CO-GENERATION GAS POWER STATIONS
AKB FORES PLC Financial Industrial Group

Polymeri JSC
Kostenets HHI JSC
Toplofikatsia Kazanlak JSC
Toplofikatsia Yambol JSC

JI PROJECT DESIGN DOCUMENT

AKB FORES PLC, SOFIA, BULGARIA

Volume 1

ERUPT 5
Final Version
Sofia/The Hague, February 2005

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Abbreviations used

ABECng	annual baseline natural gas energy consumption	GJ/y
AECng	annual natural gas energy consumption by CHP	GJ/y
AEIR	Assessment Environmental Impact Report .	
AFCng	annual consumption of natural gas	m^3
AOH	annual operational hours	h/y
BEelec	baseline CO_2 emissions that are offset by electricity supplied by CHP	tCO_2/y
BEth	baseline CO_2 emissions that would be offset by CHP heat output	tCO_2/y
BEth fug	baseline methane emissions from natural gas production and pipeline leaks corresponding to heat supply that would be offset by CHP output	tCH_4/y
BEth eq fug	CO_2 equivalent of baseline methane emissions from natural gas production and internal and external pipeline supplying natural gas to provide heat that would be offset by CHP heat output	tCO_2eq/y
BEtotal	total baseline emissions (CO_2 equivalent)	t CO_2 eq/y
BEF elec	baseline CO_2 emissions factor for electricity from grid	$kgCO_2/MWh$

CAHO	CHP annual heat output	GJ/y
CGS	Co-Generation Gas Power Station	
CHOR	CHP heat output rate	GJ/y
CEO	annual CHP electricity output	MWh/y
CPO	CHP net power output capacity	MW_e
DSWG	Distribution switchgear	
CV natural gas	lower calorific value of natural gas	$kcal/m^3$
e_b	industrial boiler efficiency (LHV basis)	%
Ecs	CO_2 emissions per year from natural gas combustion in CHP	t CO_2/y
Eeq fug	CO_2 equivalent of fugitive methane emissions from ng production and transport leakage (internal and external pipeline supplying ng to user)	t CO_2 eq/y
Eeq met comb	CO_2 equivalent of methane emissions from ng combustion	t CO_2 eq/y
Efug	fugitive methane emissions from ng production and transport losses (internal and external pipeline supplying ng to user)	tCH_4/y
EL	Energy Law	
Emet comb	methane emissions from ng combustion	tCH_4/y
Etotal	total project GHG emissions	t CO_2 eq/y
EFel gen	emission factor for electricity generation	$kgCO_2$/kWh
EF ng	CO_2 emission factor of natural gas	kg CO_2/GJ
EIRcog	energy input rate to CHP	GJ/h
ER	emission reduction from project activities	t CO_2 eq/y
EU	European Union	
GE	General Electric	
GWP (CH_4)	global warming potential of methane	21 – Kyoto protocol
GWP (N_2O)	global warming potential of nitrous oxide	310 – Kyoto protocol
MCEO	monthly electricity output of CHP	MWH/month
MCHO	monthly heat output of CHP	GJ/month
MECng	monthly ng energy consumption of CHP	GJ/month
MEF	methane emission factor for ng combustion	$kgCH_4$/TJ
MLR	methane leakage rate (from ng production, transport and distribution)	$kgCH_4$/GJ
NEF	nitrous oxide emission factor for ng combustion	kgN_2O/TJ
NES	National Environment Strategy and National Activity Plan 2000-2006	
NEC	National Electric Company	
NPS	Nuclear Power Station	
NSI	National Statistics Institute	
RES	Renewable Energy Sources	
SEC	specific energy consumption for power generation	kJ/kWh
TPS	Thermal Power Station	
WPS	Water Power Station	

REMARKS:

The following considerations are taken into account in evaluations of GHG equivalent emissions:

- GHG emissions from **CH_4 combustion; N_2O combustion; CH_4 leakage's** were not estimated due to their small contribution into the total amount of GHG emissions (estimated approx. less than 1 to 2 %) and both the lack of reliable data as corresponded emission factor and measurement problems during the monitoring period. Their contributions into the total GHG emissions are even less when emission reductions have to be evaluated;
- **CO_2 combustion** emission factor for natural gas is EFmg =56,1 kg/GJ – source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003;
- **CO_2 electricity –** these emissions associated with the electricity from the power grid depend on annually estimated CO_2 emission factor in Bulgaria. The predicted values - BEF_{el} are presented in Table E 1. (source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003;

1. PROJECT CHARACTERISTICS

1.1 Project information

1.1.1 Project developer

Company:
AKB Fores PLC.
Financial & Industrial Concern
20, F.J.Curie Str.
1113 Sofia, Bulgaria
Website: www.akbfores.com
No. of Employees: approximately 6,000
Registration number:11130
Date of registration: 18.09.2001
Bank account number:1401825419
Bank name: Tsentralna Kooperativna Banka
Bank code: 22092207
SWIFT: KORPBGSF
Contact person:
Name: Mrs. Ulia Cirkova
Job title: Foreign Programs Manager
Telephone number: +35929630570
Fax number: +35929632068
E-mail: akbfores@iterra.net

Corresponder's data (if Supplier is represented by a third party)
Company: Global Carbon BV
Visiting address, zip code + city, country:
Muzenplein 145, 2511GK, Den Haag, The Netherlands
Contact person: Erik Saat, Director
Telephone number: +31 6 13713726
Fax number: +31 70 3458055
E-mail: saat@global-carbon.com
Internet: www.global-carbon.com

Project partners
Company: Polimeri JSC, 9600 Devnia, Industrial Zone, Bulgaria
No. of Employees: 492
Registration number: 4479
Date of registration: 1993
Bank account number: 12000103517
Bank name: Tsentralna Kooperativna Banka
Bank code: 79078081
Company's core business: Polimeri JSC is the only one producer in Bulgaria of ethane dichloride, sodium hydroxide-liquid, hydrochloric acid, liquid chloride and ferrichloride. Polimeri JSC produces also technical salt, bleaching solution, liquid nitrogen, liquid oxygen, refined brine, PVC – pipes and fittings etc.
Contact person:

Name: Mr.Roumen Djakov
Job title: General Director
Telephone number:+359 519 92618, +359 886868881/2892
Fax number: :+359 519 92717
E-mail: office@polimeri.org

Company: Kostenets – HHI JSC, 2, Saedinenie Str., 2030 Kostenets, Bulgaria
URL: www.hhi-bg.com
No. of Employees: 362
Registration number: 4492
Date of registration: 1991
Bank account number: 1004792607
Bank name: Bulbank JSC
Bank code: 62196214
Company's core business: Kostenets JSC is producer of paper and products from paper like toilet paper, corrugated-board paper etc.
Contact person:
Name: Mr. Krum Ivanov
Job title: MTIFN
Telephone number:+359 7142 3754
Fax number: :+359 7142 2311
E-mail: kosshhi@infotel.bg

Company:
Toplofikatsia Kazanlak JSC, 42, Tsar Osvoboditel Str., 6100 Kazanlak, Bulgaria
URL: www.heatkz.bg
No. of Employees: 141
Registration number: 3300
Date of registration: 1995
Bank account number: 1074988946
Bank name: Bulbank Kazanlak
Bank code: 62176307
Company's core business: Toplofikatsia Kazanlak JSC is producer of energy in the form of heat water and steam for the town and electricity for the National Electrical Company (NEK).
Contact person:
Name: Mr. Vladimirov Vladimirov
Job title: A Head of Marketing Department
Telephone number:+359 62045
Fax number: :+359 431 62056
E-mail: vladimir@heatkz.bg

Company:
Toplofikatsia Iambol JSC, 8600 Iambol, Industrial Zone, Bulgaria
URL: www.jambolsite.com/heatjambol
No. of Employees: 32
Registration number:521
Date of registration: 1998
Bank account number: 1018003010
Bank name: Bulbank JSC

Bank code: 62196214
SWIFT: BFTBBGSF
Company's core business: Toplofikatsia Iambol JSC is producer of energy in the form of heat water and steam for the town and electricity for National Electrical Company.
Contact person:
Name: Mr. Vasil Aleksiev
Job title: Executive Director
Telephone number:+359 46 664433,
Fax number: :+359 46 664433
E-mail: heat_jambol@abv.bg

1.2 Project Abstract

1.2.1 Project Title

"Design, construction, and operation of a CHP (combined heat and power) portfolio with a total combined capacity of 29 MWe at the factories of Toplofikatsia Kazanlak, Toplofikatsia Yambol, Polimeri of Devnya, and Kostenets –HHI".

1.2.2 Abstract

The project comprises the design, construction, and operation for a portfolio of four highly-efficient gas power stations with a total power capacity of 29 MWe from co-generation type (CHP: combined heat and power) for generation of electric and thermal power at Polimeri Devnya, Kostenets –HHI, Toplofikatsia Kazanlak and Toplofikatsia Yambol.
Currently two of the factories already use gas as fuel Polimeri and Yambol, two others, Toplofikatsia Kazanlak and Kostenets –HHI, will switch to using gas to operate the cogeneration installations. They now use oil residue (mazut). Toplofikatsia Kazanlak will change existing fuel oil burners in its boilers to natural gas burners. Toplofikatsia Yambol will also construct a 10,000 meters conveying network based on preliminary isolated pipes to be able to supply heat 6,000 new subscribers.
The investment will be around 20 million Euro and will be financed from bank loans, own funds from AKB Fores and from profit coming from operations of AKB Fores. At this moment AKB is in detailed discussions with several banks, such as Biochim Bank.
The pre-feasibility study done by AKB Fores shows that the foreseen cogeneration modules (CHP) will have the following design and capacities:

- For factory Polimeri (Devnia) – one gas turbine set 10 MWe and 13 MWth
- For factory Kostenets –HHI - one gas turbine set 10 MWe and 13 MWth
- For district heating Toplofikatsia Kazanlak: 2 gas engines x 3.1 MWe and 2 x 3.6 MWth hot water
- For district heating Toplofikatsia Yambol: one gas engine 3.1 MWe, 3.6 MWth hot water

The estimated amount of reduction of CO2equivalent that is expected from the portfolio amounts to 196,000 ton prior to 2008 and 900,000 ton between 2008 and 2012.
The time planning is to start with the installation of the first CHP in mid 2006. The latest CHP to be commissioned will be end 2006. The technology for CHPs is rather standard and well known. The development of the project and the installation of the technology will not be a difficult task. The change of the existing boilers burners to natural gas burners also is well known in the country.

1.2.3 Project locations

The project is foreseen to be executed in the plants:

<u>Polymeri JSC</u> is located in valley of Devnia at town Devnia 30 km to town Varna, see location on the picture below. The valley of Devnia is called in Bulgaria "The valley of the big chemistry". Here are situated big plants like Solvey Sodi JSC, Agropolychim JSC, Devnia Cement JSC, Besin JSC, PS Deven JSC. Devnia like economical area possesses with own sea port inside. The town of Devnia is historical town, it had been build from the Roman Imperator Traian between (98-117). The old name is Martcianopol. The attitude of Devnia is 12 m above of the sea level that is especially friendly to the gas turbines. The average temperature is 14.6 º C. The location of Devnia is shown on the map below.

The site of the cogeneration location can be seen on the General Layout (simple orientation variant) in Annex No. 1. The site area is roughly around 1500 m² that is fully sufficient for the co-generation disposition. The site is closed situated to the main Electrical Substation and to the main consumer of the steam. The site permits easy performance of the civil and the installing works.

Kostenets HHI JSC is located in town Kostenets about 70 km from Sofia in south direction. The settlement into the present day municipal centre Kostenets started in 1884 but officially from 1964. Its population is about 15 300 inhabitants of which 60 % in employable age. On the territory of the municipality there are around 447 enterprises and the biggest one is Kostenets HHI JSC. Kostenets is situated at 508 m attitude at the foot of East Rila Mountain. The average temperature is between – 5º C and + 22 º C.

The type of the cogeneration is the same like in Polymeri Devnia. The cogeneration site is shown on part of the General Layout in Annex No.1. The area of the site is around 4000 m² and this is fully sufficient. The site is closed to the existing thermal station. The connection with the steam pipe will be performance easy. The connection with the main Electrical Substation will be more difficulty because the distance is between 230 -270 m. The site permits easy performance of the civil and the installing works.

