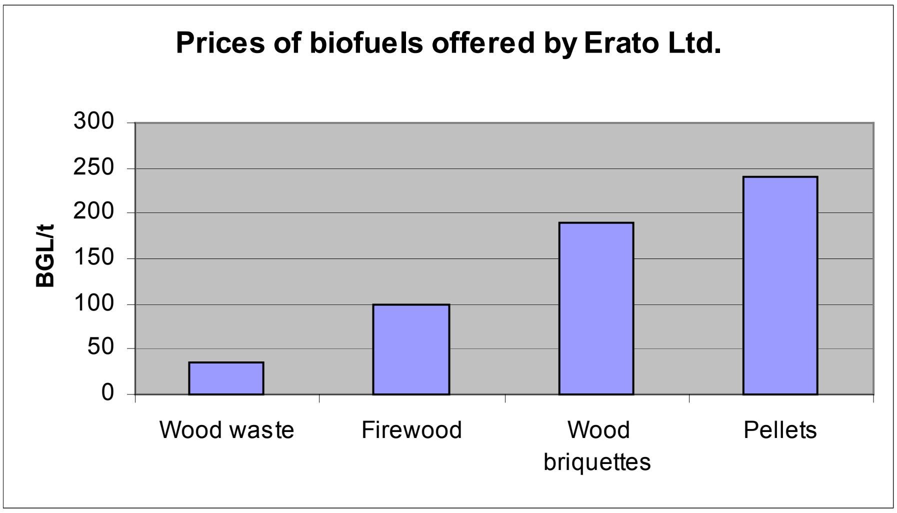


Fig.10. Price of biofuels

In the case when waste products from technological processes, whose volume is strictly limited by the volume of the main production, are used as fuel, the principle of increase of the price with the increase of consumption will apply, as well as the principle of smooth transition to the price of the fuel of the next higher level in terms of quality and price upon exhaustion of the available quantities.

Table 14. Characteristics of the biofuels offered by Erato

Indicators	Dimension	Firewood	Wood briquettes	Wood waste	Pellets
Size	mm	300-1000	Max. 270	10x10x40	Ø 6
Heat imported by the fuel	MWh/t	4.58	5,47	2.96	7.78
Humidity	%	25÷30	Max. 8	Max. 45	Max. 8
Bulk density	kg/m^3	450	1400	270	1250
Ash content	%	1÷3	0.5	3	0.5
Price	BGL/t	100	190	35	240
Heat generation cost	**BGL/MWh**	**21.8**	**34.8**	**11.8**	**30.9**

The heat energy produced from biomass with the highest price (from pellets) has a price of 30.9 BGL/MWh. This is approximately 2-3 times lower than the price of the heat energy provided by the District Heating companies to industrial consumers. For industrial heat consumers the price varies depending on the supplier in the range from 65 BGL/MWh to 90 BGL/MWh (9-12.5 EUR/GJ) for the different district heating companies.

Fuel prices

Table 15 below shows the current prices of the different types of fuel used for heat generation by March 20, 2002. The predominant portion of the energy generation facilities in Bulgaria have been in service for more than 20 years and operate at a low efficiency. In the calculation of the price of energy, generated by different types of fuel, mean coefficients of efficiency have been used for pieces of equipment that are typical countrywide in terms of type, model and age, as well as in terms of the fuel used. The relevant sources of information are as follows: LUKOil Neftochim Bourgas Joint-stock Company about the prices of liquid fuels and information from the Bulgarian press and studies of EnEffect about the prices of solid fuel.

Table 15. Prices of different fuel types and derived heat (incl. VAT)

Fuel	Fuel Price BGL/ton (natural gas 1000 m^3)	Low calorific value MWh/tonne	Efficiency -	Energy Price BGL/MWh
Wood waste	35,00	3,02	0,80	14,47
Wood				
Stove	70,00	4,03	0,50	34,76
Boiler	70,00	4,03	0,70	24,83
Pyrolysis boiler	70,00	4,03	0,86	20,21
Imported coal - Ukraina				
Stove	150,00	6,75	0,60	37,06
Boiler	150,00	6,75	0,80	27,80
Bulgarian coal from Pernik				
Stove	115,00	4,07	0,60	47,10
Boiler	115,00	4,07	0,80	35,32
Wood Briquettes				
Stove	165,00	5,47	0,55	54,89
Boiler	165,00	5,47	0,80	37,74
Pyrolysis boiler	165,00	5,47	0,86	35,11
Heavy fuel oil	596,40	11,06	0,85	63,47
Natural gas - Municipal sites	459,17	9,26	0,86	57,63
Coal Briquettes				
Stove	110,00	2,33	0,60	78,83
Boiler	110,00	2,33	0,80	59,13
LPG				
Heater	1116,00	13,90	0,87	92,30
Boiler	1116,00	13,90	0,87	92,30
Light Fuel Oil	1017,60	11,55	0,85	103,69
Diesel fuel	1240,80	11,55	0,85	126,43
Electricity	130,00	Day tariff	0,99	131,31
Municipal sites	62,00	Night tariff	0,99	62,63
	107,33	Day:Night tariff = 2 : 1	0,99	108,41

Source: EnEffect, 2002

Trends of changes in energy prices

Electricity

Currently, the average electricity price for industrial/corporate applications in this country, at which any company shall buy electricity for meeting its proper demand, is 84 BGL/

MWh. According to experts estimates in 2002 the price of electricity will retain its present level for industrial/corporate applications. There are some forecasts that in 2003-2005 it will increase by 15-40%. The pre-term decommissioning of the two oldest units of the *Kozloduy* Nuclear Power Plant will inevitably lead to increase of electricity prices. The specific amount of that increase will depend on the general state of the national economy and the capacity of the energy system to provide the required quantities of electricity.

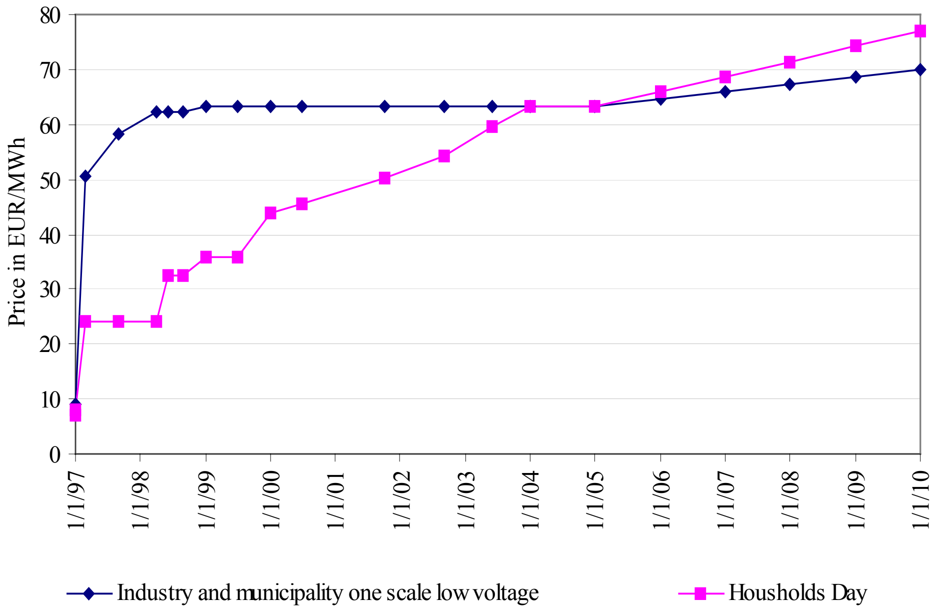


Fig.11. Changes of electricity prices in EUR/MWh

Heating energy

The price of heat for the different producers will be endorsed by the State Commission for Energy Regulation (SCER). Upon abolishment of the state subsidies the price for households will be made equal to that for industrial consumers. By now the SCER has approved sales prices for industrial applications in the range of 65-90 BGL/MWh (EUR 9-12.5/GJ) for the different district heating companies. This price is being approved on the basis of the investment costs, fuel costs component, and the permanent and variable production costs. It may be expected that the prices of heat supplied by the district heating companies will follow the changes in fuel prices.

Natural gas

The price for natural gas on the home market is unified and is determined on the basis of delivery prices and a certain margin, corresponding to the costs of *Bulgargas* for transit transmission and operation of the gas pipelines. The current price of natural gas is 300 BGL/thousand Nm^3, including VAT at 11% commercial surcharge for the gas distribution companies.

The wholesale price of Bulgargas Joint-stock Company are expected to remain close to their current levels. The submitted forecast envisages an increase that is proportional to the estimated inflation rate in the country. The large industrial consumers have an opportunity to negotiate directly the prices and sign contracts with Bulgargas. Under these assumptions the estimated price for the period up to 2010 is expected to be about 350-380 BGL/thousand Nm^3 less V.A.T.

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

4.1. 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 (see Table 8).

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.

Fig.12. Physical Map of Haskovo Region

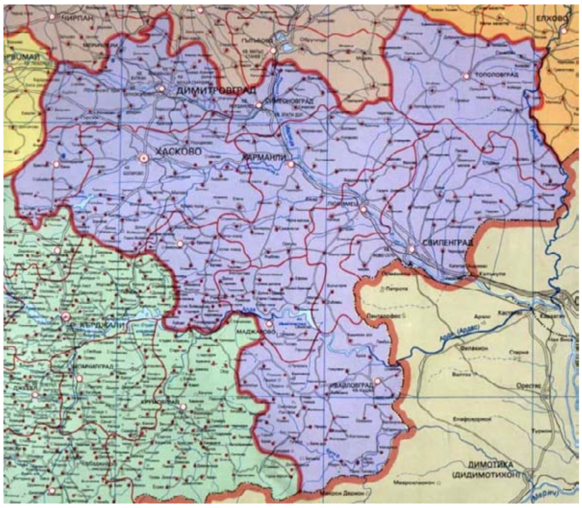


Fig.13. Administrative Map of HaskovoRegion

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 traversed 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 local economy is of industrial-agrarian nature. The structure-defining economic sectors are machine tools engineering and metal processing, electrical engineering and electronic industry, clothing, textile and food-and-beverages industries. Also developed are timber logging and wood working industries, fur and leather production and footwear manufacture. Agriculture, for whose development there are quite favorable conditions, is another integral characteristic of the economic structure of the Municipality.

The major employment ratios of the Municipality are as follows:

- Material production : the non-productive sphere – 65.1 : 34.9;
- Industry : Agriculture – 87.0 : 13.0.
- Unemployment rate – 14.19%.

The sources of revenue to the municipal budget are equity revenue, subsidies from the state budget and other sources – bank loans, transfers from extra-budgetary accounts etc. The costs for materials, fuels and energy rank on the 3rd place in the expenditure from the municipal budget and amount to about 11% of these. The annual expenditure of the municipality for electricity amounts to approximately BGL 840,000 and that for fuels and heat – to BGL 660,000.

There are branches of several Bulgarian commercial banks operating on the area of the Municipality of Haskovo, namely the United Bulgarian Bank (UBB), DSK Bank, Hebrosbank, Bulgarian Postal Bank, Commercial Bank Biochim, Teximbank and the Central Cooperative Bank.

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 GWh 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.

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.

4.2. Project approach

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 in 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.

4.3. Current situation of the sites

Vassil Levski General Secondary School
2, Stara Planina Str., City of Haskovo

The school was built in 1937. Currently, there are 600 pupils studying in grades 1 through 12. The number of teaching staff is 45. The building is a five-storeyed building with floor area of 8,680m^2 and an unheated basement. There are three distinguished zones: classrooms zone, a gym and an Inter-school Training Center. The Training Center was constructed additionally by the end of the '70s. The building structure is solid, with 38 cm thick brick walls, with plaster on both sides. The windows are twin-glazed with wooden frames. The building features four single-plated entrance doors of wood. The bearing floor slabs are made of reinforced concrete without thermal insulation. An unheated attic is formed above the top floor under the sloped roof.

The conclusion of the audit of the state of repair of the building envelope has revealed that the external plaster of the walls is in a good condition, however the joinery has not been replaced since the initial operation of the building and it is in a very bad state. Many of the windows, mainly those in the corridors and in some of the study rooms, are broken and need repair. The fact that there are single-pane windows is one of the main reasons for the deterioration of the parameters of indoor climate when the outdoor temperatures are low.

A local in-house space heating system, which uses steam as heat carrier, is constructed in the building. During classes the premises are heated all the time. Heat is supplied by a local boiler plant fueled by Light Heating Oil (LHO). The plant provides also domestic hot water, however the domestic hot water supply system has been out of use in the recent years. The boiler house is located in the main body of the building. It comprises three low-pressure boilers type ON 550, featuring heat output of 640 kW each or a total of 1920 kW. The boilers are of Bulgarian make, year of production 1975. The load of the boilers is controlled through a two-step burner at a signal from the steam pressure gauge. There are no metering devices to record heat and fuel consumption by the individual boilers. The efficiency of the boiler house operation itself is deteriorated due to the losses, which are typical for every steam condense system. The lack of automatic control of the operational heat load is a precondition for additional deterioration of the efficiency. In actual fact one of the boilers is out of use, since it is in a bad need of overhaul. The non-operating programmers lead to risks during boiler operation. The duty cycle of the boilers is aligned with the study schedule (the school is working on a single-duty regime – from 7.30 h till 13.00 h). The boilers are switched on at the discretion of the operating staff, who decides also on duty cycle. The boilers are usually in operation since 6.00 h till 10.00 h.

The annual electricity consumption is 37 MWh/year and the related costs amount to BGL 4,694. The main electricity consumer is the lighting system. The share of the other electricity consumers is negligible.

Administrative building of Haskovo Municipality
1, Obshtinski Square, City of Haskovo

This is a four-storeyed building with unheated basement and a floor area of 3,263 m^2. The main part (up to the 3^{rd} floor) was constructed prior to 1944. The 4^{th} floor has been erected later. The building structure is solid with 25 cm thick brick walls, plastered on both sides. The external plaster of the building is in a good condition. The bearing slabs of the floors are made of reinforced concrete without thermal insulation. An unheated attic is formed above the top floor of the building under the roof. There is a large variety of joinery. Originally, it has been a twin wooden joinery on the 1^{st}, 2^{nd} and 3^{rd} floors and bonded wooden joinery on the 4^{th} floor. Part of it has been replaced in stages by aluminum glass package. In the corridors there are metal single-glazed showcases. The joinery that has not yet been replaced, namely that on the 4^{th} floor, is not properly weather-stripped.

The building features and in-house local space heating system using

steam as heat carrier. During operation of the building the premises are heated permanently. A local suction ventilation system has been installed for the Conference Room on the 2nd floor. The system is of elementary design, consisting of two suction ventilation grids and a groove fan. Sucked air is exhausted at the building facade. Separation type air conditioners are installed on the windows in part of the rooms and are used mainly during the summer. The total installed capacity is 37.3 kW.

Heat supply is provided by a local boiler plant. The fuel used is Light Heating Oil (LHO). The boiler is of Bulgarian make, model PLAM 350. It generates steam, which is distributed by a collector to the branches of the space heating system. The installed heat generation capacity is 400 kW. The load of the boilers is regulated through a two-step burner METEOR type at a signal from the steam pressure gauge. There are no metering devices to record water, steam and LHO consumption to feed the boiler. The operation of the system with steam as heat carrier is connected with considerable losses of heat along the transit sections and the steam-condense systems. The absence of controls for automatic maintenance of the required heat load leads to additional deterioration of the efficiency. LHO consumption for the burner is 80-100 l/h (60-80 l/h in warmer days). The boiler is switched on at the discretion of the operative staff. The typical duty cycle of the boiler is as follows: 7.00 h – 9.00 (9.30) h; 10.30 (11.00) h - 12.00 h; 13.00 h – 15.00 h.

The annual electricity consumption is 42.960 MWh and the costs amount to BGL 5,780. The main electricity consumers are the lighting system, the PCs and the household appliances used in the building.

Kiril-i-Metodiy Primary School
37, Strashimir Str., City of Haskovo

The school was built in 1961. It has a student population of 370 pupils in grades 1 through 8 and a teaching staff of 17. The building is a four-stock structure featuring an unheated basement and a floor area of 3,330 m^2. With the aim to expand the existing building stock construction of an additional building, connected to the existing one with a blind wall has begun. For lack of funding the construction works have been suspended. The school operates an after-school study hall, which is located in a separate building in the schoolyard. The main building is of a solid structure with 25cm thick brick walls, with plaster on both sides. The windows are two-wing units with wooden joinery. The school building and the building of the study hall feature two entrance doors each. The doors are single-wing metal units. The bearing slabs between the floors are made of reinforced concrete and have no thermal insulation. An unheated attic is formed under the roof above part of the top heated floor of the school building. The roof of the study hall is flat, bordering directly on the outdoor air. The external cladding of the walls of the main building is in a relatively good state. The building of the study hall is in an extremely bad state of repair. The joinery has not been

replaced since the commissioning of the building in regular operation, the quality of weather-stripping of the window wings, which may be opened, is questionable, especially those in the study hall.

The school features a local in-house space heating system, which uses water as heat carrier and is in operation since 1996. During classes the premises are heated permanently. The boiler house is situated in the main school building, however it can supply heat to the study hall as well via an underground pipeline. The required heat is provided by LHO-fueled boiler, type ΤΥΡΟΣ - A250 “GROUP ΣTANDART”, made in Greece and featuring heat output of 290 kW, and a two-step burner type “Golling” (Greece) with automatic two-position regulation of the fuel/air ratio. There are no metering devices to control heat and fuel consumption by the boiler. The programming unit for boiler ventilation during firing and stopping operates as required. The general state of repair of the space heating system is good, there are no leaks and hence no losses of energy and heat carrier. The absence of automatic controls of the operational heat load is a prerequisite for deterioration of the performance efficiency when trying to keep up the requirements for indoor comfort. The boiler is operated between 2 and 5 hours per day, depending on the outdoor temperatures and at the discretion of the operating staff. Usually it is started from 6.00 a.m. till 9.00 a.m. and from 12.30 till 14.00/14.30 h. The teaching process is organized in two shifts and the school building is in use from 7.30 h till 19 h.

The availability of electricity consumers in the *Kiril-i-Metodiy* Primary School is very limited: several PCs, a vacuum cleaner, a coffee maker and a TV set. The annual electricity consumption is 21.98 MWh, the majority of which goes for the lighting system, and the costs amount to BGL 1,060.

4.4. Baseline scenario for the project in Haskovo

4.4.1. Baseline scenario principles

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:

1) **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.

2) **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.

3) **Application of the most available technologies**

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.

4.4.2. 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 described below. The energy costs are calculated at the price at which Light Heating Oil was offered by the only one Bulgarian manufacturer LUKOIL Bulgaria Ltd. by January 2003 (BGL 1017.6/tonne). The value of the heat equivalent imported with the fuel is BGL 88.10/MWh.

The results from the computerized model of *Vassil Levski* School indicate that the annual quantity of heat required to cover the space heating demand of the building is 373 MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the space heating system, is 516.3 MWh/year. The required annual consumption of Light Heating Oil for heating the school building is 44.7 tonnes. The annual fuel costs amount to BGL 45,486.

The results from the computerized model of the administrative building of Haskovo Municipality indicate that the annual quantity of heat required to cover the space heating demand of the building is 212 MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the space heating system, is 392.7 MWh/year. The required annual consumption of Light Heating Oil for heating the administrative building is 34 tonnes/year. The annual fuel costs amount to BGL 34,597.

The results from the computerized model of the *Kiril-i-Methodiy* School indicate that the annual quantity of heat required to cover the space heating demand of the building is 138

MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the boiler and space heating system, is 157.3 MWh/year. The required annual consumption of Light Heating Oil for heating the school building is 13.62 tonnes/year. The annual fuel costs for space heating amount to BGL 13,858.
The baseline contains the assumption that the Light Heating Oil is delivered by the only one Bulgarian manufacturer LUKOIL BULGARIA Ltd. with headquarters 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, are reported in the section on Environmental Benefits. The total amount of emissions under the baseline scenario is 4,563.7 tonnes CO_2 eqv.

4.4.3. 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. The baseline scenario envisages implementation of the following rehabilitation measures in the two sites in 2003:

- A new steam boiler, type KPN 0.55 (heat output 639 kW) of Bulgarian make, equipped with a new burner, will be installed in *Vassil Levski* School. This boiler is analogous with the currently operated boilers and uses the same type of fuel. Its price has been determined according to the quotation submitted by the manufacturer. The required funds for maintenance and repair have been envisaged. The second boiler of the currently used ones will be retained. It is also in a bad state of repair, however its service life may be extended through periodical repair at shorter time intervals. The funding required for its maintenance is, however, respectively higher.
- A new LHO-fired steam boiler, type KPN 0.35 (heat output 407 kW) of Bulgarian make, equipped with a new burner, will be installed in the administrative building of the Municipality. These pieces of equipment are analogous with the currently operated ones. Their prices have been determined according to the quotation submitted by the manufacturer. The required funds for maintenance and repair have been envisaged.

In *Kiril-I-Metodiy* School the existing boiler will be retained. Funds for maintenance and repair have been envisaged in order to maintain the norm requirements for indoor comfort.

All costs for maintenance, repair and rehabilitation with the aim to ensure operation of the existing equipment in the course of 15 years, as mentioned above, are reflected in the cashflow of the project. The total amount of these funds within this time span is BGL 104,290. Table 16 shows the envisaged distribution of the funds by sites.

The maintenance and repair comprises actions related to: replacement of the seal and the burner inlet to the boiler; (partial) replacement of a piping bundle; repair of the muffle; cleaning of the flue gases pipes; cleaning of the piping bundle from the outside – chemical degreasing; repair of the shell; replacement of the mineral wool insulation; level metering glass, master switches and ampoules.

Table 16. Costs of repair and rehabilitation of existing equipment

Year	Vassil Levski School		Administrative building of the municipality	Kiril-I-Metodiy School	Total
Boiler:	KPN 0.55	ON 550	KPN 0.35	TYPOS A-250	
2004	15250	3400	12940	400	31990
2005	400	2100	400	2000	4900
2006	400	900	900	1300	3500
2007	900	2000	400	700	4000
2008	2000	900	2500	400	5800
2009	900	1300	400	400	3000
2010	1300	3500	1800	2000	8600
2011	900	400	800	400	2500
2012	400	1300	900	2700	5300
2013	2500	2000	2000	400	6900
2014	400	1800	900	400	3500
2015	1800	3100	2300	2000	9200
2016	400	2500	900	400	4200
2017	900	400	400	700	2400
2018	2000	2300	2900	1300	8500
Total	58 350		30 440	15 500	104 290

4.5. Project Intervention

4.5.1. 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. On the Bulgarian market this kind of boilers, type SD, are offered by ERATO HOLDING Joint-stock Company with headquarters in Haskovo. Currently, a new series of boilers is being developed and is expected to come out on the market soon. Their capacity range – from 100 kW to 700 kW – will be very convenient for the needs of municipal sites. 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.

Although pyrolysis-based boilers are more efficient, their use in this site is unfeasible, because of the high demand capacity of 700 kW. The pyrolysis-based boilers manufactured by the ERATO HOLDING JsC Haskovo feature rated capacity of up to 100 kW. Therefore, at least 7 of these should be installed, however the available space in the building is not sufficient. The boilers proposed by this project have the advantage that they are fueled by waste wood and may be equipped with a system for automatic fuel charging.