Toplofikatsia Kazanlak JSC- is located in town Kazanlak. Kazanlak is administrative centre of the municipality in the pretty Valley of Roses. The town is situated at the foot of the Balkan Mountains. The natural geographical centre of Bulgaria is just here. The history of this area is very old. The first settlement in the limits of the town is from 6th-5th centuries B.C. Kazanlak is important industrial centre, here are Arsenal JSC, Hydravlika Kazanlak, Boncho Shanov and others. The attitude of Kazanlak is 350 m above sea level and the average temperature between – 0,5 º C to + 21.8 º C. The population is around 71 000 inhabitants of which 58 % in employable age.

Toplofikatsia Kazanlak JSC is thermal station for combined production of heat water, steam and electricity. Two cogeneration modules with gas engines type 620 GS are foreseen in the project. The disposition site is shown on the General Layout – Annex No.1 The cogenerations modules site is closed to the boiler installation and the Electrical Substation. The hot water pipes and the cables connections will be of short length and facilitate easy installation.

Toplofikatsia Yambol JSC - is located in town Yambol. Yambol is administrative centre of area 93 km from Black Sea. The first settlement in the limits of the town is from 2th-1th millennium B.C. The town population is 80,200 inhabitants of which 52,700 in employable age. The town attitude is 150 m above sea level. The average temperature is between 0.2 º C to 23.2 º C.

Toplofikatsia Yambol JSC is thermal station for combined production of heat water, and electricity. One cogeneration module with gas engine type 620 GS will work here. The construction of new thermal pipe lines are foreseen in the project. The cogeneration module will work inside. The site disposition is shown on the General Layout – Annex No.1 the gas pipe line and the hot water pipe line are closed to the cogeneration. The Electrical Substation distance is around 150 m.

1.2.4 Go decision date, construction works starting and completion date

The expected term for the completion of the construction works is end of 2006, and the commissioning dates are expected ultimately January 2007. The next table expresses these dates for the separate projects including the actual Go decision date:

	Date go decision of the project	**Construction starting date**	**Constructing works completion date**	**Commissioning Start of operation**
Polymeri JSC	May 2005	end July 2005	Dec 2006	1 Jan 2007
Kostenets HHI JSC	May 2005.	end July 2005	Dec 2006	1 Jan 2007
Toplofikatsia Kazanlak JSC	May 2005	end July 2005	October 2006	1 Jan 2007
Toplofikatsia Yambol JSC	May 2005	end July 2005	Dec 2006	1 Jan 2007

Note: the final decision for the go/no go of the project activities is influenced by the possibility to obtain an Emission Reduction Purchase Agreement with ERUPT5

1.3 Background and justification

1.3.1 Background

In the past several years, the Bulgarian energy sector is undergoing a rapid change, mostly driven by EU accession of Bulgarian projected for 2007. The Ministry of Energy is privatizing the energy generation capacity in the country. Several district heating installations, a.o. in the cities of Pleven and Bourgas, have already been privatized. The new owners are mostly companies that have their base in the European Union and that see opportunities in investing in energy generation capacity in Bulgaria because of future growth expectations and profit projections. RWE and EON from Germany and EdF from France are among the companies that invest in the energy sector in Bulgaria. At the same time, the energy market is in the process of liberalization. This means that subsidies for households and industrial users are gradually removed (they are now already almost 100% removed) and prices for energy therefore have increased in will continue to increase. In addition, prices for energy will increase even more when the generation capacity in Bulgaria will be decreased significantly due the decommissioning of the 3rd and 4th blocks of the nuclear power plant. These blocks are decommissioned because they cannot fulfil the strong safety requirements as required by the European Union laws for these types of installations. The factories in Bulgaria that use energy are looking for ways to reduce costs for energy and to maintain the security of supply of energy to their production processes. They start to invest in own generation capacity. Factories that currently produce energy are looking for ways to increase their efficiency to become more competitive in this liberalized and privatized market. The investments that these companies need to make in order to start generating energy or to become competitive are significant.

The investment economics of the CHP portfolio is enhanced by the possibility of selling the reduction of CO_2 emissions to the ERUPT programme. At the same time, the Bulgarian government has adopted for the encouragement of investments in combined energy production by compulsory purchasing of the produced electric energy at preferential prices.

The motives for the realization of these CHP projects are based on the analysis of the market situation in the country and the expected reforms in the energy sector with reference to the accession of our country into the EU. The explanation of the background for the projects in this portfolio is divided into 2 parts. First we will describe the **district heating projects** in the portfolio which have similar backgrounds, subsequently we will describe the **factories** in this portfolio which have similar backgrounds as well.

District heating project activities in Toplofikatsia Kazanlak and Toplofikatsia Yambol
The district heating power plants of **Toplofikatsia Kazanlak** and **Toplofikatsia Yambol** now use heavy fuel oil (HFO) to generate heat for the towns of Kazanlak and Yambol and to produce electricity for the national grid. The costs for this fuel are relatively high compared to the costs of using natural gas. In example, the price of HFO for equal caloric values is 1,34 times higher than of natural gas. The investment in a new CHP will enable these factories to use natural gas.
Beside the installation of two cogeneration modules, Toplofikatsia Kazanlak additionally will change the burners of three existing boilers which will produce the necessary steam and hot water to the meet the needs over the production of the two gas engines. Toplofikatsia Yambol will, besides the installation of 1 cogeneration module, also expand the existing district heating network to connect 6,000 new household customers. These customers use now electricity and naphtha for heating and will be provided with heat from the existing two gas boilers.
At the same time the district heating power plants will increase their efficiencies and reduce emissions thanks to the cogeneration modules. They will reduce emissions even further through the replacement of the burners and through the expansion of the district heating network in Yambol. The National Electricity Company (NEK) is obligated to purchase the generated electricity from the cogeneration systems against a preferential tariff (Energy law, article 162). Expected prices are at 5 to 6 Eurocents per kWh.

Project activities at Industrial factories in Polymeri JSC and Kostenets HHI
The **Polymeri JSC** factory currently buys thermal energy from neighbouring, coal fired Thermal Power Station Devnia and it buys electricity from the NEK With the investment in a new CHP, Polimeri will produce the majority of its own requirements for heat and electricity.
The **Kostenets HHI** pulp and paper factory will replace the use of heavy fuel oil with the use of natural gas through the investment in the new CHP. This new CHP will also increase the efficiency and reduce costs. Both factories will secure the supply of energy to their production processes with these new CHPs. They will also stabilize the price of electrical and the thermal energy around the present values for the future.

The factories Polymeri, Kostenets and the district heating power station of Kazanlak must invest in natural gas supply pipelines to supply high pressure 35 bar natural gas to the new cogeneration modules. These pipelines will be connected with the main pipeline for high pressure natural gas in Bulgaria. The additional investments that need to be done to create the necessary infrastructure decrease the attractiveness of the project. The capital investments required for the proposed JI project are about 20 million Euros. The availability of capital and the additional revenue stream coming from the sales of carbon credits are key issues for the JI project to proceed.

1.3.2 History and issues to be resolved by the execution of the project

This paragraph describes the issues to be solved following the same structure as paragraph 1.3.1.

District heating project activities in Toplofikatsia Kazanlak and Toplofikatsia Yambol
The central heating sector represents about 22-23 % of the consumed energy inside the country. Although this is a significant share, the central heating systems continue to loose part of their customers during the last 10 years. Toplofikatsia Kazanlak and Toplofikatsia Yambol are not an exception within this tendency.

The main general reasons for customers to stop the central heating heat service are:
- Old equipment with low efficiency, impossibility of control in dependence of the external conditions, big losses in the network etc.;
- High price of the thermal energy compared with alternatives, independently from the state budget help;
- The population impoverishment during the years of the economical transition;
- Impossibility for good adjustment of the consumption depending on personal needs;
- Lower demand in the central heating system due to the withdrawal of customers makes the system efficiency even worse, leading to higher prices.

The issues with reference to the construction of own cogeneration modules within the two facilities, the gasification of the boilers in Kazanlak, and the thermal network reconstruction and building of new thermal substations in Yambol are:
- The production price for thermal energy will become more competitive leading enabling Toplofikatsia Kazanlak and Yambol to increase the number of their customers.
- The power plants will better be able to serve their customers through increased flexibility in the generation capacities.
- The new network building and reconstruction of old, the building of new thermal substations and installing of new thermal measuring devices will reduce the losses and will improve the quality of the services;
- The environmental conditions in the towns will be improved with the realizing of the two projects.

Project activities at Industrial factories in Polymeri JSC and Kostenets HHI
Polymeri JSC currently receives the steam from power plant Deven, which is owned by the factory of Solvey Sodi JSC. The planed reconstruction of TPS Deven with installing of gas fuel co-generation 280MW was stopped in 2004 and will probably will not be realized in the future. Currently the price for steam paid to the Deven power plant is low, but the expectations are that after 2006 and especially after 2007 in accordance with EU regulations for environmental regulations for energy generating equipment, the price of steam will increase significantly.
In addition, a price rise for electricity is also expected due to the forced phase out of Blocks 3 and 4 of nuclear power station Kozlodui, due to EU safety and environmental regulations.
Electricity price increase also affects the operation of the factory in Kostenets. In addition, the steam production based on heavy fuel oil is economically not attractive. This also impacts operational revenue and it will affect the profitability of the new investment in the new production paper line that will begin to work at the end of 2006.

The construction of the highly efficient CHP plants will resolve the following issues for the factories of Polimeri and Kostenets:
- The installations will provide a safe and clean secured supply of heat and electricity needed for the production processes in the factories.
- The new cogeneration modules will provide for competitive generation of electricity and steam. This will result in cost reduction for the core business of the factories.

- The new facilities provide for a better flexibility to adapt to the needs of the production process while keeping efficiency at an attractive level.
- The environmental condition at the factories and the regions will be improved;

1.3.3 Core business of the project partners and their relations

AKB Fores PLC

The principal objective of the Holding Company "AKB Fores" PLC is expansion into the promising branches of the Bulgarian economy and participation at international commodity and financial markets. Implementing a contemporary style of management and innovative technologies, AKB seeks to boost the profit of the managed productive and non-productive assets and to augment their value.

To meet these objectives the following activities are executed:

- Ongoing analysis of the existing national production capacities and study of their development prospects;
- Purchase, construction or long-term lease of developable natural and productive assets;
- Recruitment, training and formation of teams of skilled Bulgarian personnel;
- Introduction of the European and world standards of production, management, energy intensity and environmental soundness;

The first of the companies, which now comprise Holding Company "AKB Fores" PLC, were established in **1990**. The companies took just several years to establish themselves in the sphere of services, trade and financial transactions. The AKB Consortium Joint-Stock Company was registered in **1994**, bringing together banks, state-owned and private commercial corporations and natural persons for participation in the mass privatization that was gaining momentum at that time. The Financial Industrial Concern AKB Fores Plc. Was established in 1996.

The Privatization Fund of AKB Fores became Bulgaria's fifth largest privatization fund, with **114,000** shareholders and BGL **4,000** billions investment capital.

Between **1990** and **2003**, AKB Fores acquired shares and interests in more than **90** Bulgarian and foreign enterprises, including Polymeri Plc of Devnya, Elma Plc of Troyan, Kostenets-HHI Plc of Kostenets, HZ Panayot Volov Plc of Shoumen, Hear Stations at Yambol and Kazanlak.

The operating structure of AK Fores comprises of 8 industrially defined holding companies and thus incorporating 117 trade companies and factories. The total number of the shareholders includes 326 juridical bodies and 98,642 individuals. More than 5,000 factory and office workers are employed in the system of AKB Fores.

Polymeri JSC

Polimeri JSC is one of the leading producers of chemical products in Bulgaria. It is specialized in the production of polymers and non-organic products. Polimeri JSC is the only producer in Bulgaria of EDC (ethylene dichloride), caustic soda liquid, hydrochloric acid, liquid chlorine and ferric chloride. The annual capacity production is: EDC – 150,000 t, hydrochloric acid – 40,000 t, caustic soda – 140,000 t, liquid chlorine – 124,000 t, ferric chloride – 1,500 t and bleacher – 150,000 t.

The plant produces also technical sodium chloride, bleacher, tryzone (a preparation for disinfection and washing), nitrogen liquid, oxygen liquid, pickle purified, PVC pipes and fittings. Since 2001 the Polimeri JSC is certified according the quality standard ISO 9001. The company is actively present at the domestic and the foreign market, exporting production to Turkey, Greece, Ukraine, Italy, Croatia, Macedonian and Albania.

Kostenets HHI JSC

The industrial plant named today **KOSTENEZ – HHI JSC** was established in 1902 by two entrepreneurs: Tahoyer (Belgian) and Muleshkov (Bulgarian). Kostenets HHI is among the leading enterprises in the paper industry in Eastern Europe. The production is of various types of papers of high quality and amounts to 19-20,000 ton per year. More than 40 per cent of the production is intended for export to foreign markets. It is in the year 1997 when KOSTENETS-PPW JSC has been transformed and since then it is a company with 100% of privately-owned capital. The ambitious investment program, the introduction and mastering of the new technologies as well as the process of modernization of the active production lines win increase the favourable and bright prospects to the company's future. The financing of project on re-construction of a machine for making of cellulose sanitary type of paper, grade A up to four-ply, with the capacity of 20 000 ton per year, is under process.

Toplifikatsia Kazanluk JSC

Represents a vertically integrated enterprise for production of electrical and heat power on the territory of the town of Kazanluk, which services they are using:

- 6,000 houses situated in the west part of the town, a region of the greatest concentration of population;
- 1,600 regarded as flats, situated on the axes east-west, which includes MBAL – Kazanluk, DKZ1 – Kazanluk, 2 school buildings and 2 kinder gardens, one military detachment, company's offices and shops.
- Three industrial enterprises of the textile branch, situated in an immediate proximity of the source of heat.

Toplofikatsia Yambol

With the Decision No 7 dated August 26-th, 1968 of the Yambol Regional People's Council a Thermal Station was founded on the base of the existing vapour stations of two neighbouring enterprises, performing the following activity: production of industrial vapour, hot water and electrical power. Since then the company has endured several changes of his legal status. In 1998 the "Toplofikatsia Yambol" Plc was founded by the separation of the company "Energoinvest engineering" Plc and was 100% owned by the state. On April 7-th, 2004 after an auction at the Sofia Stock Exchange 100% of the stocks of the company ware transferred to the Financial Industrial Concern "AKB Fores" Plc. The main activity of the company is production and conveying of heat power. According to the main activity in the year 2000 the following licensees have been issued:

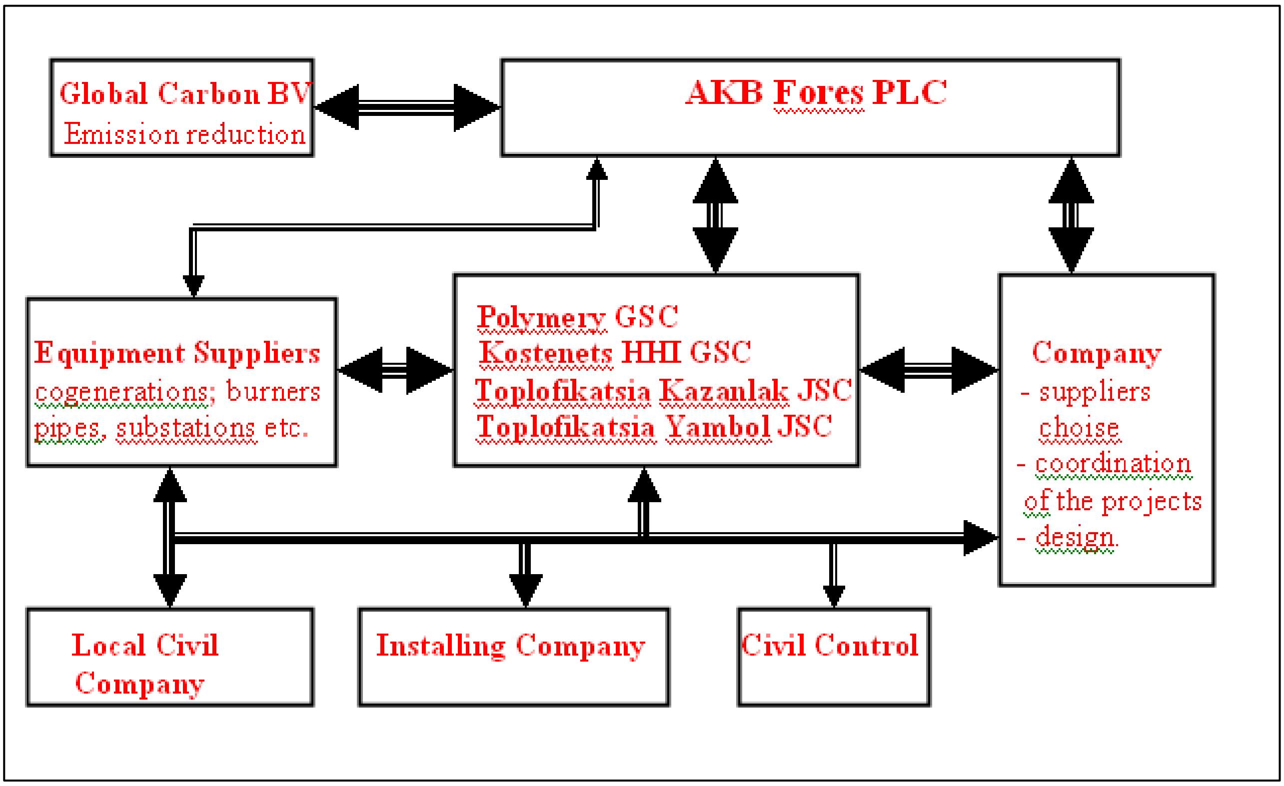
- Licensee for production of heat power – No Л-028-02/ 15.11.2000;
- Licensee for conveying of heat power – No Л-028-05/ 15.11.2000.

Relations between the different project partners.

Above is described what the relationship is between FIC AKB Fores PLC and the participating project activities. AKB will also provide for technical support with regard to the detailed engineering and project management for the development and installation of the cogeneration modules. The equipment suppliers will provide for the equipment which will be installed by the district heating plants and the factories with help from AKB on technical and other matters.

There are other project partners more in the periphery of the project activities that have roles in the development and installation of the projects. In general these project partners are local companies that support the installation of the projects at the sites.

The general outline of the supplier, the most relevant project partners and the local subcontracting structure is given in the picture below:



1.4 Intervention

1.4.1 Description the GOALS of the project

The long term strategic objectives and goals to be achieved with the realization of the projects are:

- Reduce the production costs and therefore, improved competitiveness of the factories on the international and local markets as a result of:
    - Low production costs for the electricity and the thermal energy due to the higher efficiency of the cogeneration modules
    - comparatively low price of the fuel, the factories will be able to buy directly gas from Bulgargas or to negotiate the price and the delivery options directly with foreign suppliers of gas;
    - Preferential prices for the surplus produced electricity sold to NEK on basis of tariffs in legislation now and from 2006 on the base of the green certificates market participation of the cogeneration installations.
- Security of good operating conditions for Toplofikatsia Kazanlak and Toplofikatsia Yambol to guarantee future development;
- Reliability of the electric power supply, especially significant for Polimeri and Kostenets;
- Guaranteed required electric power supply for future expansion of the production facilities in Polimeri and Kostenets;
- Local emissions reductions in the towns of Devnia, Kostenets, Kazanlak, Yambol improve from the replacement of fuel to natural gas

1.4.2 Description the PURPOSE of the project

The key purpose of the JI projects for its realization are:

- To reduces the costs per unit consumed energy and to stabilizes these costs over a long period of time for Polymeri JSC and Kostenets HHI JSC.
- To guarantee of Toplofikatsia Kazanlak and Toplofikatsia Yambol sustainable development achieved trough replacement of the fuel to natural gas, reducing of the production costs and building of new thermal network and substations;
- To improve the reliability of the electric power supply, and guarantee the possibilities for future expansion.

Thus the project will assist the commercial operation of the facilities and AKB Fores PLC, will contribute to the objectives of the national energy strategy and the environmental policy.

1.4.3 Description the RESULTS of the project

The specific results from the realization of the project will be:

- Operating Cogeneration Gas Power Stations in the factories Polymeri and Kostenets HHI which will improve their economical efficiency and competitive ability;
- Operating cogenerations modules and gas reconstructed boilers for Toplofikatsia Kazanlak which will improve the structure of production, will the efficiency, will decrease the price of the produced energy.
- Operating cogeneration module and new pipeline network with new substations for Toplofikatsia Yambol which will improve the efficiency, decrease the network looses and the price of the produced energy. The competitive ability increasing of the factories will expand their activity with involving of new consumers.
- Reduction of primarily CO2 but also other harmful emissions in the towns of Devnia, Kostenets, Kazanlak, Yambol resulting from the replacement of the fuel and reduction of emissions in the Bulgarian electricity system thanks to the installation of the cogeneration modules according to the following details:
    - Polymeri JSC – cogeneration 9-14 MWe type UGT 10000 S1 STIG– reduction of about 412,000 t CO_2 (2007 – 2112) ;
    - Kostenets HHI JSC – cogeneration 9-14 MWe type UGT 10000S1 STIG – reduction of about 291,000 t CO_2 (2007 – 2112) ;
    - Toplofikatsia Kazanlak JSC – cogeneration 2 x 3.047 MWe type J620 GS and gasification of boilers 3 x KM12-12 t/h – reduction of about 161,000 t CO_2 (2007 – 2112) ;
    - Toplofikatsia Yambol JSC – cogeneration 3.047 MWe type J620 GS and new thermal network with substations for 6000 new customers – reduction of about 232,000 t CO_2 (2007 – 2112) ;
    - Total reductions of about 1,096,000 t CO_2 (2007 – 2112);

1.4.4 Description the ACTIVITIES of the project

To achieve the results described above, AKB Fores PLC expect to execute the activities of the separates projects, beginning with preparation in the beginning of 2005 and starting with real project activities in July 2005 and ending these activities in the end of 2006.

The activities to be performed for the realization of the project are shown in the table below:

Activities	**Polymeri JSC Devnia Emissions CO2**	**Kostenets HHI -JSC Emissions CO2**	**Toplofikatsia Iambol JSC Emissions CO2**	**Toplofikatsia Kazanlak JSC Emissions CO2**
1. Feasibility study and final	Yes	Yes	Yes	Yes

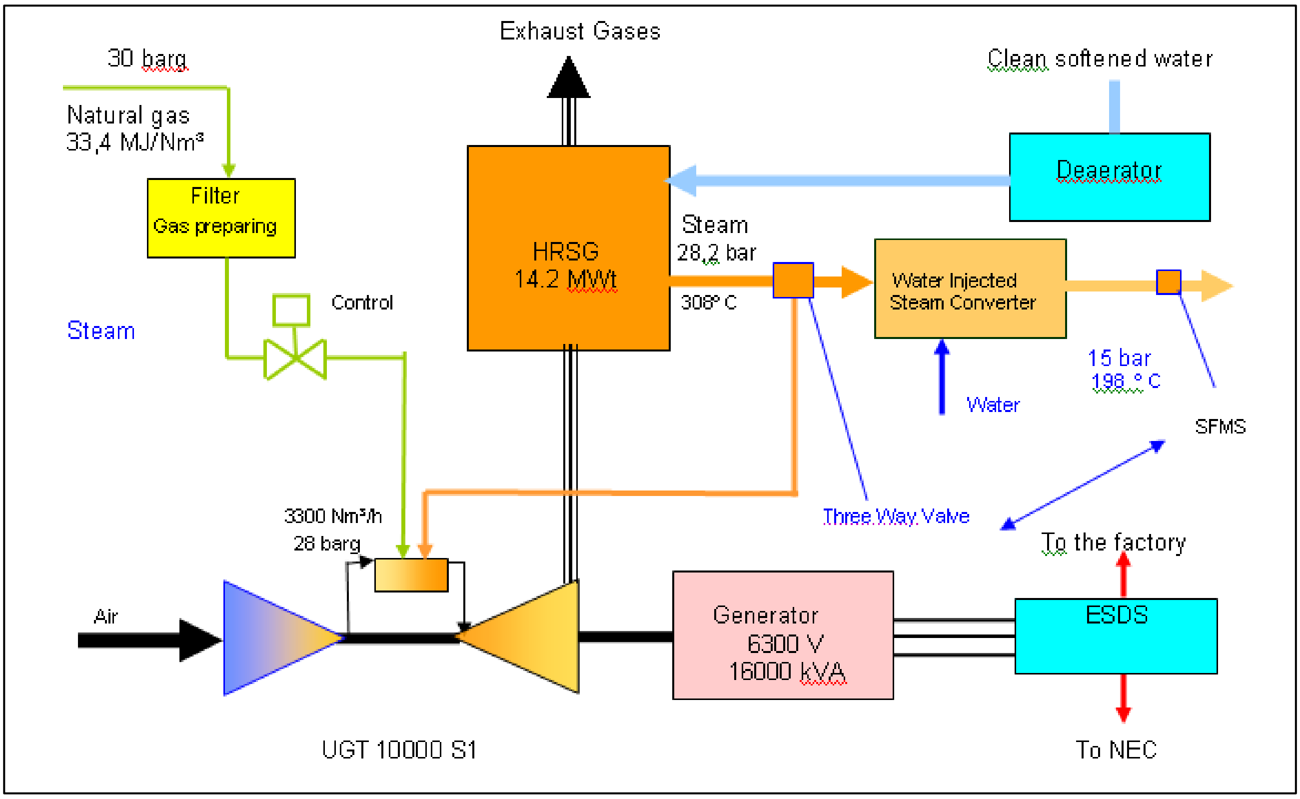
cogenerations choice.				
2. Design, projects coordination, permits issue.	Yes	Yes	Yes	Yes
3. Gasification project design, equipment supply, building.	6 km, Dn 100, Pn = 35 barg Yes	8 km, Dn 150, Pn = 35 barg Yes	No	Building of AGDS Yes
4. Boilers reconstruction 3 x KM12 - 12t/h from HFO to NG- design, equipment supply, building.	No	No	No	Yes
5. Thermal network and substations for 6000 new consumers -design, equipment supply, building.	No	No	Yes	No
6. Production and supply of the cogenerations	UGT 10000S1 STIG Yes	UGT 10000S1 STIG Yes	2 x J620GS Yes	J620GS Yes
7. Constructions on site	Yes	Yes	Yes	Yes
8. Installation and adjustment of the equipment	Yes	Yes	Yes	Yes
9. Commissioning	Yes	Yes	Yes	Yes
10. Operation, monitoring, maintenance	Yes	Yes	Yes	Yes