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, which ensures high efficiency of combustion (up to 89%) with fully automatic control of the process. The site does not have a suitable site for fuel storage. The subscription system for delivery of biomass, proposed by the Erato Resource Company, Haskovo, will be used for this site as well. The annual consumption of wood briquettes to meet the building demand is about 29 t.

4.5.2. Value of project investments

Table 17 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 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 17. Project costs

Activity	Total BGL
***Vassil Levski* School**	
Project design	2 000
Delivery of solid-fraction biomass-fueled boilers, 2 x 350 kW	107 525
Dismounting of old boilers	5 400
Installation, commissioning and tuning of biomass-fueled boilers	9 120
Replacement of pipeline network pipe 1.1/4” pipe 1/2” pipe 2”	4 060 450 645
Delivery and installation of expansion vessel 400 l	506
Circulation pumps GRUNDFOS UPS 32-80	708
Construction of a connection between the boiler house and part of the building, including pipes, elbows, collectors	7 000
Construction of fuel storage yard	4 000
Delivery of a system for automatic fuel charging	43 010
Installation and commissioning of the system for automatic fuel charging	9 360
TOTAL *Vassil Levski* School	**193 784**
Administrative building of Haskovo Municipality	
Project design	2 000
Biomass-fueled pyrolysis-based boiler, 2 X 100kW	18 738
Dismounting of old boilers	1 800
Installation, commissioning and tuning of the biomass-fueled boilers	3 500
Replacement of pipeline network pipe 1.1/4” pipe 1/2”	789 246
Delivery and installation of expansion vessel 150 l	190
Construction of connection between the boiler house and part of the building – pipes, elbows, collectors	7 000
Construction of fuel storage yard	2 000
TOTAL: Administrative building of Haskovo Municipality	**36 265**
***Kiril-i-Metodiy* School**	
Project design	2 000
Biomass-fueled boiler, 3 X 80 kW	16 930
Dismounting of old boilers	1 800
Installation, commissioning and tuning of biomass-fueled boilers	3 510
Construction of connection between the boiler house and part of the building – pipes, elbows, collectors	2 000
Construction of fuel storage yard	2 000
TOTAL: *Kiril-i-Metodiy* School	**28 240**

SUM TOTAL for the three sites:	
Investment costs	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**

4.5.3. 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.

Vassil Levski School

Savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. Due to the shift from steam boilers to water heating boilers, heat losses from non-returned condensate, secondary evaporation, additional cooling of the condensate in the condense tank and lack of insulation on the pipelines network, which have been estimated to be 83.6 MWh/year, will be eliminated. The energy to be imported with the fuel is 432.7 MWh/year. Upon the shift to biomass as fuel, at a price of BGL 35/t for delivery under subscription of waste wood, sizes up to 10 mm x 10 mm x 40 mm with calorific value 10.7 MJ/kg (0.00296 MWh/kg), the cost of 1 MWh generated heat will be BGL 11.82/MWh. The annual savings from the application of the measure amount to BGL 40,370.

Administrative building of Haskovo Municipality

In this case savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. Due to the shift from steam boilers to water heating boilers, heat losses from non-returned condensate, secondary evaporation, additional cooling of the condensate in the condense tank and lack of insulation on the pipelines network, which have been estimated to be 49.4 MWh/year, will be eliminated. The energy to be imported with the fuel is 343.3 MWh/year. Upon the shift to biomass as fuel, at a price of BGL 190/t for delivery under subscription of waste wood briquettes with calorific value 19.7 MJ/kg (0.00547 MWh/kg), the price of 1 MWh generated heat will be BGL 34.73/MWh. The annual savings from the application of the measure amount to BGL 22,672.

Kiril-i-Metodiy School

In this case savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. The energy to be imported with the fuel is 157.3 MWh/year. Upon the shift to biomass (solid fraction) as fuel, at a price of BGL 190/t for delivery under subscription of waste wood briquettes with calorific value 19.7

MJ/kg (0.00547 MWh/kg), the price of 1 MWh generated heat will be BGL 34.73/MWh. The annual savings from the application of the measure amount to BGL 8,394.

A summary of the estimated savings by sites is given in Table 18.

Table 18. 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**

4.5.4. Environmental benefits

Reduction of GHG emissions

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 reduction of GHG emissions in the atmosphere. Greenhouse gases have a negative anthropogenic impact on the climatic system. Increased concentrations of stable greenhouse gases might reduce the speed of radiation of solar energy back to space, which may lead to climate change.

CO_2 emissions from the energy sector account for the major portion of GHG emissions in Bulgaria. The ways to reduce GHG emissions comprise savings in liquid fuel and electricity consumption or fuel shift – from a traditional fuel to another, more environmentally-friendly type of fuel, for instance biomass. 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 (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 will be achieved. The specific quantities and types of avoided emissions are given in Table 19.

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.

In order to determine which GHG emissions need to be estimated and calculated for establishing the emission baseline and project emissions, the project boundary has to be defined. A project boundary is the notional margin around a project, within which the project's impact (in terms of GHG emission reductions) will be assessed. The activities and GHG emissions that are included in the project boundary reflect:

(a) The activities that will be included in the emission baseline and baseline calculations; and

(b) The activities and GHG emissions that will be monitored once the project is operational.

The procedure to define the project boundary for the calculation of the baseline emissions and for the project emissions should be consistent and similar when possible. All GHG emissions from the proposed JI activity that are under control of the project developer and that are significant and reasonably attributable to the project activity should be included in the project boundary.

The activities that are included in the emission baseline and baseline calculations for the project in Haskovo 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.

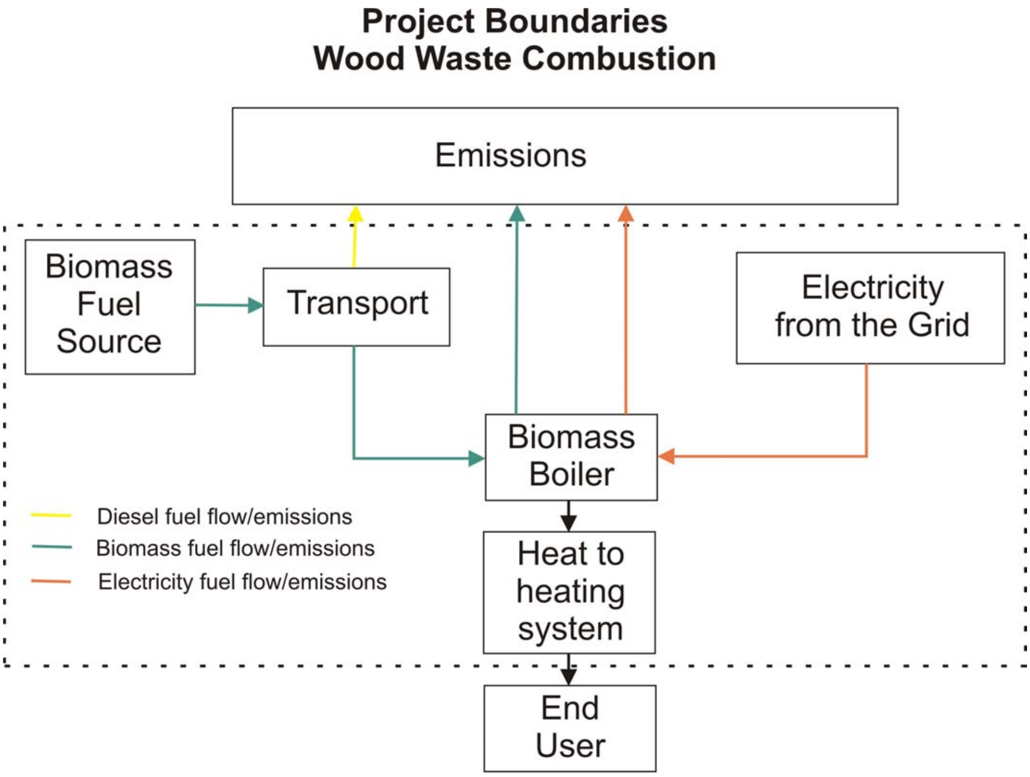
In this way all GHG emissions from the proposed JI project that are significant and reasonably attributable to the project activity, and also are under control of the project owner/developer are included in the project boundary (Fig. 14).

For evaluation of the impact of the projects emission, reductions are calculated in Carbon Dioxide Equivalent (CO_2eqv), which summarized the impact of all types of GHGs.

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.

Fig.14. Project boundaries



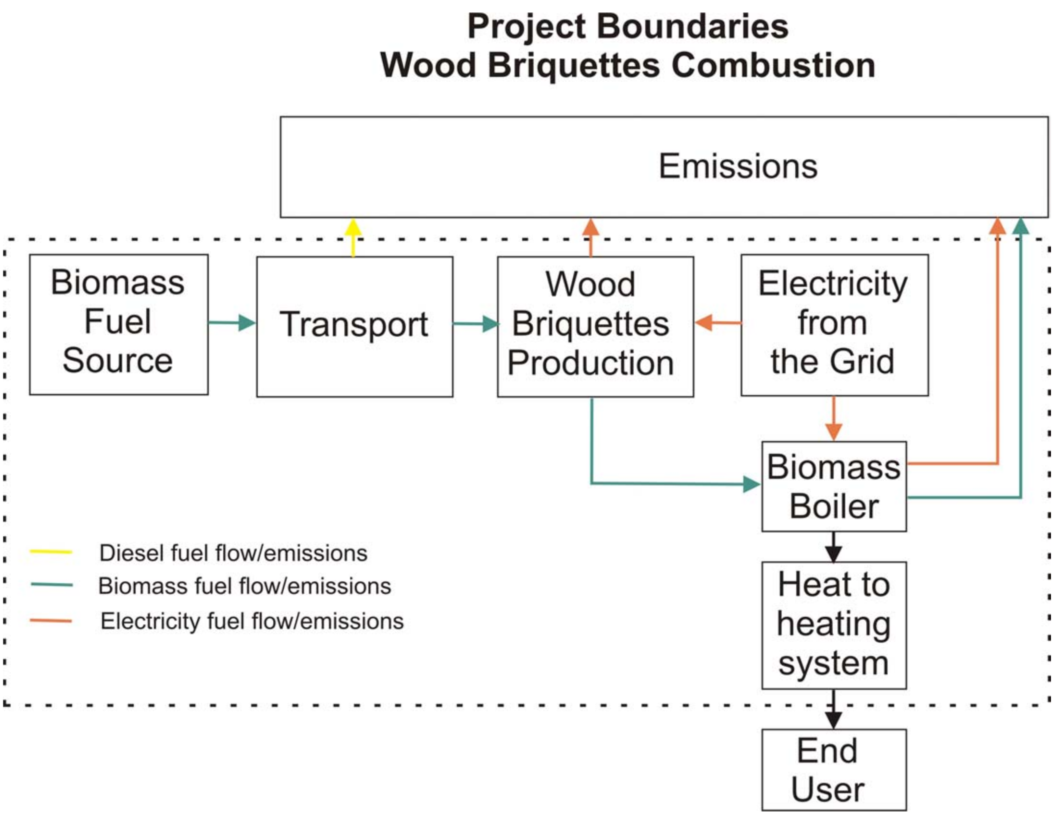


Table 19 presents also the value of CO_2eqv saved for the life of the project. The costs for emissions reduction of 1t CO_2eqv are BGL 62.36/tonne, compared to the project investment cost. The costs for emissions reduction of 1t CO_2eqv, compared to the project incremental cost (the avoided investment and maintenance costs in the baseline are subtracted from the investment and maintenance costs for the project) is BGL 50.26/tonne.

Other environmental benefits from project implementation

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. Table 6.2 shows the reduction of harmful emissions of local importance for the project life cycle of 15 years as a result of the fuel shift from LHO to wood briquettes and waste wood. Some increase in CO could be expected.

Table 20. Reduction of harmful emissions of local importance

Emissions by type	Unit	Baseline	JI scenario	Emissions reduction (JI scenario – Baseline)
SO_x emissions	tonnes	24.3	0	-24.5
NO_x emissions	tonnes	5.8	5.06	-0.7
CO emissions	tonnes	0.69	19.25	18.6
NMVOS emissions	tonnes	0.079	0	-80.5

Table 19. Reduction of GHG emissions

Project year			**0**	**1**	**2**	**3**	**4**	**…**	**15**	**Lifetime**
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**…**	**2018**	**15 years**
Item	**Dimension**	**Value**								**tonnes CO_2eq**
Baseline Scenario								…		
LHO delivery								…		
Road transport Burgas – Haskovo	Km	206						…		
Truck with a tank 22 m^3	Numbers	5						…		
Total LHO delivery by road	Km/year	1030						…		
Specific liquid fuel consumption for the truck	Liter/100 km	60						…		
Total liquid fuel consumption for trucks	Liters/year	618						…		
Emissions from Total LHO delivery by road	Tonnes CO_2eqv/year		1.6	1.6	1.6	1.6	1.6	…	1.6	
LHO combustion on sites	Tonnes/year	92								
Emission factor CO_2eqv	Kg CO_2eqv/MWh	268						…		
LHO combustion on sites	MWh/year	1066						…		
Emissions from LHO combustion on sites	Tonnes CO_2eqv/year		286.0	286.0	286.0	286.0	286.0	…	286.0	
Electricity consumption by existing boilers										
Existing boilers capacity	KW	1976						…		
Existing boilers electricity consumption	KWh/year		17194.2	17194.2	17194.2	17194.2	17194.2	…	17194.2	
Electricity emission factor CO_2eqv	G CO_2eq/kWh		787.5	787.5	787.5	787.5	1012.5	…	1012.5	
Emissions from electricity for boilers	Tonnes CO_2eqv/year		13.5	13.5	13.5	13.5	17.4	…	17.4	
Total Baseline Scenario	**tonnes CO_2eqv/year**		**301.2**	**301.2**	**301.2**	**301.2**	**305.0**	…	**305.0**	**4563.7**
								…		

Project year			**0**	**1**	**2**	**3**	**4**	**…**	**15**	**Lifetime**
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**…**	**2018**	**15 years**
Item	**Dimension**	**Value**								**tonnes CO_2eq**
JI Scenario								…		
Wood briquettes production								…		
Specific electricity consumption for wood briquettes production	kWh/tonne	26.4						…		
Wood briquettes demand for 3 sites	tonnes/year	91.5						…		
Electricity consumption for wood briquettes production to cover the demand of the 3 sites	kWh/year		2416.1	2416.1	2416.1	2416.1	2416.1	…	2416.1	
Electricity emission factor CO_2eqv	g CO_2eqv/kWh		2.4	2.4	2.4	2.4	2.4	…	2.4	
Wood briquettes & wood waste delivery, road transport								…		
Wood briquettes & wood waste delivery	liters/year	95.1						…		
Emissions from road transport for Wood briquettes & wood waste delivery	tonnes CO_2eqv/year		0.251	0.251	0.251	0.251	0.251	…	0.251	
Wood briquettes & wood waste combustion								…		
Combustion of wood briquettes & wood waste on sites	tonnes/year	237.7						…		
Emission factor CH_4	kg/MWh	0.072						…		
Emission factor CO_2eqv	kg CO_2eqv/MWh	1.512						…		
Combustion of wood briquettes & wood waste on sites	MWh/year	933.3						…		
Emissions from combustion of wood briquettes & wood waste on sites	tonnes CO_2eqv/year		1.411	1.411	1.411	1.411	1.411	…	1.411	
Electricity consumption by new boilers								…		
New wood-fueled boilers capacity	KW	1088.1						…		
New wood-fueled boilers electricity consumption	kWh/year		9466.5	9466.5	9466.5	9466.5	9466.5	…	9466.5	
Emission factor CO_2eq	g CO_2eqv/kWh		787.5	787.5	787.5	787.5	1012.5	…	1012.5	
Emissions from electricity for wood-fueled boilers	tonnes CO_2eqv/year		7.5	7.5	7.5	7.5	9.6	…	9.6	
Total JI Scenario	**tonnes CO_2eqv/year**		**11.020**	**11.020**	**11.020**	**11.020**	**13.693**	**…**	**13.693**	**197.4**
Difference = (JI - Baseline) Scenario	tonnes CO_2eqv/year		-290.1	-290.1	-290.1	-290.1	-291.3	…	-291.3	
Cumulative avoided emissions	tonnes CO_2eqv			-290.1	-580.3	-870.4	-1161.7	…	-4366.3	**-4366.3**

4.6. Business plan (schedule of activities and cash flows) for the project implementation, operation and monitoring in the pilot buildings

4.6.1. Time schedule of project implementation

The implementation of the proposed measures will be effected on the basis of specific project design. Table 21 below shows the time schedule for project implementation by types of activities.

Table 21. Implementation schedule

Activity	**Month**				
	1	**2**	**3**	**4**	**5**
Tenders, contracting, planning, project design					
Vassil Levski **School**					
Delivery of biomass-fueled boilers					
Delivery of pipes, fixtures, collectors					
Delivery of a system for automatic fuel charging					
Delivery of expansion vessels and circulation pumps					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of biomass-fueled boilers					
Installation of pipes, fixtures, collectors					
Installation of expansion vessels and circulation pumps					
Installation of a system for automatic fuel charging					
Construction of fuel storage yard					
Administrative building					
Delivery of pyrolysis boilers					
Delivery of pipes, fixtures, collectors					
Delivery of expansion vessel					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of pyrolysis boilers					
Installation of pipes, fixtures, collectors					
Installation of expansion vessels and circulation pumps					
Construction of fuel storage yard					
Kiril-i-Metodiy School					
Delivery of pyrolysis boilers					
Delivery of pipes, fixtures, collectors					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of pyrolysis					

boilers					
Installation of pipes, fixtures, collectors					
Construction of fuel storage yard					
Acceptance and commissioning into regular operation – all sites					

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.

4.6.2. Procedures related to purchase of the equipment and fuel selection

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. The terms and conditions of the tender will comprise the requirement for the equipment supplier to undertake also the dismounting and installation works on the site. The existence on the area of the city proper of a company possessing capacity and experience in the trade in and manufacture of technologies for energy generation from biomass is a guarantee for the real possibilities for high-quality project implementation.

Table 22 shows the schedule of investments in the course of project implementation.

Table 22. Time schedule of investments

Activity	**Month**				
	1	**2**	**3**	**4**	**5**
Tenders, contracting, planning, project design	3600		3000		
Vassil Levski ***School***					
Delivery of biomass-fueled boilers		53763		53762	
Delivery of pipes, fixtures, collectors			9374		
Delivery of a system for automatic fuel charging		21505		21505	
Delivery of expansion vessels and circulation pumps			971		
Delivery of materials for construction of fuel storage yard		800	1200		
Dismounting of old boilers / Installation of biomass-fueled boilers				9048	5472
Installation of pipes and fixtures				1391	1390

Installation of expansion vessels and circulation pumps				243	
Installation of a system for automatic fuel charging				3744	5616
Construction of fuel storage yard			800	1200	
Administrative building					
Delivery of pyrolysis-based boilers			9369	9369	
Delivery of pipes, fixtures, collectors			2431	3647	
Delivery of an expansion vessel			152		
Delivery of materials for construction of fuel storage yard			400	600	
Dismounting of old boilers / Installation of pyrolysis-based boilers				3201	2101
Installation of pipes and fixtures				979	978
Installation of the expansion vessel				38	
Construction of the fuel storage yard				400	600
Kiril-I-Metodiy *School*					
Delivery of pyrolysis-based boilers			8465	8465	
Delivery of pipes, fixtures, collectors			600	900	
Delivery of materials for construction of fuel storage yard			400	600	
Dismounting of old boilers / Installation of pyrolysis-based boilers				3204	2106
Installation of pipes and fixtures				500	
Construction of the fuel storage yard				400	600
Acceptance and commissioning in regular operation – all sites					500
Total	3600	76068	37162	123196	19363
Cumulative total	3600	79668	116830	240026	259389

A tender will be held for selection of fuel supplier. In two of the sites – the Administrative Building of Haskovo Municipality and *Kiril-i-Metodiy* School there is a problem – lack of platforms for fuel storage. For this reason for these sites a tender will be announced for fuel supply under subscription under a two-week delivery schedule. In Haskovo this kind of service is offered by the ERATO Resource Company for both wood briquettes and small-size wood waste.

4.6.3. Financial plan of the project

Sources of funding and funding requirements

The equipment required for the project has been calculated in the Financial Plan on the basis of the prices and official quotations submitted by the ERATO HOLDING JsC with headquarters in Haskovo and one of the most stable manufacturers of this kind of equipment on the Bulgarian market. The price of the biomass fuel has been determined on the basis of a quotation of the Erato Resource Company, including for subscription deliveries. The total amount of investment is BGL 272,300, including V.A.T. The

Financial Plan envisages **loan capital** to the amount of BGL 182,100, 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 3,559. Thus the total contribution of the borrower to project financing accounts for 34% of the total project costs.

Table 23 shows the structure of investment funding and the proposed financial scheme.

Table 23. Financial Plan

		BGL	%
Expenses			
	Primary investment	259 389	94.0
	Reserve	12 911	4.7
	Interest for the time of implementation	3 559	1.3
	Payments on loan principal during implementation	0	0.0
	Operational costs	0	0.0
	Expenses total	**275 859**	**100**
Capital structure			
	Loan	182 100	66.0
	Equity capital	93 759	34.0
	Investments total	**275 859**	**100**
Financing scheme			
	Amount of required loan	**182 100**	**66.0**
	Borrower's contribution		
	Investment	*90 200*	*96.2*
	Interest during implementation	*3 559*	*3.8*
	Additional current assets requirements during implementation	*0*	*0*
	Borrower's contribution total	**93 759**	**34.0**
	Grand total	**275 859**	**100**

Investment scheme

The funding from the different sources is shown in Table 24. This scheme is aligned with the project implementation schedule and the proposed financing scheme. The contribution of the Municipality comprises also the funding for pay-off of the interest during the project implementation period to the amount of BGL 3,559.

Table 24. Investment scheme

MONTHS	**May**	**June**	**July**	**August**	**September**	**Reserve**	**Total**
Source	1	2	3	4	5		BGL
Bank			26630	123195	19364	12911	182100
Municipality	3600	76068	10898	1507	1686		93759
TOTAL	**3600**	**76068**	**37528**	**124702**	**21050**	**12911**	**275859**

Pay-off plan

The proposed loan terms and conditions envisage as follows:

- Date of loan endorsement: July 1, 2003
- Four years pay-off term;
- Three months of grace on loan principal during project implementation;
- Forty eight monthly installments for pay-off on loan principal;
- Fifty one monthly installments for pay-off of interest.

The proposed plan with the concrete values of the monthly pay-off installments is shown in Table 25.

Table 25. Pay-off plan

Project year	Pay-off installments during the year												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Year 1													
Payment of interest	1686	1651	1616	1581	1545	1510	1475	1440	1405	1370	1335	1300	17913
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	5480	5445	5409	5374	5339	5304	5269	5234	5199	5164	5128	5093	63438
Balance on loan principal	**178306**	**174513**	**170719**	**166925**	**163131**	**159338**	**155544**	**151750**	**147956**	**144163**	**140369**	**136575**	**1889288**
Year 2													
Payment of interest	1264	1229	1194	1159	1124	1089	1054	1019	983	948	913	878	12855
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	5058	5023	4988	4953	4918	4883	4847	4812	4777	4742	4707	4672	58380
Balance on loan principal	**132781**	**128988**	**125194**	**121400**	**117606**	**113813**	**110019**	**106225**	**102431**	**98638**	**94844**	**91050**	**1342988**
Year 3													
Payment of interest	843	808	773	738	702	667	632	597	562	527	492	457	7797
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	4637	4602	4566	4531	4496	4461	4426	4391	4356	4321	4285	4250	53322
Balance on loan principal	**87256**	**83463**	**79669**	**75875**	**72081**	**68288**	**64494**	**60700**	**56906**	**53113**	**49319**	**45525**	**796688**
Year 4													
Payment of interest	421	386	351	316	281	246	211	176	140	105	70	35	2740
Payment of loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	4215	4180	4145	4110	4075	4040	4004	3969	3934	3899	3864	3829	48265
Balance on loan principal	**41731**	**37938**	**34144**	**30350**	**26556**	**22763**	**18969**	**15175**	**11381**	**7588**	**3794**	**0**	**250388**

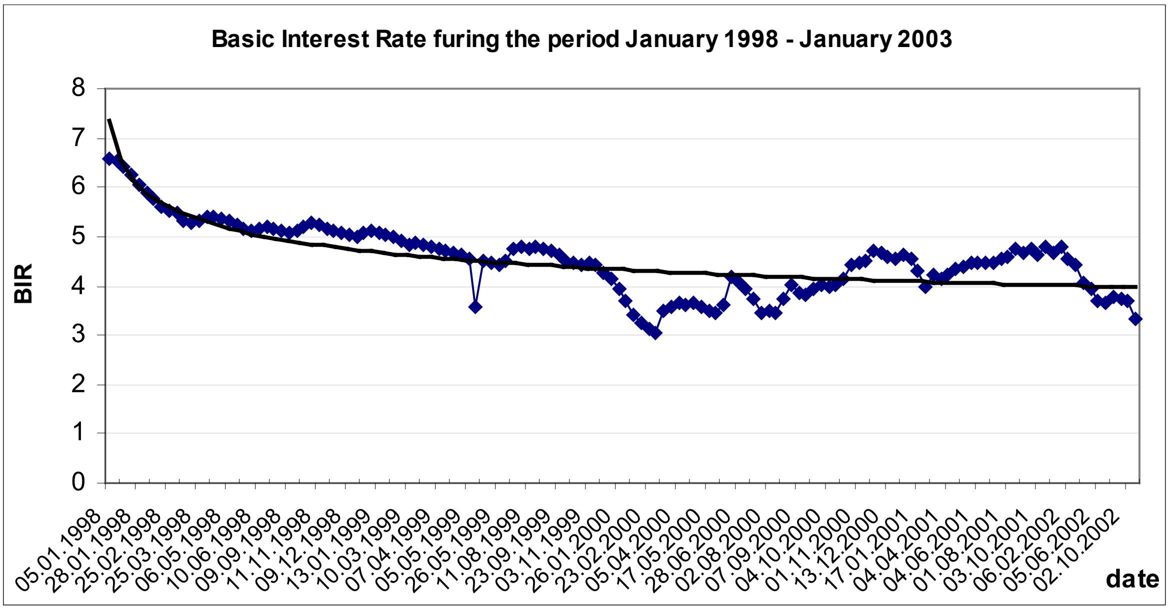
4.6.4. Macro-economic forecasts

Interest levels

The basic interest rate for mid-January 2002 was 3.31%. For the recent 4 years (since January 1999) it has never exceeded 5%, its minimum value being 3.03%. One the basis of the analysis of the monthly values of the basic interest rate during the period January 1, 1998 – January 15, 2003, as well as of the trend based on the phased approximation function, no evidence was found that the development of the trend of the basic interest rate value for the period covered by the Business Plan may exceed the 5% level.

The preliminary studies for procurement of bank loan indicate that it is possible to negotiate a loan with a floating interest rate to the amount of the basic interest rate plus a bank surcharge of about 10%. On the basis of the above, an interest rate level of 15% has been assumed for the main version of the project, and in the Sensitivity Analysis section some comments are given on the impact of the basic interest rate on the project. The changes of the basic interest rate for the past five years are shown in Fig. 15.

Fig.15. Changes in the basic interest rate from January 1998 till January 2003.

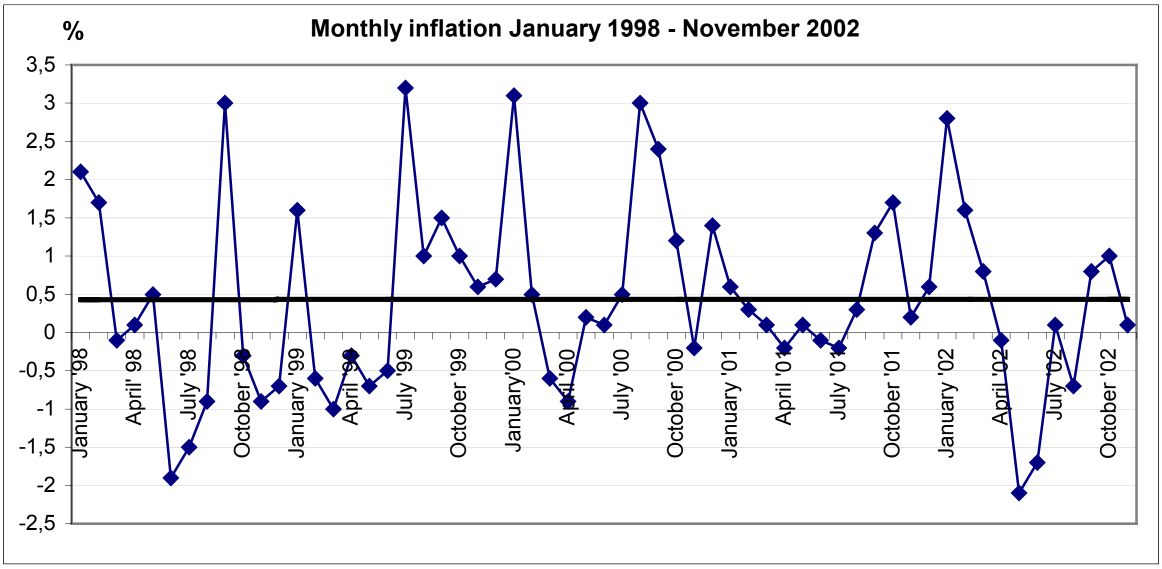


Inflation

The mean annual inflation in Bulgaria in 2002 was 3.8%. The analysis of the development of inflation may be made on the basis of the data for the recent five years. Its bottom level during this period was 1.0 % (in 1998) and the maximum of 11.4% was recorded in 2002. Making forecasts about the annual inflation rate on the basis of a longer retrospective period would be unfeasible, since the trend is thwarted because of the hyperinflation in 1996-1997. The relatively short retrospective period of 5 years does not provide for sufficiently accurate presumption concerning the trends in development of inflation. More accurate idea may be obtained by following the changes in the monthly value of inflation during this period. This graph is shown on Fig. 16. It indicates that during the period under review the value of monthly inflation is about 0.4 – 0.45%, which makes an annual inflation rate in the range of 4.8 – 5.4 %.

For the purposes of this Business Plan an annual inflation rate of 4% has been used, which is close to the rate for the preceding year (3.8%). According to our expectations, the annual inflation rates during the coming years will not exceed the forecast inflation rate of 4.2% for 2003. The maximum inflation rate for the EU for the current year is expected to be not more than 3.8%.

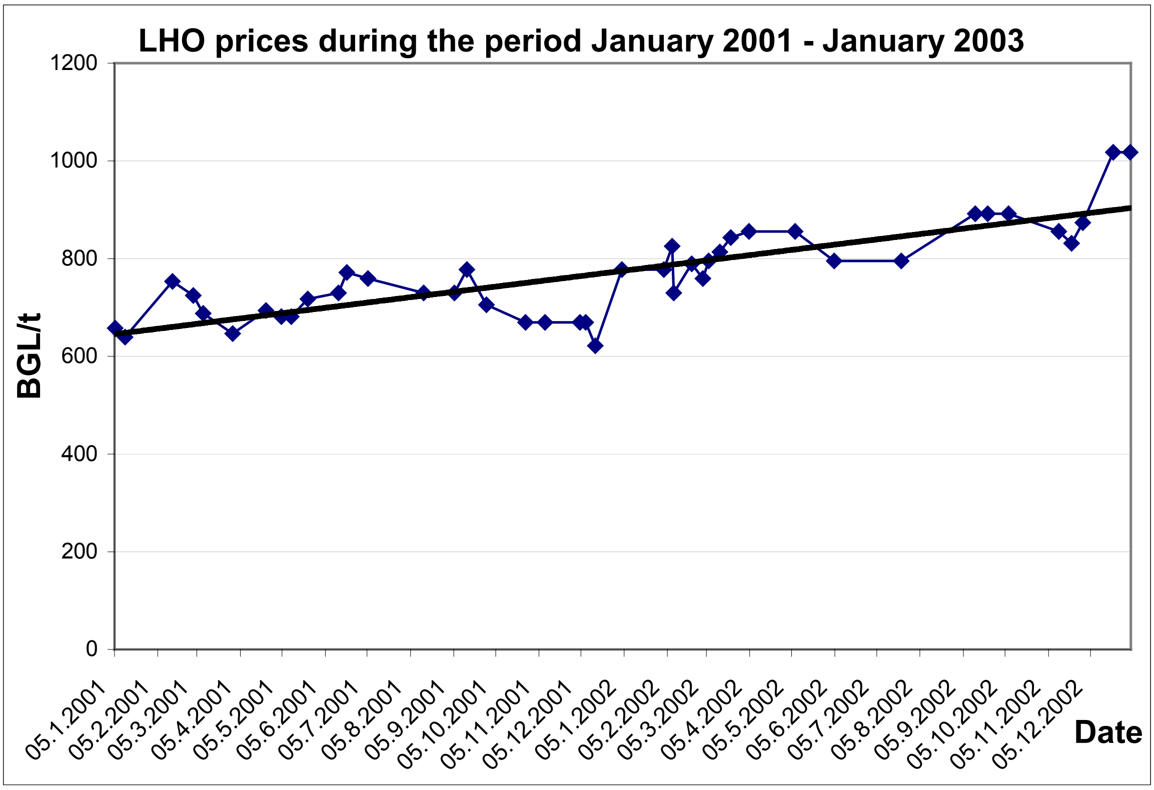
Fig.16. Changes in the basic interest rate from January 1998 till January 2003



Light Heating Oil (LHO) Price

The fluctuations of LUCKOIL Neftochim price of LHO for a period of two years have been studied. The price of 1t of fuel by January 17, 2003 was BGL 1017.6 incl. V.A.T. The minimum LHO price during the period under review (621.6 BGL/t) was recorded in December 2001. The changes in the LHO price during the part two years are presented in Fig. 17.

Fig.17. Changes in LHO prices from January 2001 till January 2003



The analysis of the reviewed statistical data shows that there are frequent periods of change in price levels, both in the direction of price increase and in the direction of price decrease, however during the 2-year period under review a trend of gradual increase has been noted. Because of the unstable political situation in the Middle East one may expect a rise in the price of oil products and persistence of this trend.

Prices of fuels from waste wood

Waste wood is a residual product from timber logging and woodworking industries. The use of biomass for energy generation is as yet extremely limited in Bulgaria. The preliminary estimates indicate that there are considerable volumes of primary fuel of this type in this country. There is, however, no system for collection and processing of the bulk of biomass, predetermined to a considerable extent by the limited demand of this product by the end-users. Market studies have shown that the price of bulk waste biomass in the form of wood waste, chips and sawdust is about BGL 25/t to BGL 40/t. The prices of the wood briquettes offered on the market are between BGL 150 and BGL 190/t.

In the years to come, more severe rules for discharge and storage of wood waste will be introduced and the enterprises will be subject to stricter environmental control and more severe administrative sanctions. This will force enterprises to make use of the waste wood, produced by their activities, or to seek for ways and means to dispose of it. At this background one may expect that there will be no big increase in the price of wood waste biomass.

4.6.5. Cashflow analysis

General provisions

The main factor which generates the project cashflow are the savings resulting from the difference between the prices of LHO and the wood waste biomass fuels and the changes in their ratio during the project lifetime. It is hard to predict how this ratio will change in the future. Both diminishing of the difference and increase of the difference is possible. For this reason the baseline scenario assumes retention of the ratio between the prices during the entire project lifetime, and the options of any change in this ratio are reviewed in the risk and sensitivity analysis.

The project scenario presumes reserves with respect to the investment costs to the amount of 5%. These means are envisaged to cover additional costs incurred as a result of emergence of changes in the values of the technical, pricing and other assumptions of the project.

The elaborated cashflow comprises the funds required for current maintenance of the new equipment and the necessary repairs during the envisaged 15 years economic life cycle of the project. On the other hand, in order to be able to use the old pieces of equipment during this time, additional expenses will be needed for maintenance and repair, and these will be far beyond those for the new equipment. These expenses are also taken into account in the cashflow.

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.

Financial indicators of the project

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.

The specific values from the cash flow analysis, the Simple Payback Period, the Internal Rate of Return and the Net Present Value are shown in Table 26. The project cashflow by years is illustrated in Table 27.

Table 26. Cost-effectiveness of the project

Rated 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 51,150 has been envisaged for maintenance and repair during that period. The avoided investment costs for replacement of the entirely worn-out equipment is BGL 27,120. The avoided costs, which would have been spent for repair and maintenance of the existing boilers, amount to BGL 25,750.

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 in this report (Table 24).

Table 27. Cashflow of the project Use of Biomass for Space Heating in Municipal Sites in the city of Haskovo

Years	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Investment	**272300**	**-27120**														
Financing:																
Loan	182100															
Equity funds	90200															
Baseline scenario																
Operation costs		93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941
Maintenance and repair costs		4600	4900	3500	4000	5800	3000	8600	2500	5300	6900	3500	9200	4200	2400	8500
After project completion																
Operation costs		22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504
Maintenance and repair costs		900	900	900	900	900	3400	1600	24400	3400	1600	1600	3400	1600	1600	3400
Net savings	**-272300**	**102657**	**75437**	**74037**	**74537**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Debt servicing – interest and charges	3559	17913	12855	7797	2740											
Depreciation																
Revenue before taxation		**84744**	**62582**	**66240**	**71797**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Tax																
Fiscal preferences																
Net revenue after taxation		**84744**	**62582**	**66240**	**71797**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Debt servicing – loan principal		45525	45525	45525	45525											
Net cashflow	**-93759**	**39219**	**17057**	**20715**	**26272**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Cumulative cashflow	-93759	-54540	-37483	-16769	9504	85841	156878	235315	284852	358189	434926	508263	585500	659537	731774	808311
Discount rate	1	0,90	0,81	0,73	0,66	0,59	0,53	0,48	0,43	0,39	0,35	0,31	0,28	0,25	0,23	0,21
Present Value (PV)	-93759	35297	13816	15101	17237	45076	37752	37516	21324	28412	26757	23014	21814	18819	16526	15758
Cumulative Present Value (PV)	-93759	-58462	-44646	-29545	-12308	32769	70521	108037	129361	157773	184530	207544	229358	248177	264702	280461

4.6.6. 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
- Operational risk
- Price risk

Risk of non-completion of the project

This risk comprises two main components:

- Exceeding the budget
- Delayed commissioning of the system

Some of the reasons for exceeding the budget may be inaccurate assessment of the investments and omission of equipment that is indispensable for the project. The project is insured against this risk through the incorporation of incidental expenses to the amount of 5% of the total amount of investments. In view of the fact that the selection of the supplier and subcontractor will be conducted by means of tender, lower prices may be expected. The maximum possible exceeding of the envisaged investments is estimated to be 5%. Table 28 shows the changes in the major financial indicators of the scenario of exceeding of the budget.

Table 28. Financial indicators of the scenario of exceeding of the budget

Indicator	Dimension	Value
Internal Rate of Return	%	27.20
Change	%	-1.60
Net Present Value	BGL	263 255
Change	BGL	-13 615
Payback Period	years	3.50
Change	years	+0.17

Delayed commissioning of the systems may occur as a result of inaccurate assessment of the time needed for project implementation or delays in the delivery and installation of the equipment. The anticipated maximum delay is 1 month. The changes in the financial parameters in this case are shown in Table 29.

Table 29. Financial indicators of the scenario of delayed commissioning

Indicator	Dimension	Value
Internal Rate of Return	%	28.14
Change	%	-0.66
Net Present Value	BGL	270 540
Change	BGL	-6 300
Payback Period	years	3.41
Change	years	+0.07

Operational risk

This risk is reduced to the minimum, since the combustion systems of the boilers, as well as the system for fuel charging of the boiler in *Vassil Levski* School are fully automated and the human factor is, generally speaking, eliminated. The risk of failure to procure the required quantities of wood has been avoided by signing a contract for deliveries under subscription. The risk analysis reviews the probability that the estimated net savings, determined on the basis of the assessments in the energy audits of the three sites, may not be achieved to the same level in actual life due to wrong operation. The value of this risk is 5%.

The changes in the financial indicators with respect to this risk are shown in Table 30.

Table 30.Financial indicators of the scenario of diminished savings during operation

Indicator	Dimension	Value
Internal Rate of Return	%	27.12
Change	%	-1.68
Net Present Value	BGL	249 383
Change	BGL	-27 457
Payback Period	years	3.51
Change	years	+0.18

Price risk

In the framework of this project the price risk exists mainly with respect to the ratio of fuel prices.

The calculations for the project have been made using the price of LHO quoted in the Price List of LUCKOIL Neftochim by January 2003. It will be realistic to expect that the price at which the fuel is delivered to the Municipality of Haskovo will be higher. On the other hand, the price of the biomass has been determined on the basis of a real quotation for Free Project Site delivery. Therefore, there is an additional reserve against this risk as early as at the point of working out of the Business Plan. For this reason the risk of diminishing of the difference between the prices of LHO and biomass is minimal and has been assumed at the level of 10%.

Table 31.Financial indicators of the scenario of risk of diminishing of the difference between fuel prices

Indicator	Dimension	Value
Internal Rate of Return	%	25.43
Change	%	-3.37
Net Present Value	BGL	221 926

Change	BGL	-54 914
Payback Period	years	3.70
Change	years	+0.37

Worst case scenario

Under this 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.

Table 32. Financial indicators of the worst case scenario

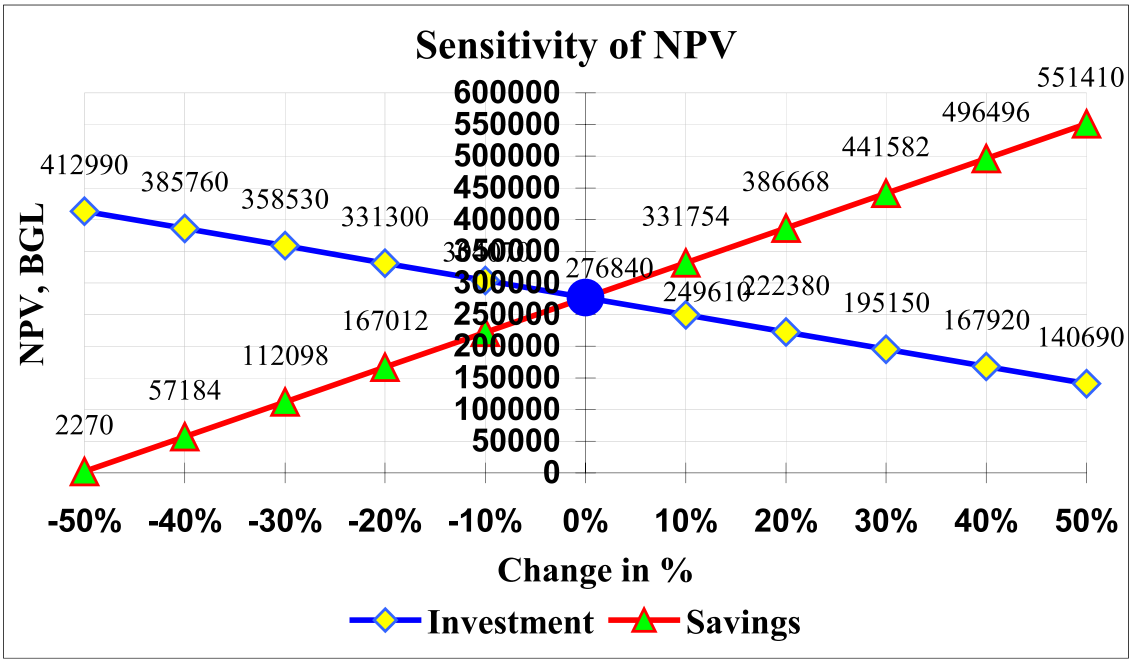
Indicator	Dimension	Value
Internal Rate of Return	%	23.41
Change	%	-5.40
Net Present Value	BGL	202 011
Change	BGL	-74 829
Payback Period	years	3.98
Change	Years	+0.65

Sensitivity analysis

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.

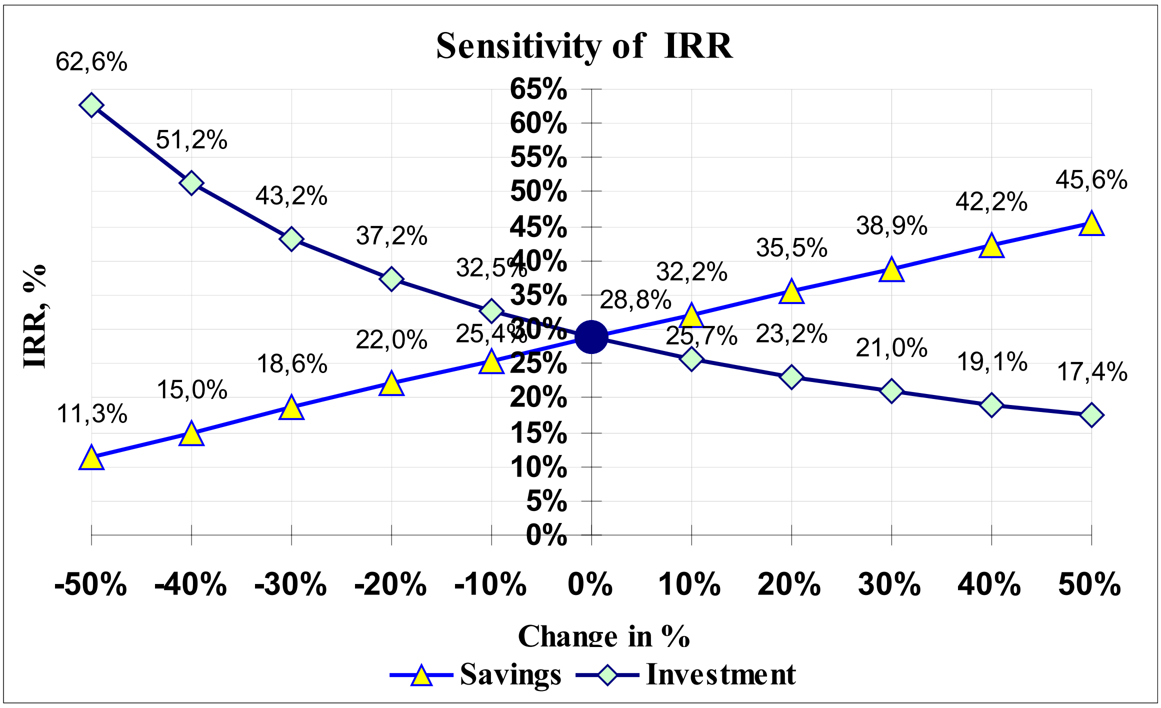
The sensitivity of the Net Present Value (NPV) with respect to the two above-mentioned factors is presented on Fig. 18.