1.5 Detailed project description

1.5.1 Description of the technology and the technical capacity

Cogeneration modules with gas turbines for the project activities at Industrial factories in Polymeri JSC and Kostenets HHI:

The cogeneration installations are the main part of the executed projects in the power plants and factories and a key factor for their development and economical efficiency. The choice of the cogenerations was done on the base of the thermal loads (see Annex No.3) and accordance with the tables for the prognostic development of the all four involved companies to 2015 shown in Annex No.2. Cogenerations of gas turbines from identical type, with electrical power about 10 MWe thermal power of steam about 14 MWt, will be installed in the factories Polymeri JSC and Kostenets HHI JSC. The steam load of these two factories is partially irregular and the choice is for STIG working gas turbines, in technological scheme shown below:



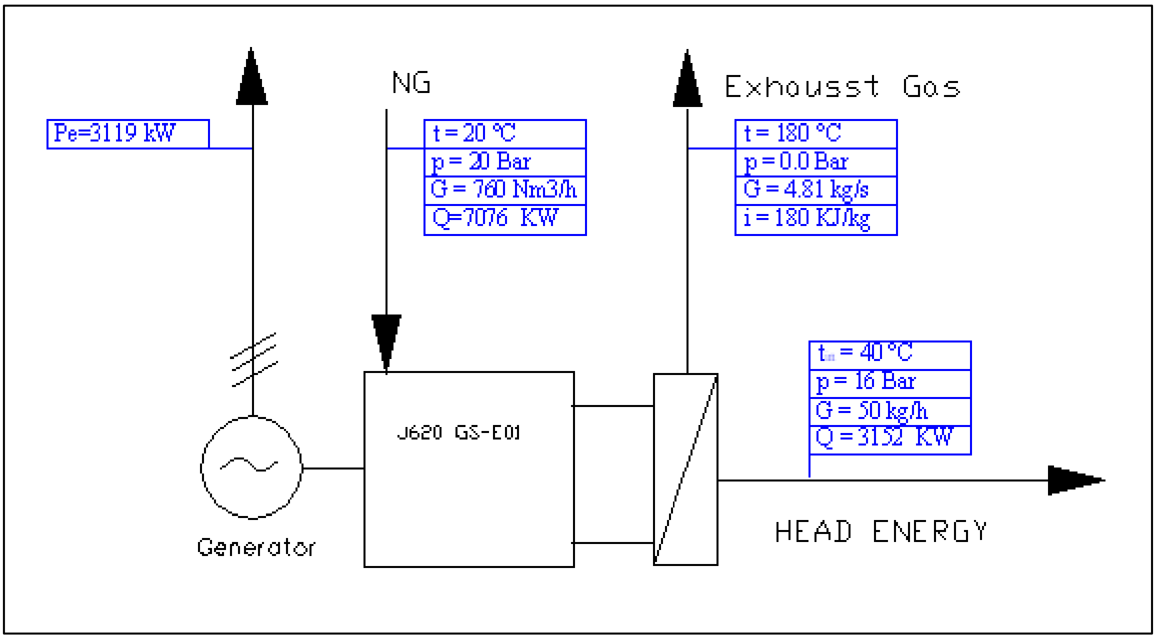
The solution is based on the cogeneration installation type UGT 10000 S1 STIG from Mashproekt Ukraine, although a contract has not been signed yet with this supplier. The installation is complete with heat recovery steam generator (HRSG). The installation with its dimensions is shown in Annex No.3.

About 35 % of the produced steam can be used in the engine for power enhancement. The working regime is very flexible and fully automatic. The necessary quantities of steam will automatically be received from the Water Injected Steam Converters which support the temperature and the pressure of the steam in closed limits. Three Way Valve feed the gas turbine with the steam exceed.

The gas turbine UGT 10000 is a modular modern three shafts construction with two modules- gas generator and power turbine assembled on common base-frame. This type of construction gives the possibility for changing the modules in time of operation. The
gas generator is two cascades (two stages) - compressor low pressure with 9 stages and high pressure compressor also with 9 stages. The construction is shaft in hollow shaft connection of the high and low pressure turbines to the compressors. The combustion chamber is low emission counter flow type consist of 10 ember pipes connected with pipes for distribution of the explosion. The free power turbine is axial console type. The starter is electrical type controlled with frequency inverter. The data sheet of the gas turbine is shown in Annex No.5. The steam generator is situated on the top of the installation, which reduces amount of space used by the installation. The Control System is production of CCC-USA. The system ensures fully automatically control of all parameters of engine and generator work, including and limited regulation of the restricted parameters for enhancement of the efficiency and resource of the turbine. There is a parametric diagnostic subsystem for prognostication of the technical condition of the turbine and the generator and clearly determines the difference between the project characteristics and these in every moment. The module defines the time to the individual repairs of the equipment. The system ensures possibility for connection to higher level control system like this of the factory. Block scheme of the Control System is shown in Annex No.6.

Cogeneration modules with gas engines for the district heating project activities in Toplofikatsia Kazanlak and **Toplofikatsia Yambol**

Cogenerations modules with gas engines will be installed in Toplofikatsia Kazanlak and Toplofikatsia Yambol. The gas engine cogenerations have the additional advantage compared to the gas turbines, that when necessary they can produce hot water. Two cogenerations are foreseen for Toplofikatsia Kazanlak and one for Toplofikatsia Yambol.
The chosen cogenerations are production of GE Jenbacher Austria and are identical for the two places. The likelihood that these cogenerations modules will be installed is rather high, although at this moment a contract with this technology supplier has not been signed yet. The electrical power per unit is 3,047 MWe and the thermal power 3,173 MWt of each module. The type of the gas engines is J620GS. The data sheet of the engine is shown in Annex No.8. The main characteristics are in the picture below:



The engine allows optimal combustion and thereby ensures high efficiencies and long life time of cylinder heads and spark plugs. The patented lean mixture combustion control developed by Jenbacher ensures the correct air/gas ratio under all operation conditions to minimize exhaust gas emissions and to improve the efficiency of the engine. The scope of delivery will include turnkey container plant. All components required for operating the set are integrated in the container and on the container roof. The electrical control and switching system separated from the engine room allows comfortable operation of the plant. The compact design ensures a space saving installation with service oriented accessibility. One common view of the installation is shown in Annex No.7.

Burner replacement in Kazanlak

The project in Toplofikatsia Kazanlak additionally to the cogenerations modules includes the gasification of three boilers, one type PKM 12 with power 8 MWt the other two KM12 with power also 8 MWt. Will be changed the heavy fuel oil burners with combined natural gas/heavy fuel oil burners of Ray (Germany) production type with 8,75 MWt power and fuel consumption of 1000 Nm³/h gas and 900 kg/h heavy fuel oil.

Rehabilitation and expansion of district heating network in Yambol

The project in Toplofikatsia Yambol, additionally to the cogeneration, will include the reconstruction of old and construction of new thermal network. The pipes of the existing network will isolated pipes which will decrease the losses to a 5 % maximum. Additionally new domestic thermal substations will be installed and improvements will be made to the individual measurements of the thermal consumption.

In Annex No. 9 are shown the schemes of the thermal flows in the projects frames for Polymeri, Kostenets HHI, Toplofikatsia Kazanlak and Toplofikatsia Yambol.

Measurements

The measurements of the steam, the hot water and the will be done with Compart DXF 351 flow computer combine system production of Endress+Hauser from Germany. Using various flow formulas the computer is capable to calculate variables important values like: steam/hot water/mass and heat, gas mass, corrected gas volume and gas combustion heat. The system

supports practically all useable communication standards interfaces. To the system like sensors are included the individual measurements devices also production of “E+H”. For the gas measurements the Vortex Flow Measuring System Prowirl 77 will be used. This system has a very low measuring uncertainty of less than 1 % , it has a wide turndown of up to 40:1, and every flow meter is wet calibrated .
For the steam/hot water/ measurements an Electromagnetic Flow Measuring System – Promag 50/53 P, will be used. This system has a high measuring accuracy of ± 0,2 %.

In Annex No.9 more data are given for the measuring devices. The electricity measurements will be performance with the existing devices for trade measurements.

1.5.2 Expected availability

The table below provides the anticipated implementation plan for execution of the project activities. The expectations for the go/ no go decision are expected around May 2005, subsequently financial closure through negotiations with banks is expected around July 2005

		Terms of execution							
No	**Stages description**	**Polymeri JSC**		**Kostenets HHI JSC**		**Toplofikatsia Kazanlak JSC**		**Toplofikatsia Yambol JSC**	
		Start	**End**	**Start**	**End**	**Start**	**End**	**Start**	**End**
1	Feasibility study, equipment specification, choice suppliers	12.04	05.05	12.04	05.05	11.04	05.05	11.04	05.05
2	Financing of the project	03.05	06.05	03.05	06.05	03.05	06.05	11.04	06.05
3	Equipment contracting	05.05	07.05	05.05	07.05	05.05	07.05	05.05	07.05
4	Execution of the working design	07.05	11.05	07.05	11.05	07.05	10.05	07.05	10.05
5	Gasification project design	08.05	10.05	08.05	10.05	03.05	07.05	-	-
	The land rights issued	08.05	03.06	08.05	03.06	08.05	03.06	-	-
	Equipment delivery	11.05	04.06	11.05	04.06	09.05	02.06	-	-
	Constructing	02.06	10.06	02.06	10.06	01.06	10.06	-	-
	Test and start of operation	10.06	11.06	10.06	11.06	10.06	11.06	-	-
6	Obtaining a construction permits	10.05	01.06	10.05	01.06	10.05	01.06	10.05	01.06
7	Preparation of the documents and obtaining a production license and green certificates	01.06	10.06	01.06	10.06	01.06	08.06	01.06	08.06
8	Thermal network and thermal substations design 6000 cons.	-	-	-	-	-	-	07.05	10.05
	Equipment delivery	-	-	-	-	-	-	10.05	02.06
	Constructing, installing	-	-	-	-	-	-	12.05	11.06
	Commissioning	-	-	-	-	-	-	11.06	12.06
9	Boilers reconstruction design	-	-	-	-	07.05	10.05	-	-
	Equipment delivery	-	-	-	-	10.05	03.06	-	-
	Constructing, installing	-	-	-	-	01.06	08.06	-	-
	Commissioning	-	-	-	-	11.06	12.06	-	-
10	Preparation of the project site	09.05	12.05	09.05	12.05	09.05	12.05	09.05	12.05
11	Execution of the civil works	11.05	05.06	11.05	05.06	11.05	03.06	11.05	03.06
	Delivery of the equipment /cogenerations and additional equipment /	07.05	09.06	07.05	09.06	08.04	04.06	08.04	04.06
12	Installation of the equipment	07.06	11.06	07.06	11.06	03.06	10.06	03.06	07.06
13	Pre-commissioning tests	11.06	12.06	11.06	12.06	11.06	12.06	07.06	08.06
14	Commissioning tests (72-hour tests)	12.06	12.06	12.06	12.06	12.06	12.06	08.06	09.06
15	**Start of regular operation**	**01.01**	**.07**	**01.01**	**.07**	**01.01**	**.07**	**01.01**	**.07**