Fig.18. Sensitivity of the Net Present Value of the project



The sensitivity of the Internal Rate of Return (IRR) is presented on Fig. 19.

Fig.19. Sensitivity of the Internal Rate of Return of the project



4.6.7. Other benefits

Besides the indicated savings of energy and costs and the environmental benefits, the implementation of the project will contribute to attaining the desired comfort of habitation for the occupants of the three buildings and will provide the required conditions for highly efficient performance of the employees and students during the cold winter months. The relative share of the expenses for maintenance will be reduced, the reliability of equipment will be increased and there will be an improvement of the management, which is particularly important for any site. The municipality's expenditure for fuel will diminish.

The success of project implementation will contribute to the initiation of other similar projects and in this way it will assist the emergence of a market for the applied technology of efficient use of waste wood biomass. Expansion of the manufacture will lead to reduction of the price of equipment.

4.7. 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 the 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 33. 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 34. 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/implementation unit;

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.

4.8. JI potential of this type of projects

Joint Implementation (JI) is defined in Article 6 of the Kyoto Protocol. JI involves climate change mitigation projects implemented between two Annex I countries and allows for the creation, acquisition and transfer of “emission reduction units” or ERUs. This implies that JI activities can be hosted by any Annex I country. However, in practice JI projects are more likely to be hosted in countries in Central and Eastern Europe, as these countries offer more cost-efficient opportunities for GHG emission reductions.

In order a project to be accepted as a Joint Implementation project, it has to answer a number of requirements. It has to cover the eligibility criteria, the criteria for environmental and economic additionality, the baseline requirements, etc.

4.8.1. Assessment of project's eligibility under JI

Eligible host countries

The Marrakech Accords state that in order to participate in JI or CDM a country needs to be a Party to the Kyoto Protocol by ratifying it. Bulgaria ratified the Protocol in July 2002 and in this way became eligible for the Kyoto mechanisms.

Another requirement for country eligibility is to have a designated national focal point for approving JI projects and to have in place national guidelines and procedures for approving JI projects. The JI Unit and the special Steering Committee established by the Bulgarian Ministry of Environment have developed and adopted rules and criteria for selection and approval of projects as JI projects.

Another eligibility requirement for the host country is to have in place a national registry and to account for its Assigned Amounts. Bulgaria has developed a study on national registries and is planning to establish its registry within the deadline – before 2005.

Eligible project categories

Neither the Kyoto Protocol nor the Marrakech Accords explicitly mention project categories that are eligible for JI. Article 6 of the KP states that emission reductions can be acquired from project activities aimed at reducing GHG emissions in any sector of the economy. However, among the most acceptable examples of eligible project categories for JI and CDM are the installations based on renewable energy sources (wind, solar, biomass, small hydro etc.).

Eligible technologies

No specific performance standards for the project technology apply. However, the project technology introduced should at least have an equal or have a better performance standard than the existing operational technologies in the host country. The efficiency of the proposed technology by the project is demonstrated by the calculated results and technical information provided.

Some investor countries prefer that the technology applied in the project facilitate technology transfer to the host country. In the case of the proposed project in Haskovo and the larger program in a number of Bulgarian municipalities, the technology applied refers to the boilers burning wood and wood waste by both direct combustion and by pyrolysis process. The production of these boilers in the country is in a process of development. There is a gap in the local production as far as pyrolysis boilers with larger capacity are concerned. There is a place for technology transfer in this respect. The investor might consider the possibility to provide similar, but more advanced, technology. Alternatively a decision could be made for the improvement of existing Bulgarian technology.

Eligible project developers

The following types of rganizations can submit JI projects:

- Governmental bodies (i.e. department of government)
- Government agencies (i.e. can be independent from the government)
- Municipalities
- Foundations
- Financial institutions
- Private sector companies
- NGOs

This variety of possible project developers allow for both municipal directed projects (as the Haskovo project is), and also for the other project management schemes proposed in 3.7. for the larger municipal program.

Host country eligibility of the project

The project must be acceptable to the host country and conform to its JI requirements. The proposed project and program fit to the priorities set by the Bulgarian government in its strategic documents on climate change, energy and environment. They also answer the national specific set of criteria for JI projects, the most important of which are feasibility, transparency, simplicity and predictability. It is expected that if the Japanese government decides to start a JI project for Bulgaria, it will go for signing a Memorandum of Understanding with the Bulgarian government, which comprises a formal requirement for project eligibility.

4.8.2. Additionality

Environmental additionality

JI projects have to '*generate emission reductions that are additional to any that would have occurred in the absence of the project activity'*. In order to assess if the project activity results in a reduction of emissions compared to the business as usual scenario, an emission baseline has to be established. The assessment to determine whether the project activity results in less GHG emissions than without the project case is also referred to as 'environmental additionality'.

Environmental additionality can be measured and is a quantitative analysis. It can be assessed by quantifying the difference in GHG emissions between the emission baseline (business as usual scenario) and project emissions (project scenario or project intervention). A project activity is environmentally additional if it generates GHG emission reductions compared to the emission baseline.

The environmental additionality of the project in Haskovo is established as the project generates reductions of GHG emissions compared to the baseline situation, and also reduces the emissions of sulphur oxide, nitrogen oxide and dust emissions. Although the calculated emission reductions are based on pessimistic assumptions, the GHG emission reduction achieved with the pilot project are of substantial quantity. The same statement can be valid for the proposed programme as a whole, as it is developed on the same basis as the pilot project.

Economic additionality

Although the potential of RES in Bulgaria is assessed to be high in numerous studies, the actual utilization of this potential is low. The elaborated National Programme for Renewable Energy Sources (NPRES) includes the agricultural, wood, industrial and household biomass as energy sources. The NPRES comprises concrete investment projects and project proposals for large-scale use of RES. The primary and the secondary set of projects for NPRES consist of about 1000 real investment projects and project proposals.

However, the funds for these projects are not ensured by the state budget or by any other source. No national funds for support to projects related to the utilization of renewable energy sources have been set up as yet. No use is made of the full range of economic tools, which may be used to promote the use of RES, for instance tax reductions etc. As a result, the actual start of large-scale market penetration of RES is still pending. The projects implemented so far have been financed exclusively from external/foreign sources.

In this situation, the initiation of JI projects for RES utilization can be considered additional to the national efforts to reduce the GHG emissions.

On the local level the project can also be claimed as additional, as the main barrier for municipal investments is the initial capital needed. First, municipalities are restricted to invest up to a certain share of their income (which is very low); and Second, the biomass-fired boilers are about 50% more expensive than the traditional liquid fuel fired ones. The Public Procurement Act requires tender selection of equipment, based mainly on the criteria of low price.

Based on these, the project can be considered as economically additional. The project and the portfolio of projects for municipalities as a whole are claimed not to have been implemented without the funding through the JI mechanism.

4.8.3. Baseline methodology selected

The determination of emission reductions requires the specification of a baseline to which reductions would be additional. The selected baseline scenario is project specific and is simulating a likely situation that would have occurred without the project. The project specific baselines are accurate enough on project level, although not perfect.

They are rooted in facts that can in principle be observed at the time of project's design or during its operation.

Based on an analysis of different factors, the project developer made the baseline case that the heat production for municipal public buildings is most likely to continue to use central boilers, fired by fossil fuels, mainly liquid fuels as in the current situation. Although it has been assumed that the present situation will continue, it is also taken into account that the energy efficiency of the old boilers will improve over the project period, mainly by replacing the worn-out boilers by new ones of the same type, but with improved efficiency. This implies that the baseline conditions are dynamic rather than static. A baseline scenario with switch to gas is ruled out due to the fact that many of the projects lie outside the main gas pipeline network, the investments needed would be much higher, and also an increase in gas prices is considered.

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:

- 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.
- 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.
- Application of the most available technologies

4.8.4. Emission reduction potential

Only greenhouse gases (GHG) covered under Annex A of the Kyoto Protocol are eligible for JI projects. These are Carbon dioxide (CO_2), Methane (CH4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6).

The project in Haskovo proposes the use of wood briquettes and waste wood to replace liquid fuel and electricity consumption. This results in savings of these types of fossil energy carriers and leads, in turn, to reduction of harmful 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), to the volume of 4366.3 tonnes CO_2 equiv. 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 emission reductions expected for the wider municipal biomass project include the same GHGases and amount to 502104.3 tonnes CO_2 equiv.

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.

During the actual project design phase the project proponent should contractually agree with the major project participants on the credit sharing, that is to accept an ownership structure of any emission reduction credits that would result from the project. Credit sharing is the concept in which a host country would like to keep a certain percentage of the credits or credit revenue. The host country of a JI project is likely to be interested in credits when it is subject to an emissions reduction target, as is the case with Bulgaria. Individual negotiations will determine how the credits will be shared.

In the case of Bulgaria, where only the government is allowed to trade with emission reductions for now, such an agreement should be signed between the governments of the two countries entering into a JI deal.

Projects starting as of the year 2000 may be eligible as a JI project, but ERUs can only be issued for a crediting period starting after 2008, which implies that emission reductions generated prior to 2008 cannot be transferred or acquired as ERUs.

As stated in the Marrakech Accords it is possible to start JI projects from the year 2000 onwards. However, it is only possible to trade emission reductions as ERUs under the JI mechanism if these are generated in the commitment period from 2008-2012. This implies that emission reductions from a JI project generated prior to 2008, cannot be verified and traded as ERUs.

The emission reductions of the project need to be measurable and need to be validated/ determined and verified by an Operational Entity/Independent Entity.

4.8.5. Side effects

The project does not result in unacceptable negative impacts on the environment. Just the opposite, it has a number of positive side effects:

- Better heat comfort in public buildings - The introduction of relatively cheap waste wood for centralized space heating will improve the heat comfort in the public and social buildings. Although indirectly, this will have a positive effect on the health and healthcare expenses of the residents.
- Improved sanitary conditions of the managed forests and reduced methane emissions of the wood decay - 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.

- New job places are to be created - Utilization of waste wood will create new jobs in heating systems production, installation, operation and maintenance, and also in the activities of waste wood collection and processing, processed waste wood supply in the mountainous and forest regions in Bulgaria which are characterised with very high unemployment rate.

Conclusions

The proposed pilot project in Haskovo and the wider municipal programme answer the key eligibility criteria for JI projects, as included in the Marrakesh Accords and the Kyoto Protocol.

The projects are in conformity with all international and national eligibility 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.

Ⅳ．巻末資料

目　次

BUSINESS PLAN

Pilot Project:

UTILIZATION OF WASTE WOOD FOR CENTRALIZED HEAT SUPPLY TO MUNICIPAL BUILDINGS IN HASKOVO, BULGARIA

Prepared by:

ЕнЕфект
Center for Energy Efficiency

January 2003

This Business Plan has been worked out in the framework of the project *Utilization of Waste Wood for Centralized Heat Supply to Buildings in Bulgaria*, financed by the Japanese Oversees Environmental Cooperation Agency (OECC). The project aims at identifying the potential for and the costs of measures to mitigate GHG emissions in the atmosphere depending on the opportunities for introduction of appropriate technologies in this country. Part of this project comprises also a concrete study through a pilot project for introduction of biomass-fueled boilers in three municipal sites in the city of Haskovo. This Business Plan evaluates the economic indicators and the feasibility of the pilot projects, as well as the project's JI potential.

The objective of the project is reduction of the energy costs of the Municipality for the three sites and achievement of a significant reduction of GHG emissions, emitted in the atmosphere as a consequence of heat generation for space heating of the buildings.

1. Information about the project owner (the borrower)

The owner of the projects and the potential borrower is the Municipality of Haskovo. By its legal status the Municipality of Haskovo is a legal entity and is represented by its Mayor.

MUNICIPALITY OF HASKOVO	
Address:	6300 Haskovo, 1, Obshtinski Square http://www.bulgaria.domino.bg/haskovo
Mayor:	Mr. Georgui Ivanov Tel.: (+359 38) 66 42 10 Fax: (+359 38) 66 41 10 E-mail: haskovo@sf.cit.bg
Contact person:	Yuksal Malkotch, Chief Expert on Energy Systems Tel.: (+359 38) 66 41 76 E-mail: eneffect_hs@mail.orbitel.bg
Taxation No.:	1263053008
Registration to BULSTAT:	000903946 Yu

The Municipality is situated on the area of Haskovo Region in Southern Bulgaria. The municipal center is situated at a distance of 234 km from the capital.

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 traversed 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 local economy is of industrial-agrarian nature. The structure-defining economic sectors are machine tools engineering and metal processing, electrical engineering and electronic industry, clothing, textile and food-and-beverages industries. Also developed are timber logging and wood working industries, fur and leather production and footwear manufacture. Agriculture, for whose development there are quite favorable conditions, is another integral characteristic of the economic structure of the Municipality

The major employment ratios of the Municipality are as follows:

- Material production : the non-productive sphere – 65.1 : 34.9;
- Industry : Agriculture – 87.0 : 13.0.
- Unemployment rate – 14.19%.

The sources of revenue to the municipal budget are equity revenue, subsidies from the state budget and other sources – bank loans, transfers from extra-budgetary accounts etc. The costs for materials, fuels and energy rank on the 3^{rd} place in the expenditure from the municipal budget and amount to about 11% of these. The annual expenditure of the municipality for electricity amounts to approximately BGL 840,000 and that for fuels and heat – to BGL 660,000.

There are branches of several Bulgarian commercial banks operating on the area of the Municipality of Haskovo, namely the United Bulgarian Bank (UBB), DSK Bank, Hebrosbank, Bulgarian Postal Bank, Commercial Bank Biochim, Teximbank and the Central Cooperative Bank.

2. Project description

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 in 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.

2.1. State of repair of the sites

***Vassil Levski* General Secondary School**
2, Stara Planina Str., City of Haskovo

The school was built in 1937. Currently, there are 600 pupils studying in grades 1 through 12. The number of teaching staff is 45. The building is a five-storeyed building with floor area of 8,680m^2 and an unheated basement. There are three distinguished zones: classrooms zone, a gym and an Inter-school Training Center. The Training Center was constructed additionally by the end of the '70s. The building structure is solid, with 38 cm thick brick walls, with plaster on both sides. The windows are twin-glazed with wooden frames. The building features four single-plated entrance doors of wood. The bearing floor slabs are made of reinforced concrete without thermal insulation. An unheated attic is formed above the top floor under the sloped roof.

The conclusion of the audit of the state of repair of the building envelope has revealed that the external plaster of the walls is in a good condition, however the joinery has not been replaced since the initial operation of the building and it is in a very bad state. Many of the windows, mainly those in the corridors and in some of the study rooms, are broken and need repair. The fact that there are single-pane windows is one of the main reasons for the deterioration of the parameters of indoor climate when the outdoor temperatures are low.

A local in-house space heating system, which uses steam as heat carrier, is constructed in the building. During classes the premises are heated all the time. Heat is supplied by a local boiler plant fueled by Light Heating Oil (LHO). The plant provides also domestic hot water, however the domestic hot water supply system has been out of use in the recent years. The boiler house is located in the main body of the building. It comprises three low-pressure boilers type ON 550, featuring heat output of 640 kW each or a total of 1920 kW. The boilers are of Bulgarian make, year of production 1975. The load of the boilers is controlled through a two-step burner at a signal from the steam pressure gauge. There are no metering devices to record heat and fuel consumption by the individual boilers. The efficiency of the boiler house operation itself is deteriorated due to the losses, which are typical for every steam condense system. The lack of automatic control of the operational heat load is a precondition for additional deterioration of the efficiency. In actual fact one of the boilers is out of use, since it is in a bad need of overhaul. The non-operating programmers lead to risks during boiler operation. The duty cycle of the boilers is aligned with the study schedule (the school is working on a single-duty regime – from 7.30 h till 13.00 h). The boilers are switched on at the discretion of the operating staff, who decides also on duty cycle. The boilers are usually in operation since 6.00 h till 10.00 h.

The annual electricity consumption is 37 MWh/year and the related costs amount to BGL 4,694. The main electricity consumer is the lighting system. The share of the other electricity consumers is negligible.

Administrative building of Haskovo Municipality
1, Obshtinski Square, City of Haskovo

This is a four-storeyed building with unheated basement and a floor area of 3,263 m^2. The main part (up to the 3^{rd} floor) was constructed prior to 1944. The 4^{th} floor has been erected later. The building structure is solid with 25 cm thick brick walls, plastered on both sides. The external plaster of the building is in a good condition. The bearing slabs of the floors are made of reinforced concrete without thermal insulation. An unheated attic is formed above the top floor of the building under the roof. There is a large variety of joinery. Originally, it has been a twin wooden joinery on the 1^{st}, 2^{nd} and 3^{rd} floors and bonded wooden joinery on the 4^{th} floor. Part of it has been replaced in stages by aluminum glass package. In the corridors there are metal single-glazed showcases. The joinery that has not yet been replaced, namely that on the 4^{th} floor, is not properly weather-stripped.

The building features and in-house local space heating system using steam as heat carrier. During operation of the building the premises are heated permanently. A local suction ventilation system has been installed for the Conference Room on the 2^{nd} floor. The system is of elementary design, consisting of two suction ventilation grids and a groove fan. Sucked air is exhausted at the building facade. Separation type air conditioners are installed on the windows in part of the rooms and are used mainly during the summer. The total installed capacity is 37.3 kW.

Heat supply is provided by a local boiler plant. The fuel used is Light Heating Oil (LHO). The boiler is of Bulgarian make, model PLAM 350. It generates steam, which is distributed by a collector to the branches of the space heating system. The installed heat generation capacity is 400 kW. The load of the boilers is regulated through a two-step burner METEOR type at a signal from the steam pressure gauge. There are no metering devices to record water, steam and LHO consumption to feed the boiler. The operation of the system with steam as heat carrier is connected with considerable losses of heat along the transit sections and the steam-condense systems. The absence of controls for automatic maintenance of the required heat load leads to additional deterioration of the efficiency. LHO consumption for the burner is 80-100 l/h (60-80 l/h in warmer days). The boiler is switched on at the discretion of the operative staff. The typical duty cycle of the boiler is as follows: 7.00 h – 9.00 (9.30) h; 10.30 (11.00) h - 12.00 h; 13.00 h – 15.00 h.

The annual electricity consumption is 42.960 MWh and the costs amount to BGL 5,780.

The main electricity consumers are the lighting system, the PCs and the household appliances used in the building.

Kiril-i-Metodiy Primary School
37, Strashimir Str., City of Haskovo

The school was built in 1961. It has a student population of 370 pupils in grades 1 through 8 and a teaching staff of 17. The building is a four-stock structure featuring an unheated basement and a floor area of 3,330 m^2. With the aim to expand the existing building stock construction of an additional building, connected to the existing one with a blind wall has begun. For lack of funding the construction works have been suspended. The school operates an after-school study hall, which is located in a separate building in the schoolyard. The main building is of a solid structure with 25cm thick brick walls, with plaster on both sides. The windows are two-wing units with wooden joinery. The school building and the building of the study hall feature two entrance doors each. The doors are single-wing metal units. The bearing slabs between the floors are made of reinforced concrete and have no thermal insulation. An unheated attic is formed under the roof above part of the top heated floor of the school building. The roof of the study hall is flat, bordering directly on the outdoor air. The external cladding of the walls of the main building is in a relatively good state. The building of the study hall is in an extremely bad state of repair. The joinery has not been replaced since the commissioning of the building in regular operation, the quality of weather-stripping of the window wings, which may be opened, is questionable, especially those in the study hall.

The school features a local in-house space heating system, which uses water as heat carrier and is in operation since 1996. During classes the premises are heated permanently. The boiler house is situated in the main school building, however it can supply heat to the study hall as well via an underground pipeline. The required heat is provided by LHO-fueled boiler, type ΤΥΡΟΣ - A250 “GROUP ΣTANDART”, made in Greece and featuring heat output of 290 kW, and a two-step burner type “Golling” (Greece) with automatic two-position regulation of the fuel/air ratio. There are no metering devices to control heat and fuel consumption by the boiler. The programming unit for boiler ventilation during firing and stopping operates as required. The general state of repair of the space heating system is good, there are no leaks and hence no losses of energy and heat carrier. The absence of automatic controls of the operational heat load is a prerequisite for deterioration of the performance efficiency when trying to keep up the requirements for indoor comfort. The boiler is operated between 2 and 5 hours per day, depending on the outdoor temperatures and at the discretion of the operating staff. Usually it is started from 6.00 a.m. till 9.00 a.m. and from 12.30 till 14.00/14.30 h. The teaching process is organized in two shifts and the school building is in use from 7.30 h till 19 h.

The availability of electricity consumers in the *Kiril-i-Metodiy* Primary School is very limited: several PCs, a vacuum cleaner, a coffee-maker and a TV set. The annual electricity consumption is 21.98 MWh or BGL 1,060, the majority of which goes for the lighting system.

2.2. Baseline scenario

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:

1) **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.

2) **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.

3) **Application of the most available technologies**

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 described below. The energy costs are calculated at the price at which Light Heating Oil was offered by the only one Bulgarian manufacturer LUKOIL Bulgaria Ltd. by January 2003 (BGL 1017.6/tonne). The value of the heat equivalent imported with the fuel is BGL 88.10/MWh.

The results from the computerized model of *Vassil Levski* School indicate that the annual quantity of heat required to cover the space heating demand of the building is 373 MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the space heating system, is 516.3 MWh/year. The required annual consumption of Light Heating Oil for heating the school building is 44.7 tonnes. The annual fuel costs amount to BGL 45,486.

The results from the computerized model of the administrative building of Haskovo Municipality indicate that the annual quantity of heat required to cover the space heating demand of the building is 212 MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the space heating system, is 392.7 MWh/year. The required annual consumption of Light Heating Oil for heating the administrative building is 34 tonnes/year. The annual fuel costs amount to BGL 34,597.

The results from the computerized model of the *Kiril-i-Methodiy* School indicate that the annual quantity of heat required to cover the space heating demand of the building is 138 MWh. The annual equivalent of the energy imported with the fuel for heat generation in the quantity required for covering this heat demand, with due consideration of the state of the boiler and space heating system, is 157.3 MWh/year. The required annual consumption of Light Heating Oil for heating the school building is 13.62 tonnes/year. The annual fuel costs for space heating amount to BGL 13,858.

The baseline contains the assumption that the Light Heating Oil is delivered by the only one Bulgarian manufacturer LUKOIL BULGARIA Ltd. with headquarters 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, are reported in the section on Environmental Benefits. The total amount of emissions under the baseline scenario is 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. The baseline scenario envisages implementation of the following rehabilitation measures in the two sites in 2003:

- A new steam boiler, type KPN 0.55 (heat output 639 kW) of Bulgarian make, equipped with a new burner, will be installed in *Vassil Levski* School. This boiler is analogous with the currently operated boilers and uses the same type of fuel. Its price has been determined according to the quotation submitted by the manufacturer. The required funds for maintenance and repair have been envisaged. The second boiler of the currently used ones will be retained. It is also in a bad state of repair, however its service life may be extended through periodical repair at shorter time intervals. The funding required for its maintenance is, however, respectively higher.

- A new LHO-fired steam boiler, type KPN 0.35 (heat output 407 kW) of Bulgarian make, equipped with a new burner, will be installed in the administrative building of the Municipality. These pieces of equipment are analogous with the currently operated ones. Their prices have been determined according to the quotation submitted by the manufacturer. The required funds for maintenance and repair have been envisaged.

In *Kiril-i-Metodiy* School the existing boiler will be retained. Funds for maintenance and repair have been envisaged in order to maintain the norm requirements for indoor comfort.

All costs for maintenance, repair and rehabilitation with the aim to ensure operation of the existing equipment in the course of 15 years, as mentioned above, are reflected in the cashflow of the project. The total amount of these funds within this time span is BGL 104,290. Table 2.2.1 shows the envisaged distribution of the funds by sites.

The maintenance and repair comprises actions related to: replacement of the seal and the burner inlet to the boiler; (partial) replacement of a piping bundle; repair of the muffle; cleaning of the flue gases pipes; cleaning of the piping bundle from the outside – chemical degreasing; repair of the shell; replacement of the mineral wool insulation; level metering glass, master switches and ampoules.

Table 2.2.1 Costs of repair and rehabilitation of existing equipment

Year	Vassil Levski School		Administrative building of the municipality	Kiril-i-Metodiy School	Total
Boiler:	KPN 0.55	ON 550	KPN 0.35	TYPOS A-250	
2004	15250	3400	12940	400	31990
2005	400	2100	400	2000	4900
2006	400	900	900	1300	3500
2007	900	2000	400	700	4000
2008	2000	900	2500	400	5800
2009	900	1300	400	400	3000
2010	1300	3500	1800	2000	8600
2011	900	400	800	400	2500
2012	400	1300	900	2700	5300
2013	2500	2000	2000	400	6900
2014	400	1800	900	400	3500
2015	1800	3100	2300	2000	9200
2016	400	2500	900	400	4200
2017	900	400	400	700	2400
2018	2000	2300	2900	1300	8500
Total	58 350		30 440	15 500	104 290

2.3. Measures to reduce energy costs and GHG emissions (Project Intervention)

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. On the Bulgarian market this kind of boilers, type SD, are offered by ERATO HOLDING Joint-stock Company with headquarters in Haskovo. Currently, a new series of boilers is being developed and is expected to come out on the market soon. Their capacity range – from 100 kW to 700 kW – will be very convenient for the needs of municipal sites. 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.

Although pyrolysis-based boilers are more efficient, their use in this site is unfeasible, because of the high demand capacity of 700 kW. The pyrolysis-based boilers manufactured by the ERATO HOLDING JsC Haskovo feature rated capacity of up to 100 kW. Therefore, at least 7 of these should be installed, however the available space in the building is not sufficient. The boilers proposed by this project have the advantage that they are fueled by waste wood and may be equipped with a system for automatic fuel charging.

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, which ensures high efficiency of combustion (up to 89%) with fully automatic control of the process. The site does not have a suitable site for fuel storage. The subscription system for delivery of biomass, proposed by the Erato Resource Company, Haskovo, will be used for this site as well. The annual consumption of wood briquettes to meet the building demand is about 29 t.

3. 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 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 3.1 Project costs

Activity	Total BGL
***Vassil Levski* School**	
Project design	2 000
Delivery of solid-fraction biomass-fueled boilers, 2 x 350 kW	107 525
Dismounting of old boilers	5 400
Installation, commissioning and tuning of biomass-fueled boilers	9 120
Replacement of pipeline network pipe 1.1/4” pipe 1/2” pipe 2”	4 060 450 645
Delivery and installation of expansion vessel 400 l	506
Circulation pumps GRUNDFOS UPS 32-80	708
Construction of a connection between the boiler house and part of the building, including pipes, elbows, collectors	7 000
Construction of fuel storage yard	4 000
Delivery of a system for automatic fuel charging	43 010
Installation and commissioning of the system for automatic fuel charging	9 360
TOTAL *Vassil Levski* School	**193 784**
Administrative building of Haskovo Municipality	
Project design	2 000
Biomass-fueled pyrolysis-based boiler, 2 X 100kW	18 738
Dismounting of old boilers	1 800
Installation, commissioning and tuning of the biomass-fueled boilers	3 500
Replacement of pipeline network pipe 1.1/4” pipe 1/2”	789 246
Delivery and installation of expansion vessel 150 l	190
Construction of connection between the boiler house and part of the building – pipes, elbows, collectors	7 000
Construction of fuel storage yard	2 000
TOTAL: Administrative building of Haskovo Municipality	**36 265**
***Kiril-i-Metodiy* School**	
Project design	2 000
Biomass-fueled boiler, 3 X 80 kW	16 930
Dismounting of old boilers	1 800
Installation, commissioning and tuning of biomass-fueled boilers	3 510
Construction of connection between the boiler house and part of the building – pipes, elbows, collectors	2 000

Construction of fuel storage yard	2 000
TOTAL: *Kiril-i-Metodiy* School	**28 240**
SUM TOTAL for the three sites:	
Investment costs	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**

4. 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.

Vassil Levski School

Savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. Due to the shift from steam boilers to water heating boilers, heat losses from non-returned condensate, secondary evaporation, additional cooling of the condensate in the condense tank and lack of insulation on the pipelines network, which have been estimated to be 83.6 MWh/year, will be eliminated. The energy to be imported with the fuel is 432.7 MWh/year. Upon the shift to biomass as fuel, at a price of BGL 35/t for delivery under subscription of waste wood, sizes up to 10 mm x 10 mm x 40 mm with calorific value 10.7 MJ/kg (0.00296 MWh/kg), the cost of 1 MWh generated heat will be BGL 11.82/MWh. The annual savings from the application of the measure amount to BGL 40,370.

Administrative building of Haskovo Municipality

In this case savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. Due to the shift from steam boilers to water heating boilers, heat losses from non-returned condensate, secondary evaporation, additional cooling of the condensate in the condense tank and lack of insulation on the pipelines network, which have been estimated to be 49.4 MWh/year, will be eliminated. The energy to be imported with the fuel is 343.3 MWh/year. Upon the shift to biomass as fuel, at a price of BGL 190/t for delivery under subscription of waste wood briquettes with calorific value 19.7 MJ/kg (0.00547 MWh/kg), the price of 1 MWh generated heat will be BGL 34.73/MWh. The annual savings from the application of the measure amount to BGL 22,672.

Kiril-i-Metodiy School

In this case savings are expected as a result of the difference in the cost of 1 MWh heat generated from the use of LHO and from biomass. The energy to be imported with the fuel is 157.3 MWh/year. Upon the shift to biomass (solid fraction) as fuel, at a price of BGL 190/t for delivery under subscription of waste wood briquettes with calorific value 19.7 MJ/kg (0.00547 MWh/kg), the price of 1 MWh generated heat will be BGL 34.73/MWh. The annual savings from the application of the measure amount to BGL 8,394.

A summary of the estimated savings by sites is given in Table 4.1.

Table 4.1 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**

5. Environmental benefits

5.1. Reduction of GHG emissions

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 reduction of GHG emissions in the atmosphere. Greenhouse gases have a negative anthropogenic impact on the climatic system. Increased concentrations of stable greenhouse gases might reduce the speed of radiation of solar energy back to space, which may lead to climate change.

CO_2 emissions from the energy sector account for the major portion of GHG emissions in Bulgaria. The ways to reduce GHG emissions comprise savings in liquid fuel and electricity consumption or fuel shift – from a traditional fuel to another, more environmentally-friendly type of fuel, for instance biomass. 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 (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 will be achieved. The specific quantities and types of avoided emissions are given in Table 5.1.

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 are included in the project boundary.

For evaluation of the impact of the projects emission, reductions are calculated in Carbon Dioxide Equivalent (CO_2eqv), which summarized the impact of all types of GHGs.

Table 5.1 presents also the value of CO_2eqv saved for the life of the project. The costs for emissions reduction of 1t CO_2eqv are BGL 62.36/tonne, compared to the project investment cost. The costs for emissions reduction of 1t CO_2eqv, 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.

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 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.

Table 5.1. Reduction of GHG emissions

Project year			0	1	2	3	4	…	15	Lifetime
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**…**	**2018**	**15 years**
Item	**Dimension**	**Value**								**tonnes CO_2eq**
Baseline Scenario								…		
LHO delivery								…		
Road transport Burgas – Haskovo	Km	206						…		
Truck with a tank 22 m^3	Numbers	5						…		
Total LHO delivery by road	Km/year	1030						…		
Specific liquid fuel consumption for the truck	Liter/100 km	60						…		
Total liquid fuel consumption for trucks	Liters/year	618						…		
Emissions from Total LHO delivery by road	Tonnes CO_2eqv/year		1.6	1.6	1.6	1.6	1.6	…	1.6	
LHO combustion on sites	Tonnes/year	92								
Emission factor CO_2eqv	Kg CO_2eqv/MWh	268						…		
LHO combustion on sites	MWh/year	1066						…		
Emissions from LHO combustion on sites	Tonnes CO_2eqv/year		286.0	286.0	286.0	286.0	286.0	…	286.0	
Electricity consumption by existing boilers										
Existing boilers capacity	KW	1976						…		
Existing boilers electricity consumption	KWh/year		17194.2	17194.2	17194.2	17194.2	17194.2	…	17194.2	
Electricity emission factor CO_2eqv	G CO_2eq/kWh		787.5	787.5	787.5	787.5	1012.5	…	1012.5	
Emissions from electricity for boilers	Tonnes CO_2eqv/year		13.5	13.5	13.5	13.5	17.4	…	17.4	
Total Baseline Scenario	**tonnes CO_2eqv/year**		**301.2**	**301.2**	**301.2**	**301.2**	**305.0**	…	**305.0**	**4563.7**
								…		

Project year			0	1	2	3	4	…	15	Lifetime
Year			**2003**	**2004**	**2005**	**2006**	**2007**	**…**	**2018**	**15 years**
Item	**Dimension**	**Value**								**tonnes CO_2eq**
JI Scenario								…		
Wood briquettes production								…		
Specific electricity consumption for wood briquettes production	kWh/tonne	26.4						…		
Wood briquettes demand for 3 sites	tonnes/year	91.5						…		
Electricity consumption for wood briquettes production to cover the demand of the 3 sites	kWh/year		2416.1	2416.1	2416.1	2416.1	2416.1	…	2416.1	
Electricity emission factor CO_2eqv	g CO_2eqv/kWh		2.4	2.4	2.4	2.4	2.4	…	2.4	
Wood briquettes & wood waste delivery, road transport								…		
Wood briquettes & wood waste delivery	liters/year	95.1						…		
Emissions from road transport for Wood briquettes & wood waste delivery	tonnes CO_2eqv/year		0.251	0.251	0.251	0.251	0.251	…	0.251	
Wood briquettes & wood waste combustion								…		
Combustion of wood briquettes & wood waste on sites	tonnes/year	237.7						…		
Emission factor CH_4	kg/MWh	0.072						…		
Emission factor CO_2eqv	kg CO_2eqv/MWh	1.512						…		
Combustion of wood briquettes & wood waste on sites	MWh/year	933.3						…		
Emissions from combustion of wood briquettes & wood waste on sites	tonnes CO_2eqv/year		1.411	1.411	1.411	1.411	1.411	…	1.411	
Electricity consumption by new boilers								…		
New wood-fueled boilers capacity	KW	1088.1						…		
New wood-fueled boilers electricity consumption	kWh/year		9466.5	9466.5	9466.5	9466.5	9466.5	…	9466.5	
Emission factor CO_2eq	g CO_2eqv/kWh		787.5	787.5	787.5	787.5	1012.5	…	1012.5	
Emissions from electricity for wood-fueled boilers	tonnes CO_2eqv/year		7.5	7.5	7.5	7.5	9.6	…	9.6	
Total JI Scenario	**tonnes CO_2eqv/year**		**11.020**	**11.020**	**11.020**	**11.020**	**13.693**	**…**	**13.693**	**197.4**
Difference = (JI - Baseline) Scenario	tonnes CO_2eqv/year		-290.1	-290.1	-290.1	-290.1	-291.3	…	-291.3	
Cumulative avoided emissions	tonnes CO_2eqv			-290.1	-580.3	-870.4	-1161.7	…	-4366.3	**-4366.3**

5.2. Other environmental benefits from project implementation

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. Table 6.2 shows the reduction of harmful emissions of local importance for the project life cycle of 15 years as a result of the fuel shift from LHO to wood briquettes and waste wood.

Table 5.2 Reduction of harmful emissions of local importance

Emissions by type	Unit	Baseline	JI scenario	Emissions reduction (JI scenario – Baseline)
SO_x emissions	tonnes	24.3	0	-24.5
NO_x emissions	tonnes	5.8	5.06	-0.7
CO emissions	tonnes	0.69	19.25	18.6
NMVOS emissions	tonnes	0.079	0	-80.5

Some increase in CO could be expected.

6. Project implementation

6.1. Time schedule of project implementation

The implementation of the proposed measures will be effected on the basis of specific project design. Table 7.1 below shows the time schedule for project implementation by types of activities.

Table 6.1 Implementation schedule

Activity	Month				
	1	2	3	4	5
Tenders, contracting, planning, project design					
***Vassil Levski* School**					
Delivery of biomass-fueled boilers					
Delivery of pipes, fixtures, collectors					
Delivery of a system for automatic fuel charging					
Delivery of expansion vessels and circulation pumps					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of biomass-fueled boilers					
Installation of pipes, fixtures, collectors					
Installation of expansion vessels and circulation pumps					
Installation of a system for automatic fuel charging					
Construction of fuel storage yard					
Administrative building					
Delivery of pyrolysis boilers					

Delivery of pipes, fixtures, collectors					
Delivery of expansion vessel					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of pyrolysis boilers					
Installation of pipes, fixtures, collectors					
Installation of expansion vessels and circulation pumps					
Construction of fuel storage yard					
Kiril-i-Metodiy School					
Delivery of pyrolysis boilers					
Delivery of pipes, fixtures, collectors					
Delivery of materials for construction of fuel storage yard					
Dismounting of old boilers / Installation of pyrolysis boilers					
Installation of pipes, fixtures, collectors					
Construction of fuel storage yard					
Acceptance and commissioning into regular operation – all sites					

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.

6.2. Procedures related to purchase of the equipment

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. The terms and conditions of the tender will comprise the requirement for the equipment supplier to undertake also the dismounting and installation works on the site. The existence on the area of the city proper of a company possessing capacity and experience in the trade in and manufacture of technologies for energy generation from biomass is a guarantee for the real possibilities for high-quality project implementation.

Table 6.2 shows the schedule of investments in the course of project implementation.

Table 6.2 Time schedule of investments

Activity	Month				
	1	2	3	4	5
Tenders, contracting, planning, project design	3600		3000		

***Vassil Levski* School**					
Delivery of biomass-fueled boilers		53763		53762	
Delivery of pipes, fixtures, collectors			9374		
Delivery of a system for automatic fuel charging		21505		21505	
Delivery of expansion vessels and circulation pumps			971		
Delivery of materials for construction of fuel storage yard		800	1200		
Dismounting of old boilers / Installation of biomass-fueled boilers				9048	5472
Installation of pipes and fixtures				1391	1390
Installation of expansion vessels and circulation pumps				243	
Installation of a system for automatic fuel charging				3744	5616
Construction of fuel storage yard			800	1200	
Administrative building					
Delivery of pyrolysis-based boilers			9369	9369	
Delivery of pipes, fixtures, collectors			2431	3647	
Delivery of an expansion vessel			152		
Delivery of materials for construction of fuel storage yard			400	600	
Dismounting of old boilers / Installation of pyrolysis-based boilers				3201	2101
Installation of pipes and fixtures				979	978
Installation of the expansion vessel				38	
Construction of the fuel storage yard				400	600
***Kiril-I-Metodiy* School**					
Delivery of pyrolysis-based boilers			8465	8465	
Delivery of pipes, fixtures, collectors			600	900	
Delivery of materials for construction of fuel storage yard			400	600	
Dismounting of old boilers / Installation of pyrolysis-based boilers				3204	2106
Installation of pipes and fixtures				500	
Construction of the fuel storage yard				400	600
Acceptance and commissioning in regular operation – all sites					500
Total	3600	76068	37162	123196	19363
Cumulative total	3600	79668	116830	240026	259389

6.3. Procedures for fuel selection

A tender will be held for selection of fuel supplier. In two of the sites – the Administrative Building of Haskovo Municipality and *Kiril-i-Metodiy* School there is a problem – lack of platforms for fuel storage. For this reason for these sites a tender will be announced for fuel supply under subscription under a two-week delivery schedule. In Haskovo this kind of service is offered by the Erato Resource Company for both wood briquettes and small-size wood waste.

7. Financial plan of the project

7.1. Sources of funding and funding requirements

The equipment required for the project has been calculated in the Financial Plan on the basis of the prices and official quotations submitted by the ERATO HOLDING JsC with headquarters in Haskovo and one of the most stable manufacturers of this kind of equipment on the Bulgarian market. The price of the biomass fuel has been determined on the basis of a quotation of the Erato Resource Company, including for subscription deliveries. The total amount of investment is BGL 272,300, including V.A.T. The Financial Plan envisages **loan capital** to the amount of BGL 182,100, 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 3,559. Thus the total contribution of the borrower to project financing accounts for 34% of the total project costs.

Table 7.1 shows the structure of investment funding and the proposed financial scheme.

Table 7.1 Financial Plan

		BGL	%
Expenses			
	Primary investment	259 389	94.0
	Reserve	12 911	4.7
	Interest for the time of implementation	3 559	1.3
	Payments on loan principal during implementation	0	0.0
	Operational costs	0	0.0
	Expenses total	**275 859**	**100**
Capital structure			
	Loan	182 100	66.0
	Equity capital	93 759	34.0
	Investments total	**275 859**	**100**
Financing scheme			
	Amount of required loan	**182 100**	**66.0**
	Borrower's contribution		
	Investment	*90 200*	*96.2*
	Interest during implementation	*3 559*	*3.8*
	Additional current assets requirements during implementation	*0*	*0*
	Borrower's contribution total	**93 759**	**34.0**
	Grand total	**275 859**	**100**

7.2. Investment scheme

The funding from the different sources is shown in Table 7.2. This scheme is aligned with the project implementation schedule and the proposed financing scheme. The contribution of the Municipality comprises also the funding for pay-off of the interest during the project implementation period to the amount of BGL 3,559.

Table 7.2 Investment scheme

MONTHS	May	June	July	August	September	Reserve	Total
Source	1	2	3	4	5		BGL
Bank			26630	123195	19364	12911	182100
Municipality	3600	76068	10898	1507	1686		93759
TOTAL	**3600**	**76068**	**37528**	**124702**	**21050**	**12911**	**275859**

7.3. Pay-off plan

The proposed loan terms and conditions envisage as follows:

- Date of loan endorsement: July 1, 2003
- Four years pay-off term;
- Three months of grace on loan principal during project implementation;
- Forty eight monthly installments for pay-off on loan principal;
- Fifty one monthly installments for pay-off of interest.

The proposed plan with the concrete values of the monthly pay-off installments is shown in Table 7.3.

Table 7.3 Pay-off plan

Project year	Pay-off installments during the year												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Year 1													
Payment of interest	1686	1651	1616	1581	1545	1510	1475	1440	1405	1370	1335	1300	17913
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	5480	5445	5409	5374	5339	5304	5269	5234	5199	5164	5128	5093	63438
Balance on loan principal	**178306**	**174513**	**170719**	**166925**	**163131**	**159338**	**155544**	**151750**	**147956**	**144163**	**140369**	**136575**	**1889288**
Year 2													
Payment of interest	1264	1229	1194	1159	1124	1089	1054	1019	983	948	913	878	12855
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	5058	5023	4988	4953	4918	4883	4847	4812	4777	4742	4707	4672	58380
Balance on loan principal	**132781**	**128988**	**125194**	**121400**	**117606**	**113813**	**110019**	**106225**	**102431**	**98638**	**94844**	**91050**	**1342988**
Year 3													
Payment of interest	843	808	773	738	702	667	632	597	562	527	492	457	7797
Payment on loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment total	4637	4602	4566	4531	4496	4461	4426	4391	4356	4321	4285	4250	53322
Balance on loan principal	**87256**	**83463**	**79669**	**75875**	**72081**	**68288**	**64494**	**60700**	**56906**	**53113**	**49319**	**45525**	**796688**
Year 4													
Payment of interest	421	386	351	316	281	246	211	176	140	105	70	35	2740
Payment of loan principal	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	3794	45525
Monthly installment	4215	4180	4145	4110	4075	4040	4004	3969	3934	3899	3864	3829	48265

total													
Balance on loan principal	**41731**	**37938**	**34144**	**30350**	**26556**	**22763**	**18969**	**15175**	**11381**	**7588**	**3794**	**0**	**250388**

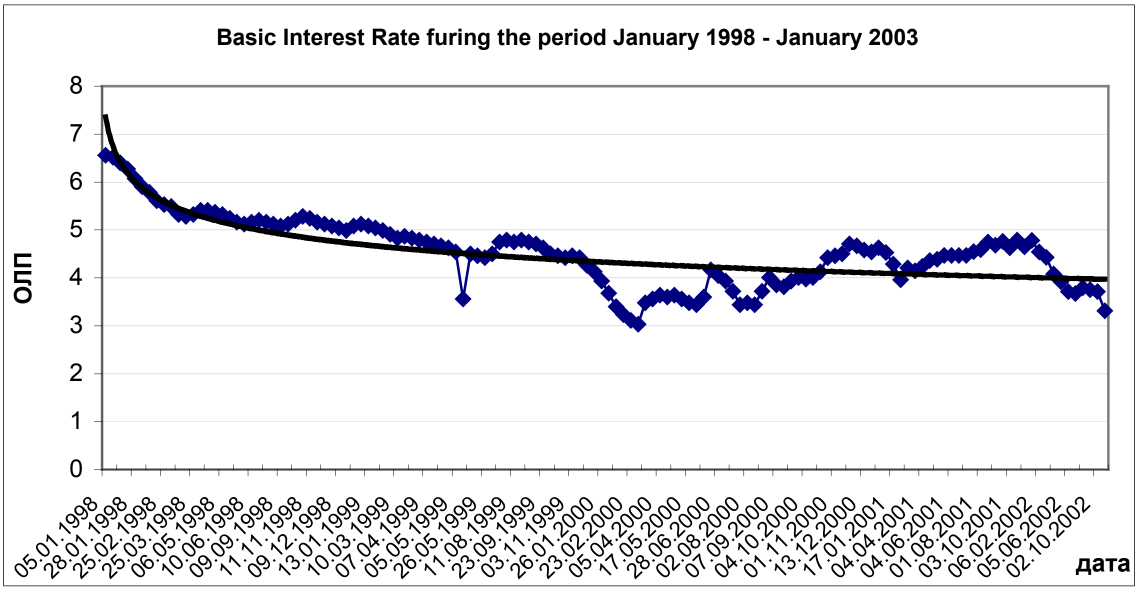
8. Macro-economic forecasts

8.1. Interest levels

The basic interest rate for mid-January 2002 was 3.31%. For the recent 4 years (since January 1999) it has never exceeded 5%, its minimum value being 3.03%. One the basis of the analysis of the monthly values of the basic interest rate during the period January 1, 1998 – January 15, 2003, as well as of the trend based on the phased approximation function, no evidence was found that the development of the trend of the basic interest rate value for the period covered by the Business Plan may exceed the 5% level.

The preliminary studies for procurement of bank loan indicate that it is possible to negotiate a loan with a floating interest rate to the amount of the basic interest rate plus a bank surcharge of about 10%. On the basis of the above, an interest rate level of 15% has been assumed for the main version of the project, and in the Sensitivity Analysis section some comments are given on the impact of the basic interest rate on the project. The changes of the basic interest rate for the past five years are shown in Fig. 8.1.

Fig. 8.1 Changes in the basic interest rate from January 1998 till January 2003.