1.5.3 Expected capacity factor and project activity level

The expected capacity factor of the cogeneration equipment is defined as follows:

- The observations of the use gas turbine installations show that the annual use normally exceeds 95 % or 8300 hours. Here for higher certainty reasons from economic perspective, as well as from the emission reductions point of view, the annual rate for equipment utilization has been set at 8200 hours/per year, i.e. at 93.6 %;

Based of the experience of operation of gas reciprocating engines the rate of the annual capacity normally exceeds 96 %.
The production capacity of the cogeneration installations have been selected mainly on the basis of the criteria to provide the minimum needs of steam and hot water, for extensive information see the load diagrams of the thermal needs of the factories in Annex No. 3. Especially for Toplofikatsia Kazanlak and Toplofikatsia Yambol the additional needs from hot water and steam in the heating season will be ensured from the existing gasified steam boilers. The cogenerations for Polymeri and Kostenets HHI had been selected from Steam Injection Generation type for flexibility of operation to meet the variations in the steam loads in the day and the needs in the year. In Kostenets HHI for example, part from the cogeneration produced steam, about 15-20% are use for additionally production of electricity for selling to NEC.

In accordance with the needs of Toplofikatsia Kazanlak the rate of annual use is 6250 hours per year and for Toplofikatsia Yambol is estimated at 8000 hours per year.
The gas engine cogenerations in Toplofikatsia Kazanlak and Toplofikatsia Yambol also will operate continuously 7 days a week and 24 hours a day at nominal load working regime in the time of annual use.

The separate projects activity levels in accordance with the energy demands of the factories are shown in the table below:

Company		Energy needs				Projects energy produced			
		Electricity		Thermal energy		Electricity		Thermal energy	
		Factory consumption	For selling to NEC	Steam	Hot water	Factory consumption	For selling to NEC	Steam	Hot water
	Years	MWhe	MWhe	MWht	MWht	MWhe	MWhe	MWht	MWht
Polymeri JSC	2007	148000	-	130500	-	80934	-	114800	-
	2008	145000	-	128500	-	80934	-	114800	-
	2009	142000	-	126500	-	80934	-	114800	-
	2010	142000	-	124500	-	80934	-	114800	-
	2011	142000	-	124500	-	80934	-	114800	-
	2012	142000	-	124500	-	80934	-	114800	-
	2013	142000	-	124500	-	80934	-	114800	-
	2014	142000	-	124500	-	80934	-	114800	-
	2015	142000	-	124500	-	80934	-	114800	-
	2007	53295	-	90183	-	53295	35270	90183	-
	2008	53852	-	93412	-	53852	33712	93412	-
	2009	56530	-	96639	-	56530	30034	96639	-

Kostenets HHI JSC	2010	57911	-	98254	-	57911	28152	98254	-
	2011	60615	-	101482	-	60615	24448	101482	-
	2012	60685	-	101482	-	60685	24378	101482	-
	2013	60685	-	101482	-	60685	24378	101482	-
	2014	60685	-	101482	-	60685	24378	101482	-
	2015	60685	-	101482	-	60685	24378	101482	-
Toplofikatsia Kazanlak JSC	2007	7713	31743	16810	68304	7713	30099	-	39662
	2008	7555	32750	16810	69740	7555	30257	-	39662
	2009	7588	32055	16810	70335	7588	30225	-	39662
	2010	7467	32742	16810	70793	7467	30346	-	39662
	2011	7588	32742	16810	70335	7588	30225	-	39662
	2012	7467	32742	16810	70793	7467	30346	-	39662
	2013	7588	32742	16810	70335	7588	30225	-	39662
	2014	7467	32742	16810	70793	7467	30346	-	39662
	2015	7588	32742	16810	70335	7588	30225	-	39662
Toplofikatsia Yambol JSC	2007	2680	21320	-	48197	2680	21880	-	25384
	2008	2680	21320	-	48197	2680	21880	-	25384
	2009	2680	21320	-	48197	2680	21880	-	25384
	2010	2680	21320	-	48197	2680	21880	-	25384
	2011	2680	21320	-	48197	2680	21880	-	25384
	2012	2680	21320	-	48197	2680	21880	-	25384
	2013	2680	21320	-	48197	2680	21880	-	25384
	2014	2680	21320	-	48197	2680	21880	-	25384
	2015	2680	21320	-	48197	2680	21880	-	25384

2. CURRENT SITUATION

Currently, the required energy resources for the normal operation of Polymeri JSC, Kostenets HHI JSC, Toplofikatsia Kazanlak. JSC and Toplofikatsia Yambol JSC electric power, gas, steam, and compressed air are provided, as follows:

Electric power
Single line diagrams of the factories power supply are shown in Annex No.11.

Polimeri JSC
The factory is a consumer of the first assurance category, which, according to the Bulgarian legislation, means that it is supplied from two independent sources.
The factory is supplied from the network of 110 kV - NEC with two “Albatros II “ and “ KipraII “leading-in/out wire and TPS Deven of three transformers of 110 kV and power 2x 40.5 MVA, 1x125 MVA. The inside supply of power to the factory is from 110 kV busbar system with two transformers 110/6 kV to a section busbar system at 6 kV. Each of the transformers has a power capacity of 75 MVA and is capable to transfer the full consumption of the factory and the capacity of the cogeneration.
The cogeneration’s generator terminals will be connected to the factory’s network in the main electrical substation to the section busbar of 6 kV voltage. This is shown in Annex No.11. The place for the cogeneration is closed to the substation.

Kostenets HHI JSC
The factory is a consumer of the second assurance category, which, according to the Bulgarian legislation, means that it is supplied from one independent source, but with two leading-in/out wire. The factory is supplied from the network of NEC with two leading-in/out wire “Muhovo “and “Mirovo” at 110 kV. Two transformers 110/6 kV one with power 20 MVA and the other one 16 MVA to distribution switchgear of 6 kV supply the factory.
The cogeneration is situated around 150 m from the main electrical substation and the connection to the network will be realized with two cables to the 6 kV voltage busbar system (See AnnexNo.11). The capacity of the transformers is fully enough for transfer of the surplus or full produced cogeneration electricity to NEC.

Toplofikatsia Kazanlak JSC
The factory is producer of electrical and thermal energy. The power plant is a consumer of second assurance category. Like consumer and producer of electricity the factory is connected to NEC with two leading-in/out wires “Turbina”20kV and “Malnia”20kV. The transformers are 6/20 kV and power 2 x 12,5 MVA. The cogenerations modules are connected to the network directly to the busbars 6 kV at the distribution switchgear 6kV in the main substation of factory. The existing transformers power is fully enough for the transfer of the produced cogenerations electricity to the NEC.

Toplofikatsia Yambol
The factory is producer of electrical and thermal energy. The factory is a consumer of second assurance category. The factory is connected to NEC, like consumer and producer of electricity, with two leading-in/out wires “Tekstil”20 kV and “DK” 20 kV. The transformers 6/20 kV are with power the one 1 MVA and the other one 0,4 MVA. This transformer power is not enough for transfer of the electricity produced from the cogeneration module. It is foreseen here to be installed additionally new transformer 6/20 kV with power 10 MVA. The cogeneration module will be connected to 6 kV busbar in the main electrical substation.

Gas supply

All the factories will be connected directly to the Bulgargas network. Polymeri and Kostenets will be connected on high pressure at 3.5 MPa Kazanlak and Yambol will be connected at 0.6 MPa. In the last case, the price of the gas is lower.

Polymeri JSC

Polymeri currently is not connected to the Gas Distribution Station. The construction of the pipeline and gas distribution station with capacity 10000 Nm³/h is foreseen in the implementation plan of the project activity. The pipeline is for high pressure is at 3.5 MPa .

The diameter of the pipe is 100 mm and the length of the pipeline is about 6 km.

The path from the Bulgargas gas distribution station Devnia to the factory is foreseen to be on the path of existing pipeline to TPS Deven with pressure 1.2 MPa, close to Polymeri. The construction of this pipeline will require approximately 350,000 Euro as can be seen in the financial plan of the project. The pipeline is expected to be finished and ready for operation in October 2006. Bulgargas has expressed to cooperate on the connection of the gas pipeline to the Gas distribution station in Devnia (see letter of Bulgargas in Annex No.18).

Kostenets HHI JSC

Kostenets HHI is currently not connected to Gas Distribution Station. The construction of a pipeline and a gas distribution station with capacity of 15,000 Nm³/h is foreseen in the implementation plan of the project. The pipeline is for high pressure at 3.5 MPa.

The diameter of the pipe is 150 mm and the length of the pipeline is about 8 km. The gas distribution station will also enable the provision of gas to the population of the town of Kostenets. The path of the pipeline is determined from an existing old project. The project needs to be updated but will function as blueprint for the construction of the pipeline.

The investments in the gas pipeline require approximately 650,000 Euro as can be seen in the financial plan of the project. The pipeline is expected to be finished and ready for operation in October 2006. Bulgargas has expressed its commitment to connect the pipeline to the Gas measuring station which is located at 100 meters from the main gas pipeline in a letter to AKB Fores (See Bulgargas in Annex No.18).

Toplofikatsia Kazanlak JSC

Toplofikatsia Kazanlak is currently not connected to Gas Distribution Station. The project for building of the gas pipeline here is combined with Municipality of Kazanlak, and other big factories in the region. The big part of the necessary investments will be ensured with objective-oriented amount from the State Budget to Municipality. The pipeline will be connected to Gas distribution station “Kalitinovo”. The length of the pipeline is about 40 km. The participation of Toplofikatsia Kazanlak in the investment in the project is estimated at 400,000 Euro for constructing of Gas distribution station on the territory of the Toplofikatsia. This amount is foreseen in the financial plan of the project. The consumption of gas including the population of town Kazanlak will increase gradually to 25,000 Nm³/h. The pipe inside of the factory will be at 0,6 MPa pressure. The consumption of the factory is estimated conservatively at 8,000-10,000 Nm³/h.

Toplofikatsia Yambol JSC

At ToplofikatsiaYambol there already exists a supply pipeline for natural gas from Bulgargaz. The diameter of the pipeline is 200 mm, and the pressure is at 0,6 MPa. The consumption of the gas by Toplofikatsia Yambol in the heating season is around 1300 Nm³/h. With the expansion of the network approximately 6,000 consumers will be added to the network, therefore the gas consumption of the factory will increase to 11,000 Nm³/h.

Thermal energy

The cogenerations realized in the project will produce steam and hot water. In Annex No.2, Annex No.3 and Annex No. 9 the thermal needs of the factories are given in accordance with their prognostic development, the load profile of their thermal energy demands and the thermal flows produced from the cogenerations.

Polymeri JSC

Polymeri uses now three kinds of steam 0.6 MPa, 1.5 MPa, 3.6 MPa for technological needs. The annual quantities of steam for 2004 are 0.6 MPa-40400 MWht, 1.5 MPa-83200 MWht, 3.6 MPa – 3700 MWt.

Polymeri receives the whole quantity of the necessary steam from TPS Deven. TPS Deven produce the steam with three Russian boilers 160 t/h, 10 MPa, 540° C.

The fuel are coals type "Anthracite ". Polymeri uses the steam without returned condensate, this will prevent chemical decontaminated water in the factory. Now they receive water with good quality for technological needs from lake "Tsonevo".

The factory will introduce new technology in the future and chemical processing of the water will be necessary. In parallel with the cogeneration implementation, in the factory a plant for preparation of the water for the cogeneration and the new technology will be realized. Polymeri has a big set of technological steam pipelines. The cogeneration is situated closed to the biggest consuming installation of technological steam.

The cogeneration will cover about 93-96 % from their 0.6 MPa and 1.5 MPa steam needs

Kostenets HHI JSC

Kostenets HHI produce all the steam that is necessary for the technological processes in the factory. In the factory steam boilers type KM 12 – 12 t/h, 1,3 MPa, 198° C - 1 ps Bulgarian production, type DE 25/24, GM-23 t/h, 2,4 MPa,198° C – 2 ps. Russian production, are installed. The boilers use heavy fuel oil as fuel. The average annual steam needs are about 66,000 MWht now and increase to 91,000 – 101,400 MWht after introducing of the new production line in 2006. The efficiency of the boilers is about 89%. Within the factory a chemical processing plant is located for the treatment of the water from the boilers. The capacity of the installation is 50t/h. The capacity is enough to include requirements from the new cogeneration equipment. The cogeneration will be closely situated to the existing thermal station and the connection to the steam pipeline will be easy. The cogeneration will produce about 20,000 MWht surplus steam annually. The exceed quantity will be fed additionally into the gas turbine.

Toplofikatsia Kazanlak

Toplofikatsia Kazanlak produce thermal energy for the population of Kazanlak and industrial factories in the region. There are five boilers for producing of the thermal energy. Two pieces of the type EPG 2 and EPG 3 Bulgarian production 1974, 35 MWt, steam with parameters 3.9 MPa pressure and 440 ° C temperature. One piece type PKM-12 - 8 MWt, steam with parameters 1.3 MPa pressure and 190 ° C temperature, two pieces type KM-12 with the same technical dates like PKM-12. There are also two turbo sets with steam turbines type P-6-35/11 and P-6-35/6 6 MW, 3,5 MPa pressure of the steam on the inlet and 435 ° C temperature. The generators in the sets are type T2-6-2, 6,3 kV voltage and power 7.5 MWe. The turbo sets work with the boilers EP2 and EP3. The EP2 or EP3 boilers work in the heating season with the one of the turbines.

All of the boilers work of heavy fuel oil. The overall efficiency of the existing thermal systems is low because the boilers work operate at low load factors. The average efficiency of the boilers is low, about 83 %. This is low since the systems design applies for much bigger loads. Due to reduced demand the boilers receive less load and therefore also the electricity produced from the turbo sets is with low efficiency.

With the installation of the new cogeneration modules, the two big boilers EP2, EP3 and the steam turbines will be stopped with operation.

The three industrial boilers KM-12 and PKM-12 will be reconstructed from heavy fuel oil to natural gas and the new two cogeneration modules and these boilers will cover the steam and hot water needs more flexible and with higher efficiency. See the table in p.1.5.3. The chosen cogenerations location permits easy installation, short connections of pipelines and electrical cables.

Toplofikatsia Yambol JSC

Four boilers are currently installed at the premises of Toplofikatsia Yambol. The boilers are of the type KM-12, Bulgarian production (1974) - with 8 MWt thermal power and steam parameters 1.3 MPa pressure and 190 ^{o} C temperature. Until 1999 the boilers used heavy fuel oil as fuel and during 1999 the boilers were made ready to use natural gas and the exhaust stack was reconfigured with the installing of a low temperature heat exchanger. During 2003, two boiler units were reconstructed from steam to water heating boilers.

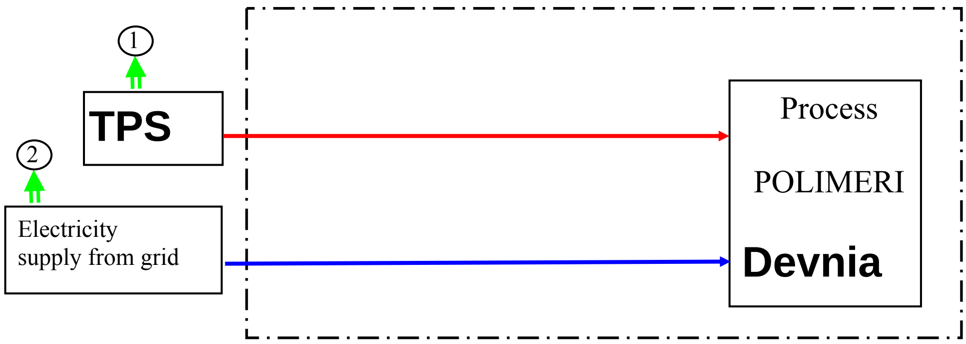
However, investments in expanding the thermal network have never been performed even since the initial installing of the power station. Even the current thermal network is not used well with only 500 customers now, but with increased competitiveness of the thermal generation, made available through the use of the cogeneration module, many new customers can be added. A feasibility study provides for the increase of the amount of customers to 6,000.

3. Greenhouse Gas Sources And Project Boundaries

3.1 Polimeri Greenhouse Gas Sources And Project Boundaries

3.1.1 Flowchart of the current delivery system – separate generation of heat and electricity

Flowchart of current delivery system with it's the main components and their connections.



1 – CO_2 emissions (combustion in boilers)
2 – CO_2 emissions (electricity from grid)

Description of the anthracite coal consumers in Devnja in the current situation:

- Boilers energy in TPS– outside of POLIMERI Devnja. Steam supply from TPS for technological needs of the Plant.

  Annual heat consumption are presented in Chapter 2. Load profile of heat demand is presented in Chapter1.5.3.

Electricity supply: by electricity grid for POLIMERI Devnja own needs

Description of the heat consumers:

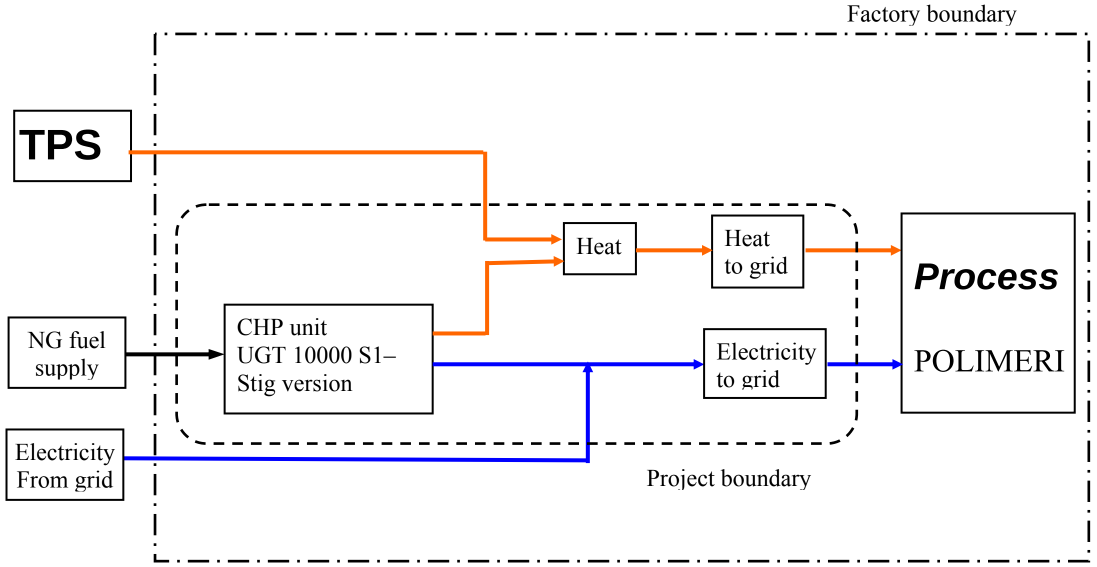
- Steam for technological needs. There is slight difference in seasonal consumption

3.1.2 Flowchart of the project

The following considerations are taken into account in the flowchart construction of the project:

- CHP for combined heat and power generation will be installed.
- The production of heat from CHP will cover only the base heat load. The rest of the heat (pick load) will be covered by existing "back up" boilers from TPS;
- According to energy demand scenario the production of electricity from CHP will cover partially electricity demand for own needs of POLIMERI Devnja and the rest of electricity will be imported additionally from the grid.

Flowchart of the project with its main components and their connections



3.1.3 Project boundaries

Project boundaries for natural gas fired in CHP is given in fig. 3.3.1.

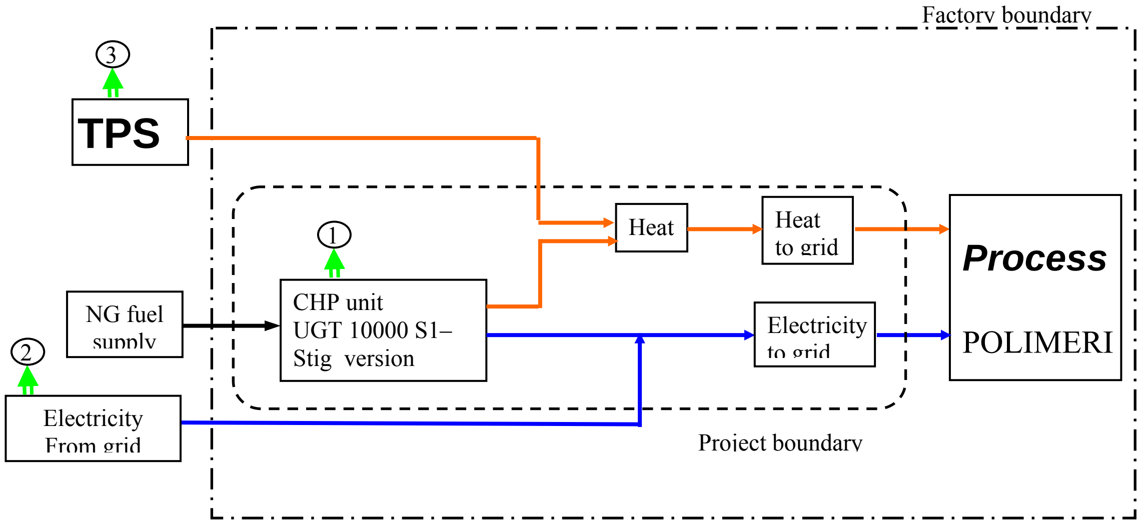


Fig. 3.1.3.1 Project boundary for natural gas fired in CHP

1 – Direct on-site CO_2 emissions (comb in CHP)
2 – Direct off-site CO_2 emissions (comb in back up boilers)
3 – Direct off-site CO_2 emissions (electricity from grid)

The project comprises the installation of the CHP whose input is with natural gas from the pipeline, and whose outputs are electricity and heat supplied to the relevant grids in POLIMERI Devnja. Although the project will be installed at the factory site, the project boundary is strictly the CHP and heat and power connected grids in POLIMERI Devnja. That is why CO_2 emissions, caused by the natural gas combustion in the CHP are direct on-site emissions.

The cogeneration system is sized to provide base heat load to the POLIMERI.
Prior to project installation, Devnja acquires all of electricity from the power grid and meets all of its heat requirements by steam supply from TPS. Once the project is realized, the plant acquires heat and electricity from CHP to meet some of its heat and electricity needs. The remaining heat demand is met by existing (back up) boilers in the existing TPS. CO_2 emissions, caused by combustion in back up boilers in order to cover heat demand, are in the TPS boundary, but out of the project boundary. They are directly influenced by the project. That is why they are direct off-site emissions. The produced by CHP electricity will cover partially the electricity demand in POLIMERI Devnja and the rest will be bought from the power grid. The baseline emissions are determined by the electricity and fuel purchases by the plant.

The project emissions depend on gas input to the CHP, back up boilers and electricity used by the plant, while emissions avoided can be determined from the difference between baseline emissions and the project ones. The associated monitoring determines both project and baseline emissions.