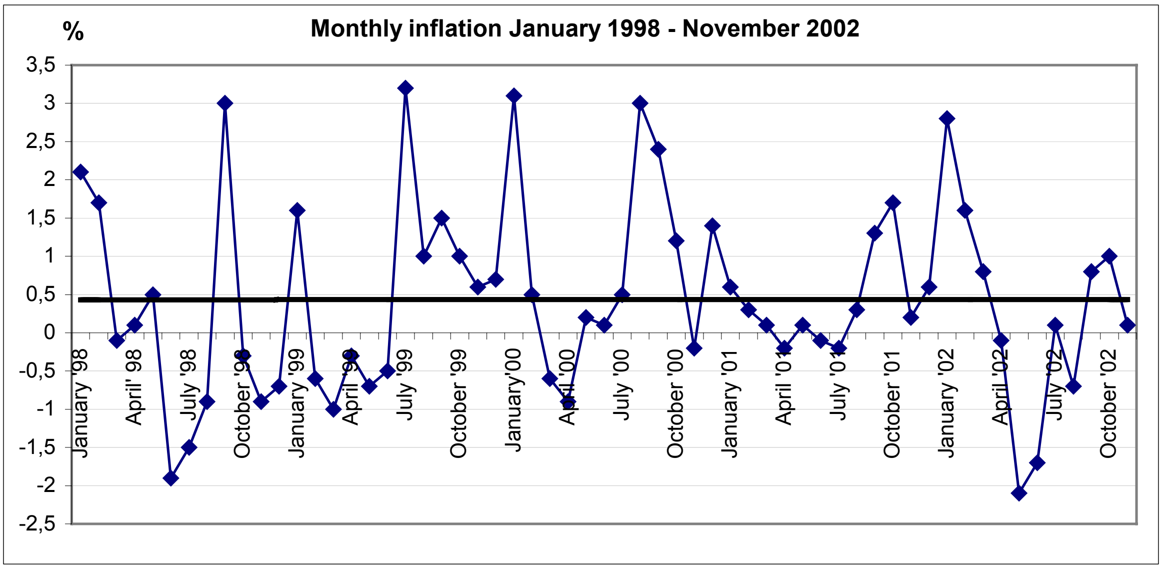


8.2. Inflation

The mean annual inflation in Bulgaria in 2002 was 3.8%. The analysis of the development of inflation may be made on the basis of the data for the recent five years. Its bottom level during this period was 1.0 % (in 1998) and the maximum of 11.4% was recorded in 2002. Making forecasts about the annual inflation rate on the basis of a longer retrospective period would be unfeasible, since the trend is thwarted because of the hyperinflation in 1996-1997. The relatively short retrospective period of 5 years does not provide for sufficiently accurate presumption concerning the trends in development of inflation. More accurate idea may be obtained by following the changes in the monthly value of inflation during this period. This graph is shown on Fig. 8.2. It indicates that during the period under review the value of monthly inflation is about 0.4 – 0.45%, which makes an annual inflation rate in the range of 4.8 – 5.4 %.

For the purposes of this Business Plan an annual inflation rate of 4% has been used, which is close to the rate for the preceding year (3.8%). According to our expectations, the annual inflation rates during the coming years will not exceed the forecast inflation rate of 4.2% for 2003. The maximum inflation rate for the EU for the current year is expected to be not more than 3.8%.

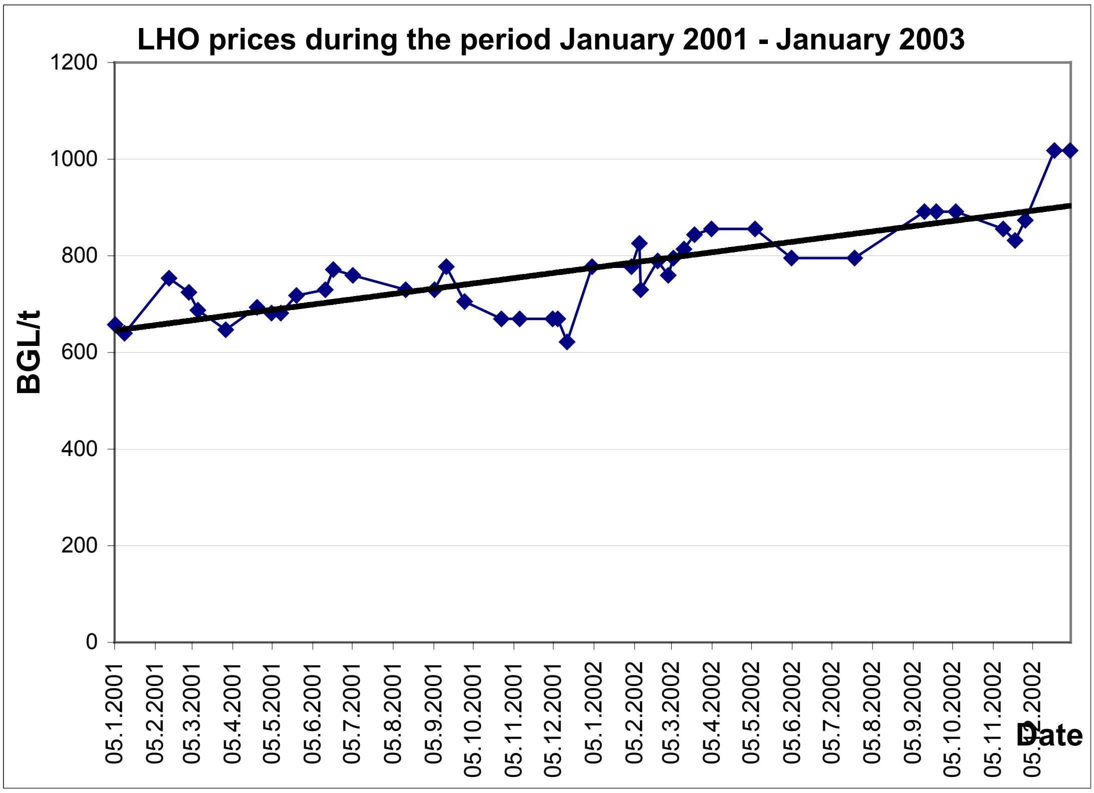
Fig. 8.2 Changes in the basic interest rate from January 1998 till January 2003



9.3. Light Heating Oil (LHO) Price

The fluctuations of LUCKOIL Neftochim price of LHO for a period of two years have been studied. The price of 1t of fuel by January 17, 2003 was BGL 1017.6 incl. V.A.T. The minimum LHO price during the period under review (BGL 621.6/t) was recorded in December 2001. The changes in the LHO price during the part two years are presented in Fig. 9.3.

Fig. 9.3 Changes in LHO prices from January 2001 till January 2003



The analysis of the reviewed statistical data shows that there are frequent periods of change in price levels, both in the direction of price increase and in the direction of price decrease, however during the 2-year period under review a trend of gradual increase has been noted. Because of the unstable political situation in the Middle East one may expect a rise in the price of oil products and persistence of this trend.

8.4. Prices of fuels from waste wood

Waste wood is a residual product from timber logging and woodworking industries. The use of biomass for energy generation is as yet extremely limited in Bulgaria. The preliminary estimates indicate that there are considerable volumes of primary fuel of this type in this country. There is, however, no system for collection and processing of the bulk of biomass, predetermined to a considerable extent by the limited demand of this product by the end-users. Market studies have shown that the price of bulk waste biomass in the form of wood waste, chips and sawdust is about BGL 25/t to BGL 40/t. The prices of the wood briquettes offered on the market are between BGL 150 and BGL 190/t.

In the years to come, more severe rules for discharge and storage of wood waste will be introduced and the enterprises will be subject to stricter environmental control and more severe administrative sanctions. This will force enterprises to make use of the waste wood, produced by their activities, or to seek for ways and means to dispose of it. At this background one may expect that there will be no big increase in the price of wood waste biomass.

9. Cashflow analysis

9.1. General provisions

The main factor which generates the project cashflow are the savings resulting from the difference between the prices of LHO and the wood waste biomass fuels and the changes in their ratio during the project lifetime. It is hard to predict how this ratio will change in the future. Both diminishing of the difference and increase of the difference is possible. For this reason the baseline scenario assumes retention of the ratio between the prices during the entire project lifetime, and the options of any change in this ratio are reviewed in the risk and sensitivity analysis.

The project scenario presumes reserves with respect to the investment costs to the amount of 5%. These means are envisaged to cover additional costs incurred as a result of emergence of changes in the values of the technical, pricing and other assumptions of the project.

The elaborated cashflow comprises the funds required for current maintenance of the new equipment and the necessary repairs during the envisaged 15 years economic life cycle of the project. On the other hand, in order to be able to use the old pieces of equipment during this time, additional expenses will be needed for maintenance and repair, and these will be far beyond those for the new equipment. These expenses are also taken into account in the cashflow.

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 CO_2eqv, 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.

9.2. Financial indicators of the project

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 (Re. to Item 8).

The specific values from the cash flow analysis, the Simple Payback Period, the Internal Rate of Return and the Net Present Value are shown in Table 9.1. The project cashflow by years is illustrated in Table 9.2.

Table 9.1 Cost-effectiveness of the project

Rated 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 51,150 has been envisaged for maintenance and repair during that period. The avoided investment costs for replacement of the entirely worn-out equipment is BGL 27,120. The avoided costs, which would have been spent for repair and maintenance of the existing boilers, amount to BGL 25,750.

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 in this report (Table 7.1).

Table 9.2. Cashflow of the project Use of Biomass for Space Heating in Municipal Sites in the city of Haskovo

Years	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Investment	**272300**	**-27120**														
Financing:																
Loan	182100															
Equity funds	90200															
Baseline scenario																
Operation costs		93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941	93941
Maintenance and repair costs		4600	4900	3500	4000	5800	3000	8600	2500	5300	6900	3500	9200	4200	2400	8500
After project completion																
Operation costs		22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504	22504
Maintenance and repair costs		900	900	900	900	900	3400	1600	24400	3400	1600	1600	3400	1600	1600	3400
Net savings	**-272300**	**102657**	**75437**	**74037**	**74537**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Debt servicing – interest and charges	3559	17913	12855	7797	2740											
Depreciation																
Revenue before taxation		**84744**	**62582**	**66240**	**71797**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Tax																
Fiscal preferences																
Net revenue after taxation		**84744**	**62582**	**66240**	**71797**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Debt servicing – loan principal		45525	45525	45525	45525											
Net cashflow	**-93759**	**39219**	**17057**	**20715**	**26272**	**76337**	**71037**	**78437**	**49537**	**73337**	**76737**	**73337**	**77237**	**74037**	**72237**	**76537**
Cumulative cashflow	-93759	-54540	-37483	-16769	9504	85841	156878	235315	284852	358189	434926	508263	585500	659537	731774	808311
Discount rate	1	0,90	0,81	0,73	0,66	0,59	0,53	0,48	0,43	0,39	0,35	0,31	0,28	0,25	0,23	0,21
Present Value (PV)	-93759	35297	13816	15101	17237	45076	37752	37516	21324	28412	26757	23014	21814	18819	16526	15758
Cumulative Present Value (PV)	-93759	-58462	-44646	-29545	-12308	32769	70521	108037	129361	157773	184530	207544	229358	248177	264702	280461

10. 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
- Operational risk
- Price risk

10.1. Risk of non-completion of the project

This risk comprises two main components:

- Exceeding the budget
- Delayed commissioning of the system

Some of the reasons for exceeding the budget may be inaccurate assessment of the investments and omission of equipment that is indispensable for the project. The project is insured against this risk through the incorporation of incidental expenses to the amount of 5% of the total amount of investments. In view of the fact that the selection of the supplier and subcontrator will be conducted by means of tender, lower prices may be expected. The maximum possible exceeding of the envisaged investments is estimated to be 5%. Table 10.1 shows the changes in the major financial indicators of the scenario of exceeding of the budget.

Table 10.1 Financial indicators of the scenario of exceeding of the budget

Indicator	Dimension	Value
Internal Rate of Return	%	27.20
Change	%	-1.60
Net Present Value	BGL	263 255
Change	BGL	-13 615
Payback Period	years	3.50
Change	years	+0.17

Delayed commissioning of the systems may occur as a result of inaccurate assessment of the time needed for project implementation or delays in the delivery and installation of the equipment. The anticipated maximum delay is 1 month. The changes in the financial parameters in this case are shown in Table 10.2.

Table 10.2 Financial indicators of the scenario of delayed commissioning

Indicator	Dimension	Value
Internal Rate of Return	%	28.14
Change	%	-0.66
Net Present Value	BGL	270 540
Change	BGL	-6 300
Payback Period	years	3.41
Change	years	+0.07

10.2. Operational risk

This risk is reduced to the minimum, since the combustion systems of the boilers, as well as the system for fuel charging of the boiler in *Vassil Levski* School are fully automated and the human factor is, generally speaking, eliminated. The risk of failure to procure the required quantities of wood has been avoided by signing a contract for deliveries under subscription. The risk analysis reviews the probability that the estimated net savings, determined on the basis of the assessments in the energy audits of the three sites, may not be achieved to the same level in actual life due to wrong operation. The value of this risk is 5%.

The changes in the financial indicators with respect to this risk are shown in Table 10.3.

Table 10.3 Financial indicators of the scenario of diminished savings during operation

Indicator	Dimension	Value
Internal Rate of Return	%	27.12
Change	%	-1.68
Net Present Value	BGL	249 383
Change	BGL	-27 457
Payback Period	years	3.51
Change	years	+0.18

10.3. Price risk

In the framework of this project the price risk exists mainly with respect to the ratio of fuel prices.

The calculations for the project have been made using the price of LHO quoted in the Price List of LUCKOIL Neftochim by January 2003. It will be realistic to expect that the price at which the fuel is delivered to the Municipality of Haskovo will be higher. On the other hand, the price of the biomass has been determined on the basis of a real quotation for Free Project Site delivery. Therefore, there is an additional reserve against this risk as early as at the point of working out of the Business Plan. For this reason the risk of diminishing of the difference between the prices of LHO and biomass is minimal and has been assumed at the level of 10%.

Table 10.4 Financial indicators of the scenario of risk of diminishing of the difference between fuel prices

Indicator	Dimension	Value
Internal Rate of Return	%	25.43
Change	%	-3.37
Net Present Value	BGL	221 926
Change	BGL	-54 914
Payback Period	years	3.70
Change	years	+0.37

10.4. Worst case scenario

Under this 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.

Table 10.5 Financial indicators of the worst case scenario

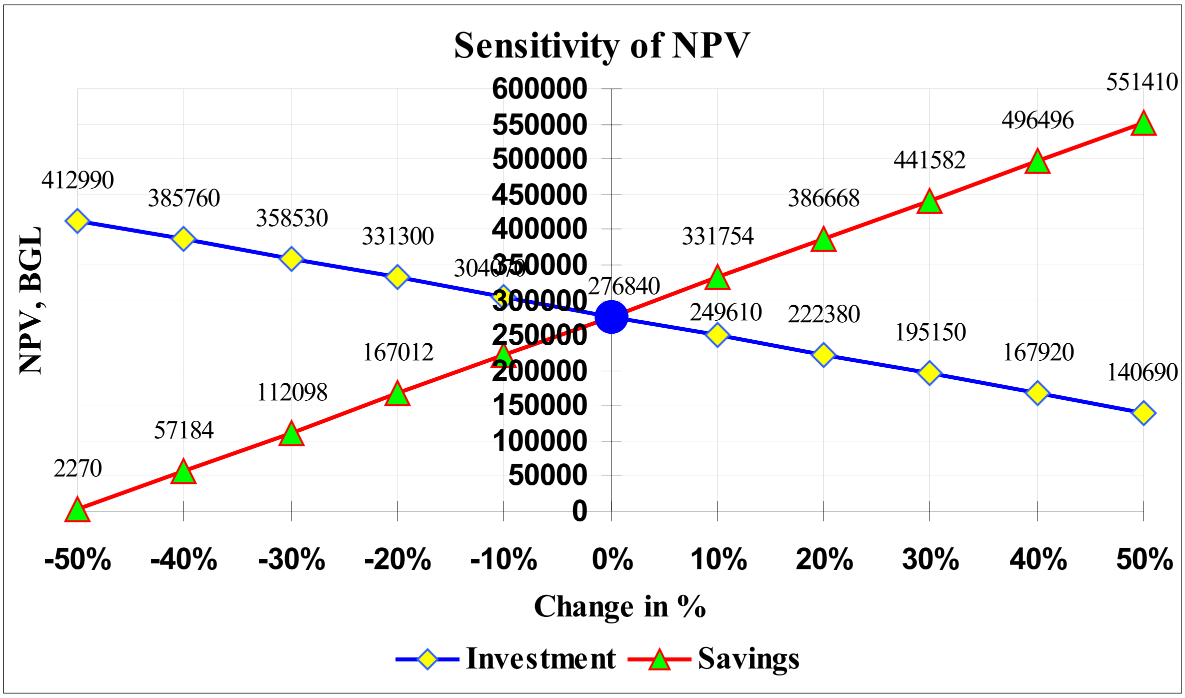
Indicator	Dimension	Value
Internal Rate of Return	%	23.41
Change	%	-5.40
Net Present Value	BGL	202 011
Change	BGL	-74 829
Payback Period	years	3.98
Change	Years	+0.65

10.5. Sensitivity analysis

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.

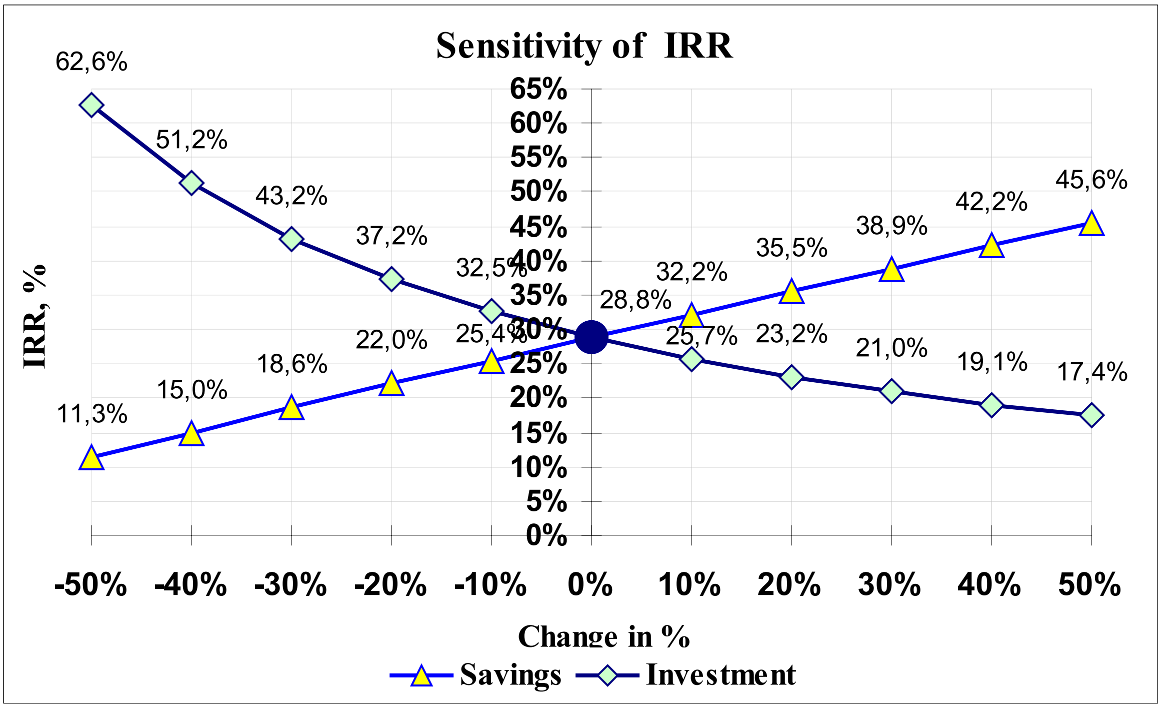
The sensitivity of the Net Present Value (NPV) with respect to the two above-mentioned factors is presented on Fig. 10.1.

Fig. 10.1 Sensitivity of the Net Present Value of the project



The sensitivity of the Internal Rate of Return (IRR) is presented on Fig. 10.2.

Fig. 10.2 Sensitivity of the Internal Rate of Return of the project



11. Other benefits

Besides the indicated savings of energy and costs and the environmental benefits, the implementation of the project will contribute to attaining the desired comfort of habitation for the occupants of the three buildings and will provide the required conditions for highly efficient performance of the employees and students during the cold winter months. The relative share of the expenses for maintenance will be reduced, the reliability of equipment will be increased and there will be an improvement of the management, which is particularly important for any site. The municipality's expenditure for fuel will diminish.

The success of project implementation will contribute to the initiation of other similar projects and in this way it will assist the emergence of a market for the applied technology of efficient use of waste wood biomass. Expansion of the manufacture will lead to reduction of the price of equipment.

WELCOME TO

EnEffect

What is EnEffect?

Status. The Center for Energy Efficiency EnEffect is a non-profit NGO, initially established in 1992 in Sofia. Its establishment has been called forth by the acute need of energy conservation throughout society - in households, industry, transport, construction, agriculture and the energy sector. By its active involvement in activities to improve energy efficiency, the Center supports the efforts of central and local authorities in Bulgaria to attain sustainable development.

Establishment. EnEffect has been founded with the initial financial support of Battelle/Pacific Northwest National Laboratory, USA, in collaboration with the US Environmental Protection Agency, the US Department of Energy and the US Agency for International Development.

Sponsors. The projects developed by EnEffect are funded by US, European, international and Bulgarian organizations. The US Agency for International Development, the Commission of the European Communities, the United Nations, and the Global Environment Facility are sponsors of significant projects implemented by EnEffect.

Staff. EnEffect employs highly skilled professionals in the field of economics and finance, thermal engineering and electrical engineering, architecture and construction, etc. Members of the management bodies of the Center are senior officials and experts from Bulgaria and abroad, renowned for their professional skills, public status and personal authority.

What are EnEffect's objectives?

The principal objectives of the Center are as follows:

- to contribute to the formation of energy conservation policy at all management levels in Bulgaria as a means to achieving economic and environmental benefits for the country;
- to assist the process of institutional development and capacity building in Bulgaria as a prerequisite for the initiation, development and implementation of energy efficiency programs;
- to assist the development of a local market and promote local manufacture of energy-saving materials, products and services;
- to assist technology transfer and exchange of experience and information on energy efficiency.

What are EnEffect's priorities?

The major priorities in the activities of the Center are as follows:

- investigation of the energy efficiency potential in various sectors of the national economy and the environmental impact of energy conservation;
- overcoming of the barriers to energy conservation in Bulgaria and introduction of incentives for energy savings;
- development and management of demonstration and investment projects for energy conservation;
- elaboration of local/municipal energy efficiency programs;
- provision of education and training in the field of energy conservation and rational use of energy;
- collection, processing and distribution of information on energy efficiency.

Who are EnEffect's major partners?

In Bulgaria EnEffect works in close collaboration with state bodies responsible for the energy conservation policies of the country, with local authorities, research and educational centres and NGOs. Among these groups are: the Ministry of Environment and Water Resourses, the National Energy Efficiency Agency, the Ministry of Industry, the Committee of Energy, the Ministry of Regional Development and Urban Planning, the Committee of Standardization and Metrology, the Technical Universities of Sofia and Gabrovo, the University of Architecture, Building Construction and Geodesy, the European Energy Centre, the Black Sea Regional Energy Centre, the Municipality of Gabrovo, etc.