3.1.4 Direct and indirect emissions

With this definition of the project boundary, the Project and Baseline emissions, both *On-site and Off-site* are as shown in Table 3.4.1:

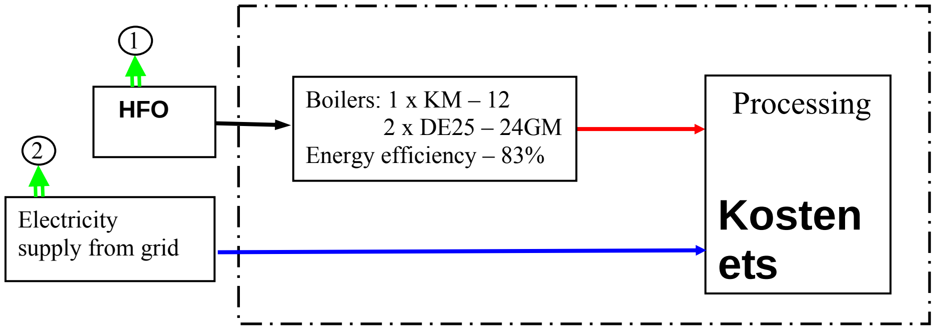
Table 3.4.1. Project and baseline emissions, direct and indirect, on and off-site

On-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in CHP	CO_2 emissions from HFO combustion in boilers	Direct	Include
Off-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in back - up boilers		Direct	Include
	CO_2 emissions from electricity grid	Direct	Include

3.2 Kostenets HHI Greenhouse Gas Sources And Project Boundaries

3.2.1 Flowchart of the current delivery system – separate generation of heat and electricity

Flowchart of current delivery system with it's the main components and their connections.



1 – CO_2 emissions (combustion in boilers)
2 – CO_2 emissions (electricity from grid)

Description of the HFO (heavy fuel oil) consumers in KAZANLAK in the current situation:

- Boilers – number:

  N1 to N2: - 2 units DE 25-24GM – (2x25 t/h; 15 bar; 198 ºC)

  N3 - 1 unit KM 12 – (1 x 12 t/h, saturated steam with 8.5 bar)

  Annual heat productions and HFO consumption are presented in Chapter 2. Load profile of heat demand is presented in Chapter 1.5.3. The boilers' efficiency values are varied, but a conservative mean value of 85 % is taken into account into the further evaluations

Electricity supply: by electricity grid for Kostenets Plant own needs

Description of the heat consumers:

- Steam for technological needs

Operational modes:

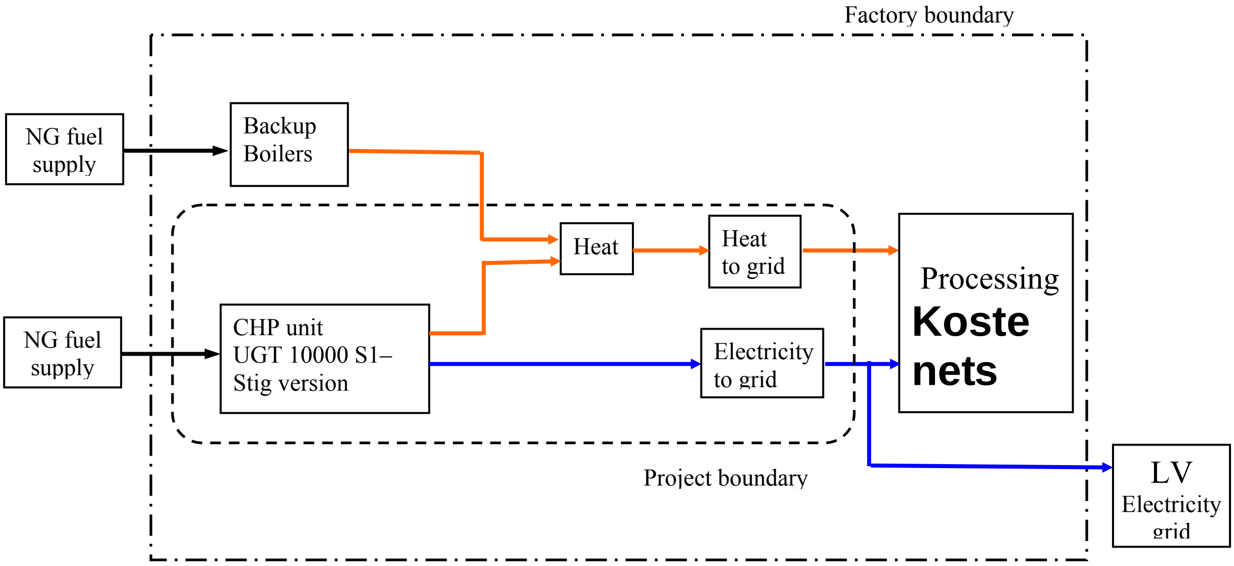
- Almost constant heat consumption

3.2.2 Flowchart of the project

The following considerations are taken into account in the flowchart construction of the project:

- CHP for combined heat and power generation will be installed.
- The production of heat from CHP will cover only base heat load. The rest of the heat (pick load) will be covered by existing “back up” boilers;
- The fuel base will be entirely changed: instead of HFO (heavy fuel oil) natural gas (NG) will be used.
- According to energy demand scenario the production of electricity from CHP will cover entirely electricity demand for own needs of Kostenets Plant and the rest of electricity production will be exported to the grid.

Flowchart of the project with its main components and their connections



3.2.3 Project boundaries

Project boundaries for natural gas fired in CHP is given in fig. 3.3.1.

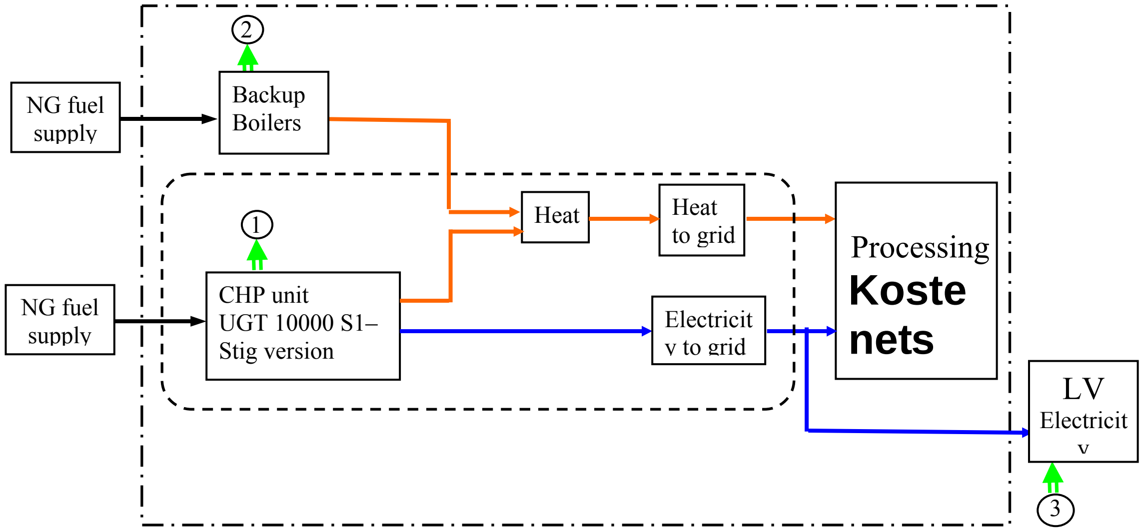


Fig. 3.2.3.1 Project boundary for natural gas fired in CHP

1 – Direct on-site CO_2 emissions (comb in CHP)
3 – Direct off-site CO_2 emissions (comb in back up boilers)
2 – Indirect off-site CO_2 avoided emissions (electricity to grid)

The project comprises the installation of a CHP whose input is natural gas (NG) from the gas pipeline, and whose outputs are electricity and heat supplied to the relevant grids in Kostenets Plant. Back up boilers will be also connected to the natural gas pipeline system in the frame of this project, but as the output of the system is changed by introduction of CHP, that is why the project is related to the specific project category – CHP. Although the project will be installed at the factory site, the project boundary is strictly the CHP and heat and power connected grids in the Plant. That is why CO_2 emissions, caused by NG combustion in CHP are direct on-site emissions.

The cogeneration system is sized to provide base heat load to the DHC. Prior to project installation, Kostenets Plant acquires all of electricity from the power grid and meets all of its heat requirements by combustion in boilers. Once the project is realized, the plant acquires heat and electricity from CHP to meet some of its heat and all electricity needs. The remaining heat demand is met by existing (back up) boilers at the plant with natural gas from NG pipeline. CO_2 emissions, caused by NG combustion in back up boilers in order to cover heat demand, are in the factory boundary, but out of the project boundary. They are directly influenced by the project. That is why they are direct off-site emissions. The produced by CHP electricity will cover the whole Kostenets Plant electricity demand and the rest will be sold to the power grid. At this case it will shift power load in the grid. It will reduce CO_2 emissions – indirect avoided off-site emissions.
The baseline emissions are determined by the electricity and fuel purchases by the plant.

The project emissions depend on gas input to the CHP, back up boilers and electricity sold by the plant, while emissions avoided can be determined from the difference between baseline emissions and the project ones. The associated monitoring determines both project and baseline emissions.

3.2.4. Direct and indirect emissions

With this definition of the project boundary, the Project and Baseline emissions, both *On-site and Off-site* are as shown in Table 3.4.1:

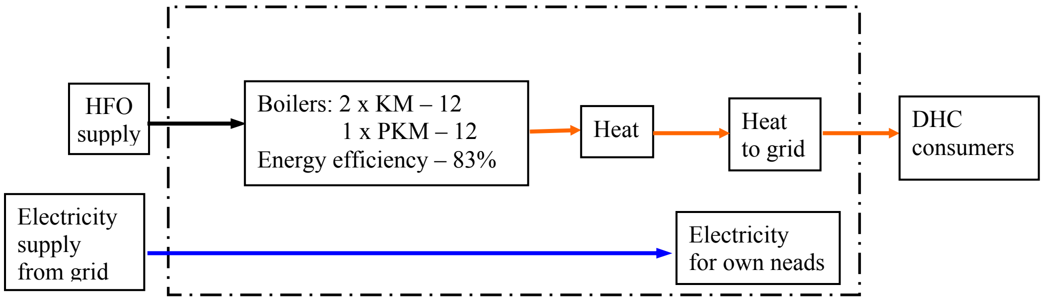
Table 3.4.1. Project and baseline emissions, direct and indirect, on and off-site

On-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in CHP	CO_2 emissions from HFO combustion in boilers	Direct	Include
Off-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in back - up boilers		Direct	Include
CO_2 avoided emissions to Electricity grid		Indirect	Include

3.3 Toplofikatsia Kazanlak Greenhouse Gas Sources And Project Boundaries

3.3.1 Flowchart of the current delivery system – separate generation of heat and electricity

Flowchart of current delivery system with it's the main components and their connections.



1

– CO_2 emissions (combustion in boilers)
2 – CO_2

missions (electricity from grid)

Description of the HFO (mazut) consumers in KAZANLAK in the current situation:

- Boilers – number:

  N1 to N2: - 2 units KM 12;

  N3 - 1 unit PKM 12

  All 3 boilers are with steam capacity 12t/h (saturated steam with 8,5 bar pressure);

  Annual heat productions and HFO consumption are presented in Chapter 2. Load profile of heat demand is presented in Chapter1.5.3. The boilers' efficiency is presented in **Annex No. 9** These values are varied, but a conservative mean value of 83 % is taken into account into the further evaluations

Electricity supply: by electricity grid for DHC Kazanlak own needs

Description of the heat consumers:

- DHC Kazanlak heating and tap hot water consumers;

Operational modes:

- heating demand for DHC Kazanlak consumers – seasonal operation mode;

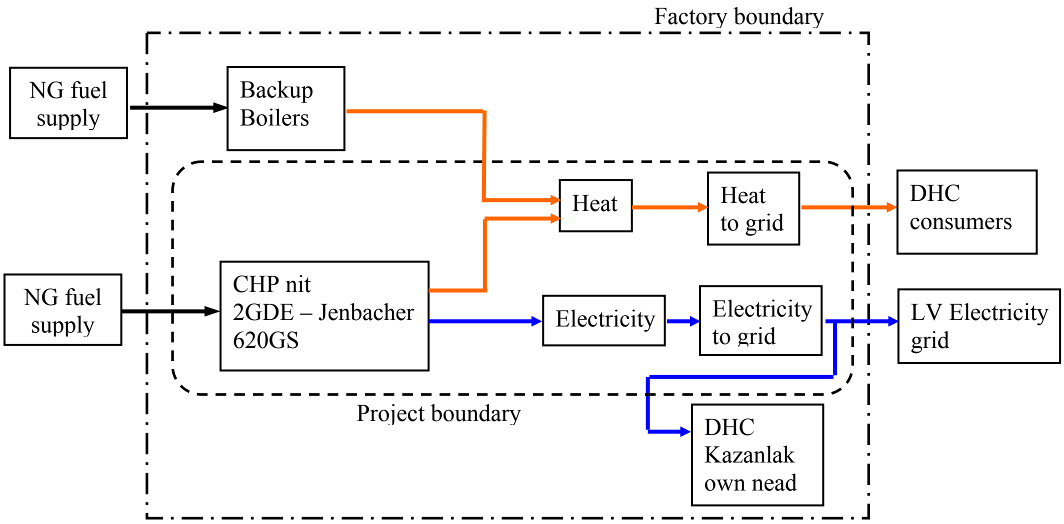
3.3.2 Flowchart of the project

The following considerations are taken into account in the flowchart construction of the project:

- CHP for combined heat and power generation will be installed.
- The production of heat from CHP will cover only base heat load. The rest of the heat (pick load) will be covered by existing "back up" boilers;
- The fuel base will be entirely changed: instead of HFO (mazut) natural gas (NG) will be used.