EnEffect's partners abroad are: UNDP and the Global Environment Facility (New York), the US Agency for International Development, Battelle/PNNL and Electrotek Concepts, Inc. (USA), the UN Economic Commission for Europe (Geneva), the Regional Environmental Center for Central and Eastern Europe (Szentendre, Hungary), the World Resources Institute (Washington D.C.), the Dutch Agency for Energy and Environment (Novem), the Dutch Gas Technology Institute GASTEC, the European Association "Energie Cites" (Besancon, France), the "Energy Saving International" (ENSI) consultancy company (Norway), etc.

EnEffect - part of national and international Networks

EnEffect is part of a network of energy efficiency centres which includes the Polish Energy Efficiency Foundation (FEWE) with its branch offices in Katovitze, Krakow and Warsaw, the Czech Centre for Energy Efficiency (SEVEn) in Prague, the Russian Centre for Energy Efficiency (CENEf) in Moscow, the Chinese Centre for Energy Efficiency and Renewable Energy Sources (BECon) in Beijing and the Centre for Energy Efficiency of Ukraine (ArenaECO) in Kiev. Although only a few years old, these organizations exert influence on the energy policies of their respective countries, assisting technology transfer and exchange of information for supply- and demand-side energy efficiency improvements.

EnEffect has been assigned to serve as the Secretariat for the Municipal Energy Efficiency Network EcoEnergy which presently has a membership of 26

Bulgarian municipalities. EnEffect and the Municipal Energy Efficiency Network in Bulgaria exchange information with the European network "Energie cites". Preparations are underway to convert EnEffect into a centre for dissemination of information among the energy efficiency demonstration zones in South-Eastern Europe in the framework of international programs.

EnEffect is acting as a secreatriat of the Regional Network for Efficient Use of Energy and Water Resources in Southeast Europe (RENEUER). Municipalities, NGOs and companies from Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Macedonia, Moldova, Romania and Slovenia are members of the network.

Membership: Association of Energy Engineers (AEE-Bulgaria), Bulgarian-Japanese Centre for Energy Efficiency in Industry, Bulgarian National Committee for Industrial Energy Engineering, Technical Committee 43 on Refrigeration and Cryogenic Technology at the Committee on Standardization and Metrology of the Republic of Bulgaria, CoGen Europe, etc. EnEffect is registered under No. CCR BUL-18528 in the list of organizations which are licensed to take part in projects launched under the PHARE Program.

Most important projects of EnEffect

Capacity for Climate Protection	
Bulgarian Case Study for National Registry under the Kyoto Protocol (OECD) (2000-2001)	Development of a national registry in Bulgaria: Options and Recommendations
Climate Change Vocabulary (Royal Netherlands Embassy in Bulgaria, MATRA KAP Fund, 2002)	A vocabulary of the specific terms and abbreviations relevant to the UNFCCC and the Kyoto Protocol with translation and explanation in Bulgarian language
Capacity for Climate Protection in Central and Eastern Europe (REC/WRI) (1999-2002)	• JI and its Pilot Phase in Bulgaria • Survey on Capacity for National Systems for the Kyoto Protocol under Article 5, 7 and 8 • Good Practices in Policies and Measures to Mitigate GHG Emissions. Local Policies and Measures for Energy Efficiency • Public Access to Information and Participation in Climate Related Decision Making in Bulgaria
Dutch-Bulgarian Workshop “Capacity Building for Joint Implementation in Central and Eastern Europe” (NOVEM) (October 19-20, 1998)	Organisation of the workshop, presentations.
International Conference “Joint Implementation of Climate	Organisation of the conference, presentations.

Technology Initiatives” (UNDP/USAID/MOEW) (Sofia, 1995)	
Energy Efficiency Policies and Measures to Mitigate Climate Change	
Energy Efficiency Strategy to Mitigate GHG Emissions. Energy Efficiency Demonstration Zone in the City of Gabrovo, Republic of Bulgaria (GEF/UNDP) (1998-2004)	• Municipal Energy Efficiency • Training and Education • Overcoming Financial Barriers • Energy Efficiency Improvement of the Street Lighting System in the City of Gabrovo • Energy Efficiency Renovation of District Heating and Heating End-Use in the City of Gabrovo • Energy Efficiency Retrofit of Existing Buildings in the City of Gabrovo: a school building, a residential building, an industrial building
Regional Network for Efficient Use of Energy and Water Resources in Southeast Europe (RENEUER) (UNECE/USAID/ASE) (2000-2003)	EnEffect is initiator of the RENEUER network and is acting as its secretariat. Municipalities, NGOs and companies from Albania, Bulgaria, Bosnia and Herzegovina, Croatia, Macedonia, Moldova, Romania and Slovenia are members of the network.
Municipal Network for Energy Efficiency (MUNEE) (USAID/ASE) (2000-2003)	Municipal Network for Energy Efficiency (MUNEE) in the countries of Central and Southeastern Europe, the Balkans, the Central Asian Republics, Russia, and the former Soviet Union. The energy efficiency network is designed to provide a more conducive environment for sustainable development and enhanced economic growth at the municipal level.
SCORE Programme in Bulgaria (NOVEM) (2000)	SCORE Country Document - fact-finding and analysis of the present situation regarding energy efficiency and environmental policies, study on the institutional setting of energy efficiency and related environmental issues.
Municipal Energy Efficiency Initiative (USAID/Electrotek Concepts Inc.) (1998-1999)	• Municipal Energy Efficiency Network • Energy Efficiency Retrofit of the Regional Hospital in Gabrovo • Energy Efficiency Retrofit of the Regional Hospital in Stara Zagora
Energy Efficiency in the Building Sector in Bulgaria (Battelle/PNNL) (1995-1997)	• Energy Efficiency Potential in the Building Sector in Bulgaria • Energy Efficiency Policy for the Bulgarian Building Sector

	• Incentive Programs for Energy Efficiency in Buildings

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FAX: +359 2 963 25 74
E-mail: eneffect@mail.orbitel.bg
Internet: http://www.eneffect.bg

HASKOVO

District	*Haskovo*
Population	*100,124 inhabitants*

Municipality of Haskovo

Address

6300 Haskovo
1, Obshtinski Square
Tel. (038) 25 045
Fax (038) 33 740
e-mail: city@haskovo.spnet.net
bulgaria.domino.bg/haskovo

Mayor

Georgui Ivanov
Tel. (038) 66 42 10
Fax (038) 66 41 10

Deputy Mayors

Kostadin Kalakov
Education and Culture
Tel. (038) 66 41 90

Myumyun Iskender
Agrarian policy, economic activities and protection of consumers
Tel. (038) 23 061

Secreatry

Ivan Popov
Tel. *(038) 66 41 70*

Chairman of the Municipal Council

Ilian Vassilev
Tel. (038) 66 41 11

RESOURCES

GEOGRAPHIC LOCATION AND NATURAL RESOURCES

The municipality is situated on the area of Haskovo District in Southern Bulgaria. The municipal center is situated at a distance of 234 km from the capital. The total area of the municipality is 740 km^2. On the territory of the municipality there are 37,488 ha arable land and 15,503 ha forest areas, predominantly deciduous species.

The relief is flat (in the northern end) and undulating (in the southern end).

The area of the municipality is traversed by the river Harmanliyska.

HASKOVO

CLIMATIC CHARACTERISTICS

The climate is transient continental with hot summers (23.6° mean July temperature and 41.8°absolute maximum) and relatively mild winters (0.2° mean January temperature and -25.5° absolute minimum). The mean annual temperature is 12.5°.

The mean annual precipitation rate is 668 mm with marked winter maximum and summer minimum. Northeastern and northern winds predominate.

STATE OF THE ENVIRONMENT

The state of the various environmental components (air, water, soils, etc.) depends on the development of the industrial manufactures, sources of community nature (households) and traffic. The municipality features relatively good environmental conditions. The implementation of a project for construction of a wastewater treatment plant in Haskovo is underway. It is designed to treat industrial and household wastewater discharged in the river Harmanliyska and via it - into the river Maritsa (Category III wastewater discharge reservoir).

TRANSPORT CONNECTIONS

Railroads Sofia-Svilengrad-Istanbul and Rousse-Podkova.

Class A roads I-8 (E-80) and I-5 Rousse-Haskovo-the frontier; Class B road II-66; project design for a highway.

European corridors No. 4 and 9.

Airport.

POPULATION AND HUMAN SETTLEMENTS

The Municipality of Haskovo comprises 37 human settlements, including one city - the city of Haskovo. The population of the municipality is 100,124 inhabitants, including 78.9% urban population and 21.1% rural population (1999).

BUILDING STOCK

Total number of dwellings in the municipality: 38,703, including 4.01% state-owned, 1.65% institutional, 0.12% public and 94.23% privately-owned (1999).

Residential floor area 1,641,704 m^2, 387 dwellings/1000 occupants, 16.40 m^2 floor area/occupant.

The structure of dwellings according to their construction method is as follows: steel concrete large-panel buildings 23.44%, steel concrete skeleton buildings 18.65%, solid frame buildings 56.12% and shanty buildings 10.65%.

Residential stock: panel apartment blocks, solid frame low-rise multifamily residential buildings, detached houses.

ECONOMY

CHARACTERISTICS OF LOCAL ECONOMY

The economy of the municipality is of industrial-agrarian nature. The structure-defining sectors are machine tools engineering, metal processing, electrotechnical engineering and electronics, clothing, textile and food and beverages industries. Wood-logging and wood-working industry, fur and leather industry and shoe-making are also developed. There are favorable conditions for development of agriculture and it complements the economic structure of the municipality.

STRUCTURE OF EMPLOYMENT

The principal employment ratios in the municipality are as follows: material production : non-productive sphere 65.1 : 34.9; industry : agriculture 87.0 : 13.0. The unemployment level is 14.19%.

BANKS

UBB, DSK Bank, Hebrosbank, Bulgarian Postal Bank, Commercial Bank Biochim, Teximbank, Central Co-operative Bank.

MUNICIPAL BUDGET

The sources of income of the municipal budget are equity revenue, subsidies from the state budget and other sources (revenue balance, transfer from extra-budgetary accounts etc.).

DEVELOPMENT PRIORITIES

STRATEGIC PROGRAMS OF THE MUNICIPALITY

- Regional Development Strategy and Program of Action of Haskovo Municipality for the Period 2000-2006
- Municipal Energy Efficiency Program

DEVELOPMENT PRIORITIES OF THE MUNICIPALITY

- Enrichment of the industrial structure by modern competitive manufactures
- Expansion of the market and institutional infrastructure
- Development of public services
- Development of agriculture

MEMBERSHIP IN NATIONAL AND INTERNATIONAL ORGANIZATIONS, PARTNERSHIPS

National Association of Municipalities in the Republic of Bulgaria
Maritsa Regional Association of Municipalities
Municipal Energy Efficiency Network *EcoEnergy*

HASKOVO

ENERGY EFFICIENCY

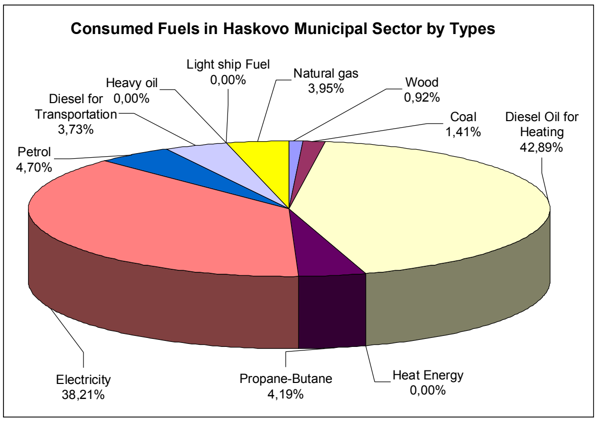
ENERGY SUPPLY

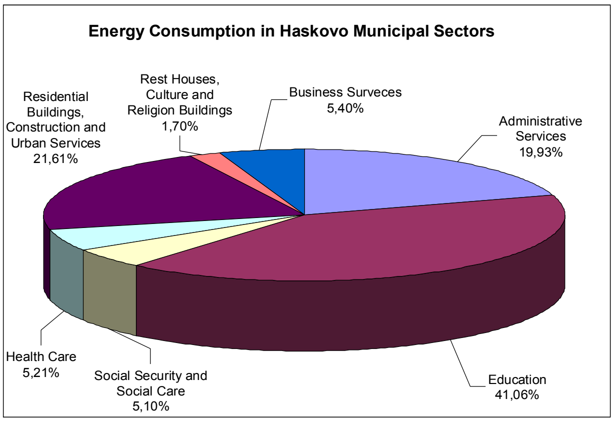
Electricity distribution enterprise: *Electrorazpredelenie* Plovdiv SPJsC, Haskovo Branch
Gas distribution company: *Gasagroterm*

ENERGY CONSUMPTION

Main energy carriers used locally: diesel oil for heating (43%), electricity (38%), natural gas (4%), propane-butane (4%), wood and coal (2%).

Energy consumption by municipal sectors: education (41%), residential buildings, construction and urban services (22%) and administrative services (20%) account for the largest share.





MUNICIPAL ENERGY EFFICIENCY PROGRAM

A municipal energy efficiency program was elaborated in the beginning of 2002. It was accepted by the Municipal council in May 2002. The main objectives of the program are diminishing of energy costs paid from the municipal budget, improvement of the quality of municipal energy services, in compliance with the regulatory requirements for illumination level and temperature levels in municipal buildings and aimed at reduction of GHG emissions.

ENERGY EFFICIENCY PROJECTS

Energy efficiency retrofit of students hostels, Block 1.

MUNICIPAL ENERGY EFFICIENCY OFFICE

The municipal energy efficiency office was officially inaugurated on 4 May 2001.
Municipal energy efficiency officer: Yuxel Malkoch.
Contact address:
6300 Haskovo
1, Obshtinski Square
Tel. (038) 66 41 76
Fax (038) 66 41 10
E-mail: eneffect_hs@mail.orbitel.bg

COMPANY INFORMATION

BACKGROUND

Energy Institute is a joint-stock company dedicated to providing science and technology-based solutions in the field of energy, environmental protection and climate change. To carry out its mission, the **Institute** implements a wide program for scientific research, technology development, designing and consulting services.

Energy Institute is created during the privatization of the previously state-owned company Energoproekt PLC. The founders of the Institute - experts with unique background and rich experience in the research and engineering activities of former Energoproekt PLC - decided to establish a new company oriented mainly to providing scientific, designing and consulting services in the field of energy and environment.

PERSONNEL

The educational background of the company officers is mainly in mechanical and electrical engineering, and environmental-related disciplines. Most of the officers have scientific degrees and honors, and during the last decades have worked as senior research associates and heads of departments in Energoproekt PLC.

Energy Institute's staff is working practically in all fields of the energy and power sector, such as energy and power planning, nuclear power, thermal power and co-generation, electricity, heat and natural gas transmission and distribution networks, energy efficiency, development of renewable energy, and climate change.

The founders and the personnel of the **Institute** have vast experience in research, survey and design activities gained in the restructuring, privatization and rehabilitation of the Bulgarian energy sector that have taken place in the last decades. They have worked on many programs and projects supported or financed by various foreign institutions such as EU PHARE program, US Trade and Development Program, WANO; banks like The World Bank, EBRD, and the US Exim Bank. Various multilateral activities and tasks are completed in collaboration with world wide-known companies like Westinghouse, BELGATOM, EdF, ENEL, Tractabel, Siemens, Bechtel - USA, AEA Technology - UK, POWERGEN - UK, IVO - Finland.

ACTIVITIES OF THE COMPANY

The specific activities offered by the **Institute's** divisions are listed below.

Electric Energy

The division is specialized in consulting and engineering services in the areas of high, medium and low voltage transmission and distribution systems. The division carries out energy and electric power systems analyses and planning, preliminary studies, feasibility studies and conceptual and detailed designing of substations, power plant switch yards and auxiliaries, overhead transmission lines, urban networks, automation, control and remote control, as well as development of tender documentation and assessment of tenders, equipment selection and work supervision of projects in Bulgaria and abroad. The energy efficiency and environmental policy analysis, energy system environmental impact assessment, climate change, greenhouse gas emissions inventories, greenhouse gas mitigation policy and measures and emissions projections and approximation of Bulgaria energy and environmental legislation to the EC legislation complement the Division profile.

A unit within this division has been established to carry out research, analysis and consultancy in climate change related matters. This unit has been entirely responsible for the preparation of the First, Second and Third National Communications on Climate Change, as well as for compiling and submitting of the National Greenhouse Gases Inventories for the years 1988, 1990 – 1999. In addition, the unit advises the Governmental officials on national policies and measures for reducing GHG emissions in compliance with the international treaties; and has developed the National Action Plan on Climate Change approved by the Bulgarian government in 2000. The criteria for assessing JI projects in Bulgaria were also developed with the help from the Institute's experts. Several in-depth reviews of other countries' National Communications and GHG Inventories were carried out by experts of the Institute.

Thermal Energy and Fossil Fuels

The main areas of its activities have been studies and design work for thermal power projects (electric and co-generation thermal power plants, thermal power systems, and boiler plants). Activities cover feasibility studies, technical and detailed design, consultancy, assistance and expert support, project management and general construction services, planning, technical and economic evaluations and budget estimation, organization of operations and maintenance, equipment qualification analysis, assessment of rest lifetime, quality assurance, on-site supervision and commissioning, acceptance testing and start-up.

Nuclear Energy

It carries out study and design of nuclear power plants and research nuclear reactors, conducts different research studies; provides the Bulgarian Nuclear Regulatory Authority with technical support, and delivers technical support for the modernization program of Kozloduy NPP. The main activities and functions are:

- Feasibility studies.
- Development of concepts and strategies for the nuclear energy sector.
- Development and implementation of nuclear facilities modernization program.
- Technical assistance to the Bulgarian Committee for Peaceful Use of Nuclear Energy.
- Regulations and standards development.
- Implementation of programs for modernization of NPP "Kozlodouy".
- Design of equipment and systems for NPP.
- Project management and delivery of consultancy and expert advice.
- Research and analysis in the field of NPP safety.
- Implementation of thermo-hydraulic and emergency analyses.

Hydro Energy

At present the Hydro Energy Division efforts are directed at promoting utilization of the country hydro potential through construction of small and micro hydro power plants. The Hydro Energy Division's main priority is to consult engineers specializing in all aspects of water resources development. The division carried out technical and economic studies, master plans, feasibility reports, preparation of designs and contract documents, supervision of construction, erection and commissioning on site for schemes for mini and micro hydro plants in Bulgaria and abroad.

High-tech Services

The relevant activities of the division cover:

- Development of hardware and software projects for technological process control.
- Implementation of digital control systems.
- Service of digital control systems (in operation).
- Implementation of optimization procedures and regimes for equipment and facilities in energy sector.
- Before and after repairing tests of energy facilities (units, boilers, turbines).
- Development and implementation of water chemistry regimes in power plants.

QUALITY MANAGEMENT SYSTEM

There is a quality management system (QMS) implemented in the Institute, which is part of the general management strategy of the company. The system is developed in accordance with the requirements of the Bulgarian State Standard (BDS) EN ISO 9001:2001 – an approved Bulgarian standard based on ISO 9001:2000 (pertaining to the requirements for membership of the Bulgarian State in the European Committee for Standardization). The QMS in the Institute has been awarded an internationally-recognized certificate for compliance with ISO 9001:2000 issued by UKAS QM, UK; DAR, Germany and RvA, Netherlands.

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Energy Institute, 20 Joliot – Curie Blvd, Sofia 1113, Bulgaria
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Annex 2

Information on boilers for utilization of wood and wood wastes

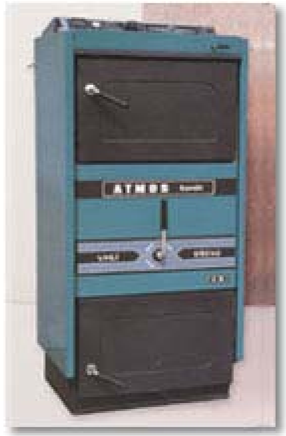
Pyrolysis Boilers:

Atmos Kombi -	models C18S, C20S, C30S, C40S, C80S
Atmos -	models DC18S, DC22S, DC25S, DC25GS, DC32S, DC32GS, DC40GS, DC50S, DC80, DC100
Ling -	model 25D

Regular (non-pyrolysis) boilers:

Carborobot	
Atmos -	models D15P and D20P
Dakon DOR - DOR32,	models DOR12, DOR16, DOR20, DOR24, DOR25M, DOR32D, DOR45D
Ling -	model 25
Viadrus -	model U22
SD -	model 300

ATMOS Kombi



These steel boilers are designed to burn brown coal and wood. The burning utilizes the principle of releasing gas by **PYROLYSIS DISTILLATION**, inputting air by fan and combustion in ceramic burning chamber.

There are two mechanisms for regulation:

- electro-mechanical – models C 18 S, C 20 S, C 30 S, C 40 S.
- electro-mechanical with thermostat for the exhaust gases – models C 80 S.

ADVANTAGES

- Revolving cast-iron piece allows for removal of the dust during operation and sustenance of power for long time period.
- Burning process takes place at high temperature, which allows the gas to be released.
- The air that is need for the burning is supplied by means of exhaust gases fan.
- The placing of the cast-iron piece remains the same regardless of whether wood or coal are being burned.
- The larger fuel bunker ensures the utilization of brown coal and wood logs with maximum length of 330-530 mm, depending of the boiler type model. Large waste wood pieces can also be burned.

TECHNICAL SPECIFICATIONS

Code	Model	Thermal Power [kW]	Capacity of burning chamber [dm3]	Efficiency Coefficient [%]	Maximum Wood Length [mm]	Fuel Consumption [kg/h]	Recomm. Fuel	Weight [kg]	Length [mm]	Height [mm]	Width [mm]
00296	C 18 S	10-20	65	81-85	330	4,5	dry wood with caloricity 15-18 [MJ/kg] coal with caloricity 17-20 [MJ/kg]	220	848	1120	590
00297	C 20 S	12-24	100	81-84	330	6,5		292	845	1360	590
00298	C 30 S	15-30	125	81-83	430	7,3		330	945	1360	590
00299	C 40 S	20-40	150	86-87	530	10		370	1045	1360	590
00300	C 80 S	40-80	300	86-90	530	7,3		620	1130	1590	980

ATMOS

The steel boilers from the Atmos line are designed for central heating of small and medium-size household and workshop buildings. They utilize the **PYROLYSIS BURNING** of wood and wood wastes which ensures high efficiency of the burning process.
The boilers are manufactured in two versions:

- Normal type - **ATMOS DC**, models from 18 S to 100.
- Generator type - **ATMOS DC**, models from 25 GS to 40 GS.

and can feature two regulation mechanisms:

- Electro-mechanical – models DC 18S, 22S, 25S, 32S; DC 25GS, 32GS.
- Electronic – models DC 40GS; DC 50S, 70S, 80, 100.

ADVANTAGES:

- Automatic regulation of the burning process.
- Possibility for burning of wood logs.
- Ceramic burning chamber.
- High efficiency and low emissions of pollutants.
- Low condensation at small operational temperature (model G).
- Easy to supervise and service.
- Model S features flue gas fan.

TECHNICAL SPECIFICATIONS

Code	**Model**	**Thermal Power [kW]**	**Burning Chamber Capacity [dm3]**	**Efficiency Coefficient [%]**	**Maximum Wood Length [mm]**	**Fuel Consumption [kg/h]**	**Fuel Consumption per season [m3]**	**Recomm. Fuel**	**Weight [kg]**	**Length [mm]**	**Height [mm]**	**Width [mm]**
00335	DC18S	10-20	66	80-89	350	3,8	15		243	845	1120	590
00336	DC22S	10-22	100	80-89	550	5,6	18		275	1045	1120	590
00337	DC25S	12-25	100	80-89	550	6,5	21	dry wood	280	1045	1120	590
00332	DC25GS	12-25	130	80-89	550	6,3	21	with caloricity	380	1045	1200	680
00338	DC32S	14-32	140	80-89	550	7,2	29	15-18 [MJ/kg]	320	1045	1200	680
00333	DC32GS	14-32	130	80-89	550	7,2	29	or	380	1045	1200	680
00334	DC40GS	20-40	170	80-89	550	10	35	wood	433	1045	1350	680
00339	DC50S	25-48	180	80-89	750	13	45	briquettes	380	1245	1200	680
00340	DC80	35-70	180	80-89	750	18	70		450	1060	1320	680
00341	DC100	50-99	400	82-90	750	26	85		780	1180	1590	980

LING 25 D

The steel Ling 25 D is designed for central heating of small household or workshop buildings (cottages, single-family houses, mountain huts, small motels, wood workshops and others). It utilizes the **PYROLYSIS BURNING** of wood and wood wastes which ensures high efficiency of the burning process and is very environmentally-friendly. The boiler is own production of the holding “Erato” JSC from the City of Haskovo, Bulgaria.

ADVANTAGES

- Automatic regulation of the burning process.
- Possibility for burning of wood logs.
- Ceramic burning chamber.
- High temperature in the burning process.
- High efficiency and low emissions of pollutants.
- Low condensation at small operational temperature.
- Easy to supervise and service.

TECHNICAL SPECIFICATIONS

Code	**Thermal Power [kW]**	**Bunker Capacity [dm3]**	**Efficiency Coefficient [%]**	**Maximum Wood Length [mm]**	**Water Capacity [l]**	**Fan Power [W]**	**Maximum Work Pressure [MPa]**	**Exhausting Power [Pa]**	**Weight [kg]**	**Length [mm]**	**Height [mm]**	**Wight [mm]**
00390	10-25	0,100	80-85	380	70	37	0,25	15-20	240	745	1095	685

CARBOROBOT

This steel boiler delivers automatic, un-interrupted and regulated heating for buildings, schools, hospitals, workshops and greenhouses. The larger coal bunker makes it possible - depending on the required temperature - to store fuel supply for several days run. As long as the bunker is full, the boiler does not need supervision and service. The cinder is removed when the bunker gets re-filled. Depending on the quality of the coal, the boiler operates for 2-5 days without secondary re-supply of fuel, which practically means that the kindle takes place one time per season. The discharge of soot and carbon dioxide is minimal. As a whole, the boiler is economical and environmentally-friendly.

ADVANTAGES

- Fully automatic control, by means of embedded or space thermostat the necessary temperature is provided, no possibility for overheating.
- Self-regulated, does not require qualified supervision, does not depend on the quality of the coal and is not influenced by the weather changes.
- Very good burning parameters, the optimal efficiency coefficient is similar to the boilers running on gas or industrial oil

TECHNICAL SPECIFICATIONS

Code	Model	Coal Consumption max [kg/h]	Capacity/weight of the fuel in the bunker [m3/kg]	Operational Pressure [MPa]	Water Temperature input/output [°C]	Water Capacity [l]	Thermal Power [kW]	Weight [kg]	Efficiency Coefficient [%]	Length [mm]	Height [mm]	Width [mm]
00391	PV 40	10	0.3 / 400	2	70 / 90	90	40	500	80-86	1470	1750	740
00392	PV 80	20	0.4 / 500	2	70 / 90	110	70	700	80-86	2080	1950	920
00393	PV 140	34	0.6 / 850	2.4	70 / 90	350	130	1100	80-86	2280	2100	1120
00394	PV 180	44	0.8 / 1100	2.4	70 / 90	450	170	1800	80-86	2280	2100	1320
00395	PV 300	72	1 / 1400	2.4	70 / 90	550	290	2400	80-86	2280	2100	1620

ATMOS D15P – D20P

The water-heating steel boilers ATMOS D15P and D20P are suitable for heating small households or office buildings. They utilize wood pellets as fuel, and when there is a power cut, solid wood can be used as a fuel too.

ADVANTAGES

- Universal, with automatic burning process.
- High reliability and efficiency.
- Gradual power regulation.
- Environmentally-friendly.
- Does not require strong exhausting power.
- Easy to supervise and service.

TECHNICAL SPECIFICATIONS

Code	Model	Thermal Power [kW]	Capacity of burning chamber [dm3]	Efficiency Coefficient [%]	Maximum Wood Length [mm]	Fuel Consumption [kg/h]	Recommended fuel	Weight [kg]	Length [mm]	Height [mm]	Width [mm]
00310 -	D 15P D 20P	7-14,5 10-19,5	70 105	86-90 86-90	300 500	3,7 5	Pellets or dry wood with caloricity 15-17 [MJ/kg]	259 345	490 490	1340 1340	590 590

DAKON DOR

Dakon Dor is a line of steel boilers, designed for central heating of dwellings, cottages, family houses and other small buildings. The boilers utilize solid fuels such as brown coals, briquettes, black coals, wood and wood waste. High burning efficiency is ensured by means of special grill and burning chamber, which receive primary, secondary and regulated tertiary air streams.
Dakon Dor 32 D burns wood and wood waste. It can also utilize coal.
Dakon Dor 45 D is a water-heating boiler for heating big family houses and similar buildings. Main fuel is wood or wood waste. The boiler can also utilize briquettes, coke and coal.

ADVANTAGES

- Built-in fuel bunker.
- Removable cast-iron grill.
- Un-interrupted operational burning cycle.
- Dust-free clean-up of the boiler.
- Perfect thermal insulation.
- Automatic power regulation.

TECHNICAL SPECIFICATION

Code	Model	Caloricity of fuel [MJ/kg]	Fuel Consumption [kg/h]	Exhausting Power [Pa]	Work Pressure [MPa]	Water Temp. [C] input/output	Water Capacity [l]	Thermal Power [kW]	Weight [kg]	Efficiency Coefficient (coke) [%]	Length [mm]	Height [mm]	Width [mm]
00006	DOR 12	brown coal 17,79 [Mj/kg]	3,2	12-14	0,2	70 / 90	47	6-12	158	78-84	730	920	600
00001	DOR 16		4,7	16-18	0,2	70 / 90	46	8-16	166	74-78	698	907	600
-	DOR 20		6,0	20	0,2	70 / 90	56	6-20	200	74-78	730	1040	700
00002	DO R24		3,2-7,6	22-26	0,2	70 / 90	57	12-24	215	74-78	730	1040	700
00008	DOR 25M		7,9	26	0,2	70 / 90	63	8-25	232	74-78	830	1040	700
00003	DOR 32		3,9-8,4	25-32	0,2	70 / 90	64	16-32	240	74-78	830	1040	700
00011	DOR 32D		8,4	26-32	0,2	70 / 90	64	1-28	240	74-78	830	1040	700
00004	DOR 45D		14	26-36	0,2	70 / 90	73	36-45	320	74-78	980	1045	770

LING 25

The steel water-heating boiler Ling 25 utilizes wood pellets and provides heating for households and office buildings which require guaranteed thermal power of up 25 kW.

ADVANTAGES

- Delivers automatic, un-interrupted and regulated pre-set heating for period of 1 to10 days.
- Possibility for gradual power regulation.
- Burns wood pellets, which ensure optimal burning process.
- Excellent burning parameters.
- Environmentally-friendly.
- Easy to supervise and service.
- Does not require big exhausting power.

TECHNICAL SPECIFICATIONS

Code	Model	Thermal Power [kW]	Efficiency Coefficient [%]	Maximum Length of Pellets [mm]	Fuel Consumption [kg/h]	Recommended Fuel	Weight [kg]	Length [mm]	Height [mm]	Width [mm]
-	LING 25	25	82	300	3,7	Pellets with caloricity 15-17 [MJ/kg]	340	725	1418	1249

VIADRUS U 22

VIADRUS U 22 C is a cast-iron, single-column, multi-section water heating boiler utilizing solid fuel (coal, coke and wood). It is designed to work in the heating systems of small and medium buildings; with maximum temperature of the water up to 110 degrees Celsius and maximum operational pressure of up to 0.35 MPa.

ADVANTAGES

- High reliability and efficiency
- Easy to use and service
- Does not require high exhausting power
- Selection of the required power according to the number of sections
- Long exploitation period for the boiling chamber
- Easy to convert from solid to liquid fuel and vice versa

TECHNICAL SPECIFICATIONS

Code	Number of Sections	Caloricity [MJ/kg]	Exhausting Power [Pa]	Operational Pressure [MPa]	Water Temp. [C] input/output	Water Capacity [l]	Termal Power [kW]	Weight [kg]	Efficiency Coefficient (coke) [%]	Lenght [mm]	Height [mm]	Widht [mm]
00101	2	coke 26,0 brown coal 17,79	10-20*	0,35	70 / 90	26,8	11,7	195	83	655	1005	520
00102	3			0,35	70 / 90	31,5	17,5	232	83	750	1005	520
00103	4			0,35	70 / 90	36,2	23,3	268	83	845	1005	520
00104	5			0,35	70 / 90	40,9	29,1	304	83	940	1005	520
00105	6			0,35	70 / 90	45,6	34,8	342	83	1035	1005	520
00106	7			0,35	70 / 90	50,3	40,7	380	83	1130	1005	520
00107	8			0,35	70 / 90	55	46,5	418	83	1225	1005	520
00108	9			0,35	70 / 90	59,7	52,3	456	83	1320	1005	520
00109	10			0,35	70 / 90	64,4	58,1	494	83	1415	1005	520

* - depending on the size of the bolier

SD 300

The SD 300 boiler utilizes small-size waste wood with humidity varying between 8 and 45%. It is suitable for heating workshops or for providing heat in dryers or other technological applications. The system consists of four elements: burning chamber, heat exchanger, fuel proportioner with bunker, and electric control board.

ADVANTAGES

- Automatic power regulation.
- Automatic start-up and shut-down.
- High reliability and efficiency.
- Environmentally-friendly.
- Easy to supervise and service.

TECHNICAL SPECIFICATIONS

Code	Model	Thermal Power [kW]	Water Temperature [C] input/output	Efficiency Coefficient [%]	Maximum Fuel Size [mm]	Work Pressure [MPa}	Recommended fuel	Flue Fan Power [kW]	Air Fan Power [kW]	Schenk Motor [kW]
-	SD 300	300	70/90	0,8	10/10/40	0,6	Small waste wood with humidity 8-25%	1,1	0,25	0,12

EcoEnergy

MUNICIPAL ENERGY EFFICIENCY NETWORK

The Municipal Energy Efficiency Network "EcoEnergy" is an informal non-profit voluntary association of Bulgarian municipalities, established in February 1997 at the initiative of the mayors of 23 municipalities. The foundation of the Network and its first steps were supported by the US Agency for International Development (USAID) in the framework of the project "Municipal Energy Efficiency Initiative". Several projects of the USAID still render support to EcoEnergy. Currently, the activity of the Network is supported mainly through the project "Energy Efficiency Strategy to Mitigate GHG Emissions. Energy Efficiency Demonstration Zone in the City of Gabrovo, Republic of Bulgaria", funded by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP).

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BURGAS
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GORNA ORYAHOVITZA
HASKOVO
KARLOVO
KAZANLAK
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MONTANA
OMURTAG
PAZARDJIK
PLEVEN
PERNIK
RAZGRAD
RAZLOG
ROUSSE
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THE SITY OF DOBRICH
TROYAN
VARNA
VELIKO TARNOVO
VIDIN
YAMBOL
ZLATOGRAD

MUNICIPAL ASSOCIATIONS

ASSOCIATION OF DANUBE RIVER MUNICIPALITIES "DANUBE"
ASSOCIATION OF BULGARIAN BLACK SEA MUNICIPALITIES
REGIONAL ASSOCIATION OF MUNICIPALITIES "TRAKIA"
REGIONAL ASSOCIATION OF MUNICIPALITIES FROM SOUTH-WESTERN BULGARIA
REGIONAL ASSOCIATION OF MUNICIPALITIES FROM SOUTH-CENTRAL BULGARIA "HEBAR"
REGIONAL ASSOCIATION OF MUNICIPALITIES "CENTRAL STARA PLANINA"

INSTITUTIONAL BACKGROUND

OBJECTIVES

The Municipal Energy Efficiency Network has three strategic objectives:

- to coordinate efforts by member municipalities to consider and improve energy efficiency as a means of addressing important national issues within the energy and environmental policy.

- to create conditions for diminishing the burden of energy costs on municipal budgets so that the savings can be used for other municipal priorities.

- to reduce the energy costs incurred by individual end-users within the municipalities and to increase public support for a municipal energy conservation policy.

TASKS

The barriers to energy efficiency in municipalities are institutional, financial and shortage of information. EcoEnergy contributes to their overcoming by performing the following major tasks:

- to render support to municipalities to identify energy saving opportunities and to formulate municipal energy efficiency policies;

- to assist the exchange of experience among Network member-municipalities in the field of efficient energy management;

- to contribute to the development of the institutional and human capacity for developing and managing energy efficiency programs and projects in member-municipalities;

- to contribute to the elaboration of joint proposals for institutional and legislative measures for energy efficiency improvement in line with the needs and requirements of municipalities;

- to assist the cooperation of efforts for influencing the state policy with respect to financing of municipal energy efficiency projects from specialized funds;

- to collect and disseminate information about achievements in the field of energy efficiency and about new technologies for energy conservation.

RULES OF PROCEDURE

The approved Rules of Procedure of the Network regulate the tasks, forms of activities, representative and co-ordinating bodies, forms of membership and responsibilities of the participants.

The Municipal Energy Efficiency Network is represented by a Board of Directors, whose members are elected Network member-municipalities. The Board of Directors is elected on the principle of rotation by the General Assembly of the member-municipalities for a one-year term. The elected municipalities are represented at the Board of Directors by their mayors. The activities of the Network are co-ordinated by the Center for Energy Efficiency EnEffect, which acts as its Secretariat. The Head of EnEffect is ex-officio member of the Board of Directors of the Network.

MEMBERSHIP

Member or associated member of EcoEnergy may be every Bulgarian municipality. Associations may participate only as associated members.

After the Fourth Annual Conference of EcoEnergy the number of member municipalities is 39, and that of the associated members 109 (within 6 municipal associations), making a total of 148 municipalities. The centres of the member municipalities are mostly big and medium-sized cities. 23 of them are regional centres as well. The population in the municipalities from the MEEN amounts to 5.3 million people, or 66 percent of the national total.

COLLABORATION

The collaboration of EcoEnergy with the National Association of Municipalities in the Republic of Bulgaria and with regional associations of municipalities creates better opportunities for overcoming of the regulatory barriers to investment initiatives in Bulgarian municipalities. The international contacts of EcoEnergy with the European Network Energy Cites and with the International Council for Local Environment Initiatives (ICLEI) provide for access to the valuable experience of European municipalities. The Municipal Network for Energy Efficiency (MUNEE) realizes activities similar to those of EcoEnergy in the countries of Central and Eastern Europe and the former Soviet Union. The Regional Network for Efficient Use of Energy and Water Resources (RENEUER) is co-ordinated by the Secretariat of EcoEnergy and hence makes an active use of the Bulgarian Network.

MEEN ACTIVITIES

Network tasks are implemented by collecting and facilitating the exchange of relevant information; training and education; conferences, workshops, and business meetings; publishing a network newsletter; joint studies, programs, and projects; and institutional contacts at national and international levels.

CAPACITY BUILDING

Institution building

The institutional building activities include first the organisational set up of the Network itself. A strategy for the development of the MEEN for the period up to the year 2006 has been elaborated. The annual conferences of the Network are the milestones in the consolidation of the Network and the development of its activities.

The tasks of the MEEN in the member-municipalities are carried out by the Municipal Energy Efficiency Offices. They are part of the municipal administration and are the agents for promoting energy efficiency and incorporating energy efficiency considerations into municipal programmes and strategies. Until now 31 such offices have been established and equipped. A computer network linking the Municipal Energy Efficiency Offices and the Secretariat has been established.

Some municipalities from the network have established municipal energy agencies in partnership with other stakeholders in the municipality, such as utilities, companies, and industries.

Information database

An information system about energy consumption in MEEN member-municipalities has been created. The system covers information about actual fuel and energy consumption by municipal sectors, groups and facilities. Special information database software for municipal energy management has been developed and is in use in all member-municipalities.

Municipal energy planning

The priority actions of the MEEN in the period 1999-2002 aimed to create the basis for development of a municipal energy efficiency policy. Planning for energy efficiency is a new activity for the municipal authorities. A model for a municipal energy efficiency programme was developed and discussed. Draft pilot projects for municipal energy efficiency programmes were developed for two municipalities (Gabrovo and Stara Zagora). 20 municipal energy efficiency programmes were developed during the training courses for municipal experts. The programmes identified the priority actions for realizing the energy efficiency potential in the municipal sector of the respective municipalities. They envisaged a 25-30 percent reduction of energy consumption in the facilities included in the programmes. Priority target groups are schools, kindergartens, street lighting, administrative buildings.

Training and Education

Seminars and workshops are conducted on different energy efficiency topics of interest to municipal experts and leaders. A specialized training program on energy planning and financial management for municipalities is under way. Training materials on municipal energy planning and management; energy audits, assessment of the energy efficiency potential and environmental benefits; planning, management and financing of energy efficiency projects were developed. All municipalities from the Network have the possibility of sending several representatives in this training programme. The approach of the training programme is "learning by doing". The participants in the training course develop draft municipal energy efficiency programmes and business plans for priority energy efficiency projects.

Information dissemination

The Network publishes and distributes a newsletter, EcoEnergy. Information on different energy efficiency issues is disseminated among the member-municipalities. A Network website was created (www.ecoenergy-bg.net).

Overcoming Financial Barriers

Overcoming the financial barriers to the implementation of municipal energy efficiency projects is carried out through three major directions of Network activities:

- improvement of the regulatory framework and provision of greater fiscal autonomy for Bulgarian municipalities;
- development of innovative financing mechanisms for energy efficiency projects;
- implementation of investment projects as practical tests of the financial mechanisms and the opportunities provided by the different sources of funding.

An important part of this component was the analysis of the legal framework and the recommendations for its amendment to be submitted to central and local authorities in order to support municipal energy conservation.

ENERGY EFFICIENCY PROJECTS

The project in the Gabrovo hospital was followed by similar projects in Stara Zagora, Varna and Gorna Oryahovitsa.

A series of specific energy efficiency projects have been developed or are in a process of development by Network member-municipalities:

- Street lighting projects have been initiated in most of the municipalities from the Network (e.g., Gabrovo, Stara Zagora, Rousse, Sliven, Pazardjik, Pernik, Dobrich, Belogradchik, Blagoevgrad, Kardjali, Gorna Oryahovitsa, Svishtov).
- Energy efficient retrofit of school buildings in Karlovo, Kazanluk, Pleven, Stara Zagora, Gabrovo, Pernik, Pazardjik, Varna, etc.
- Solar system for domestic hot water production in combined child care establishments on the area of the city of Belene
- Installation for incineration of solid urban and industrial waste in the municipality of Berkovitza
- Construction of a system for combined heat and power generation at the Regional Hospital of Botevgrad.
- Bulgarian-Dutch demonstration project for gasification in Botevgrad
- Design and construction of a system for combined heat and power generation at the Ritual Hall of Botevgrad
- Energy efficient rehabilitation of "Otets Paisii" School for handicapped children, Bourgas
- Energy efficient retrofit of St. Ivan Rilski Municipal Hospital in Gorna Oryahovitsa: energy audit and a business Plan (EcoLinks Program, 1999-2001)
- Energy efficient rehabilitation of the Daily Kindergarten No. 10 in Dobrich

- Gasification of boiler systems in educational facilities in Dobrich
- Energy efficiency retrofit of students hostels, Haskovo
- Project for efficient management and upgrading of street lighting in the city of Varna
- Energy efficient retrofit of the building of D-r Tota Venkova Regional Hospital in Gabrovo
- Energy efficiency retrofit of the building of Otets Paisii School in Gabrovo
- Energy efficiency rehabilitation of the street lighting system in Gabrovo
- Rehabilitation of the district heating system and heating end-use in Gabrovo
- Energy efficiency retrofit of the building of municipal administration in Gabrovo
- Energy efficiency retrofit of a panel apartment block in Gabrovo
- Energy efficiency retrofit of the building of Mehatronika JsC in Gabrovo
- Programme for energy efficiency reconstruction of the heating system of 9 municipal buildings - schools and kindergartens in Rousse using the ESCO mechanism.
- Programme for energy efficiency retrofit of municipal buildings in Pazardjik: 9 schools and 4 kindergartens, the municipal building, the regional hospital.

PROGRAM OF ACTION 2002 - 2007

MAJOR DIRECTIONS OF ACTIVITIES OF ECOENERGY IN THE PERIOD 2002 - 2007

- Tasks ensuing from the national energy policy.
- Tasks ensuing from the national strategy for environmental protection.
- Tasks ensuing from the national policy on local self-government.
- Tasks ensuring organizational consolidation of the network and conditions for its sustainable development.

TASKS ENSUING FROM THE NATIONAL ENERGY POLICY

- Conducting a goal-oriented municipal energy efficiency policy as an important factor for sustainable development

- Cooperation between municipalities to increase the opportunities of local authorities to influence the national energy policy under the conditions of demonopolization and privatization

- Institutional capacity building for energy efficiency in municipalities

- Specialized training for the energy efficiency specialists and institutions in municipalities

TASKS ENSUING FROM THE NATIONAL STRATEGY ON ENVIRONMENTAL PROTECTION

- Support for municipalities' participation with projects and programs for improvement of energy efficiency and promotion of the use of renewable energy sources in activities under the mechanisms of the Kyoto Protocol

- Creation of prerequisites for the use of RES by municipalities and other end-users on their area

- Creation of prerequisites for more active involvement of municipalities in the development of the market for low-pressure natural gas

TASKS ENSUING FROM THE NATIONAL POLICY ON LOCAL SELF-GOVERNMENT

- Expansion of the opportunities for municipalities to apply progressive financing mechanisms for energy efficiency improvement and the use of RES

- Ensuring opportunities for municipalities to retain the savings made through implementation of energy efficiency projects and programs and to use them for paying off their investments

- Expansion of the opportunities of municipalities to influence energy consumption by businesses and private end-users and to interact with them for enhancement of energy efficiency on the basis of different forms of partnership

ORGANIZATIONAL CONSOLIDATION OF THE NETWORK

- Strengthen and further develop the information system on energy efficiency in municipalities as a tool for energy management and a basis for implementation of energy efficiency policy

- Strengthen the energy efficiency offices in municipalities as a driving force of municipal policies for efficient use of energy and water resources and as active participants in municipal planning for sustainable development

- Strengthen the role and influence of EcoEnergy and broadening of its capacity for impact and for attainment of its strategic goals

- Broadening and enrichment of the international contacts of the Network and its establishment as a reliable partner for joint participation in international and foreign energy efficiency programs and projects

- Setting up an energy efficiency information clearinghouse within EnEffect for the needs of the Network member-municipalities