- According to energy demand scenario the production of electricity from CHP will cover entirely electricity demand for own needs of DHC Kazanlak and the rest of electricity production will be exported to the grid.

Flowchart of the project with its main components and their connections



3.3.3 Project boundaries

Project boundaries for natural gas fired in CHP is given in fig. 3.3.1.

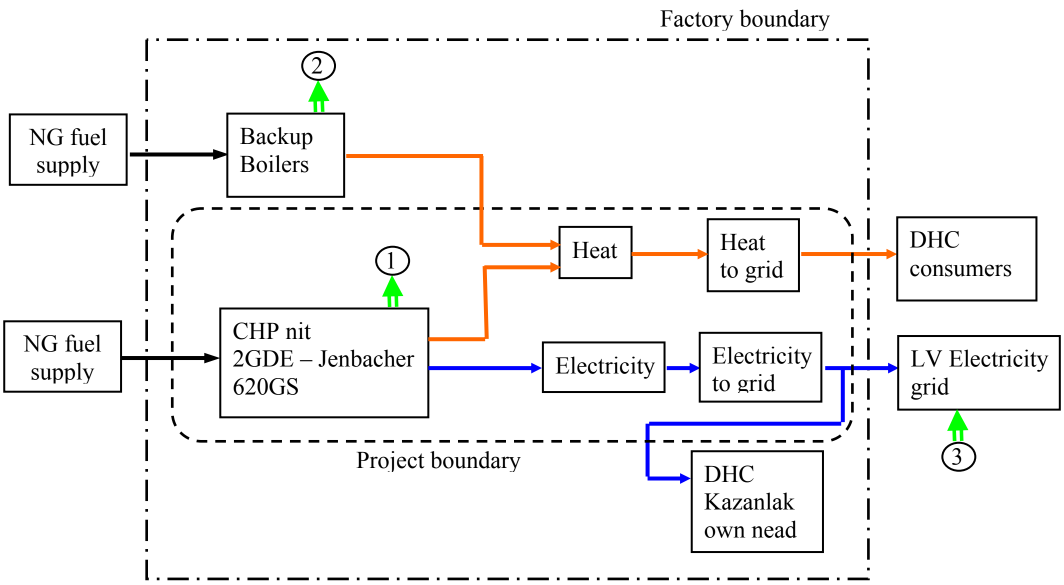


Fig. 3.3.3.1 Project boundary for natural gas fired in CHP

1 – Direct on-site CO_2 emissions (comb in CHP)
2 – Direct off-site CO_2 emissions (comb in back up boilers)
3 – Indirect off-site CO_2 avoided emissions (electricity to grid)

The project is the installation of a CHP whose input is natural gas (NG) from gas pipeline, and whose outputs are electricity and heat supplied to the relevant grids in DHC Kazanlak. Back up boilers will be also connected to the NG gas pipeline system in

the frame of this project, but as the output of the system is changed by introduction of CHP, that' why the project is related to the specific project category – CHP. Although the project will be installed at the factory site, the project boundary is strictly the CHP and heat and power connected grids in DHC Kazanlak. That is why CO_2 emissions, caused by NG combustion in CHP are direct on-site emissions.
The co-generation system is sized to provide base heat load to the DHC. Prior to project installation, DHC acquires all of electricity from the power grid and meets all of its heat requirements by combustion in boilers. Once the project is realized, the plant acquires heat and electricity from CHP to meet some of its heat and all electricity needs. The remaining heat demand is met by existing (back up) boilers at the plant with natural gas from NG pipeline. CO_2 emissions, caused by NG combustion in back up boilers in order to cover heat demand, are in the factory boundary, but out of the project boundary. They are directly influenced by the project. That is why they are direct off-site emissions. The produced by CHP electricity will cover the whole DHC Kazanlak electricity demand and the rest will be sold to the power grid. At this case it will shift power load in the grid. It will reduce CO_2 emissions – indirect avoided off-site emissions.
The baseline emissions are determined by the electricity and fuel purchases by the plant.

The project emissions depend on gas input to the CHP, back up boilers and electricity sold by the plant, while emissions avoided can be determined from the difference between baseline emissions and the project ones. The associated monitoring determines both project and baseline emissions.

3.3.4 Direct and indirect emissions

With this definition of the project boundary, the Project and Baseline emissions, both *On-site and Off-site* are as shown in Table 3.4.1:

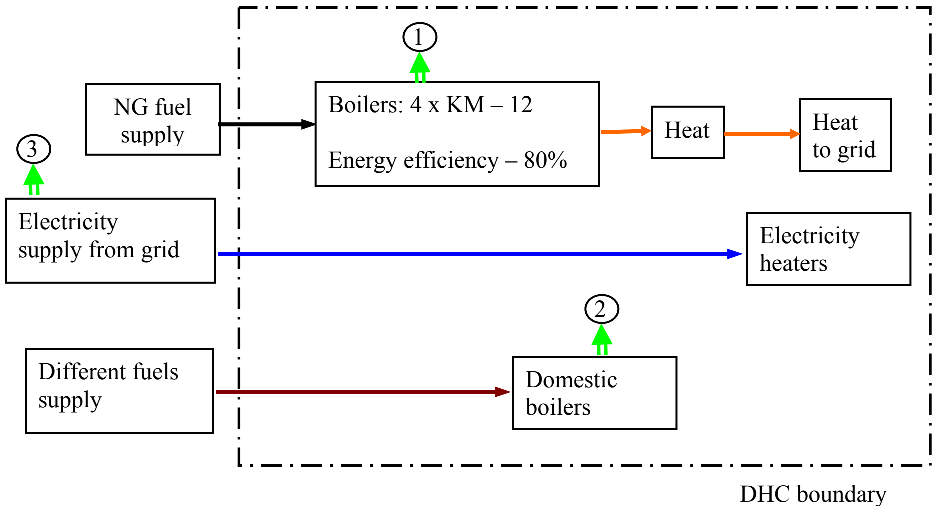
Table 3.4.1. Project and baseline emissions, direct and indirect, on and off-site

On-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in CHP	CO_2 emissions from HFO combustion in boilers	Direct	Include
Off-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in back - up boilers		Direct	Include
	CO_2 emissions from electricity grid	Indirect	Include
CO_2 avoided emissions to Electricity grid		Indirect	Include

3.4 Toplofikatsia Yambol Greenhouse Gas Sources And Project Boundaries

3.4.1 Flowchart of the current delivery system – separate generation of heat and electricity

Flowchart of current delivery system with it's the main components and their connections



1 – CO_2 emissions (combustion in DHC boilers)
2 - CO_2 emissions (combustion in domestic boilers)
3 – CO_2 emissions (electricity from grid) for heating purposes

Description of the different fuel consumers in DHC Yambol in the current situation:

1. NG fuel consumption in DHC Yambol Boiler House

- Boilers – number:

  N1 to N4: - 4 units KM 12;

  All 4 boilers are with steam capacity 4 x 12t/h.

  Annual heat productions and NG fuel consumption are respectively: annual heat consumption: 3540 MWh/y;

  annual fuel consumption: 4400 MWh/y

  Load profile of heat demand is presented in Chapter1.5.3. The boilers' efficiency is equal to η= 3540/4400 = 0.805 and it is taken into account into the further evaluations

The project has estimated to add 6000 new consumers to be connected to the DHC Yambol grid. A statistical data was prepared in order to be evaluated what kind of fuel or electricity and percentage of them in the city of Yambol are used. The results are presented in Table 1:

Table 1

FUEL	%	Kton/TJ
Coal	**11**	**0.1012**
Electricity	**62**	**Reporting form**
Wood	**15**	**0**

DHC	**5.5**	**Reporting form**
No answer	**2**	**-**
Propan/butan	**2**	**0.0631**
Light oil (nafta)	**0.5**	**0.0733**
NG	**1**	**0.0561**
no heating	**1**	**0**
TOTAL	**100**	

2. Electricity supply: by electricity grid in Yambol are connected heating devices for domestic heating and tap hot water preparing. As it is shown in Table1 62 % of the consumers in Yambol used electricity for heating an tap hot water.
3. Other different fuels for domestic boilers: (100 - 62 – 5.5 = 32.5%) is the percentage of the other different fuel supplied to the existed domestic boilers in the city. On this base and according to the Emission factors of the different used fuel (see Table 1) the average Emission factor of them is estimated as 0.043677 Kton/TJ .

The annual heat demand after realization of the project is determined on 62000 MWh/y (65000 MWh/y according to the fuel base). From it;

Winter heat demand is – 48 600 MWh;

Summer heat demand is – 13 400 MWh;.

The annual heat demand at the current situation is divided on:

1. The existed DHC load – 3540 MWh/y;
2. The electricity consumers:

   SHD – AH(DHC)*SHD/AHD+WHD*62/100

   Where: SHD – summer heat demand, MWh/y;

   AH(DHC) - annual heat by DHC, MWh/y;

   AHD – annual heat demand, MWh/y;

   WHD – winter heat demand, MWh/y
3. Annual heat by different fuels in domestic boilers:

   AHD (DF) = WHD*(100-62)/100 – AH(DHC)*WHD/AHD;

   Where: AHD (DF) – annual heat by different fuels.

Description of the heat consumers:

- DHC Yambol heating and tap hot water consumers;

Operational modes:

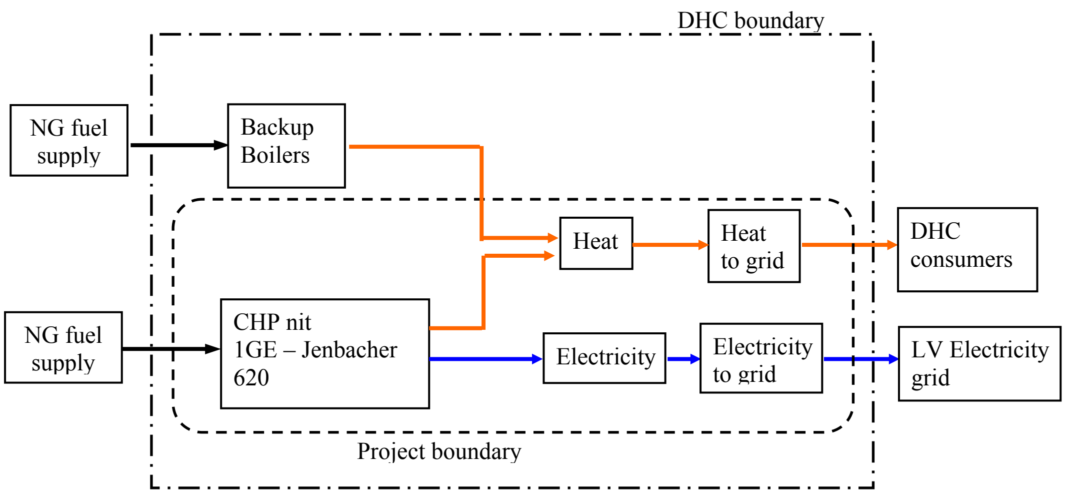
- heating demand for DHC Yambol consumers – seasonal operation mode;

3.4.2 Flowchart of the project

The following considerations are taken into account in the flowchart construction of the project:

- CHP for combined heat and power generation will be installed.
- The production of heat from CHP will cover only base heat load. The rest of the heat (pick load) will be covered by existing "back up" boilers;
- The fuel base will be partially changed: instead of different fuels and electricity natural gas (NG) will be used.
- According to energy demand scenario the production of electricity from CHP will cover entirely electricity demand for own needs of DHC Yambol and the rest of electricity production will be exported to the grid.

Flowchart of the project with its main components and their connections



3.4.3 Project boundaries

Project boundaries for natural gas fired in CHP is given in fig. 3.4.1.

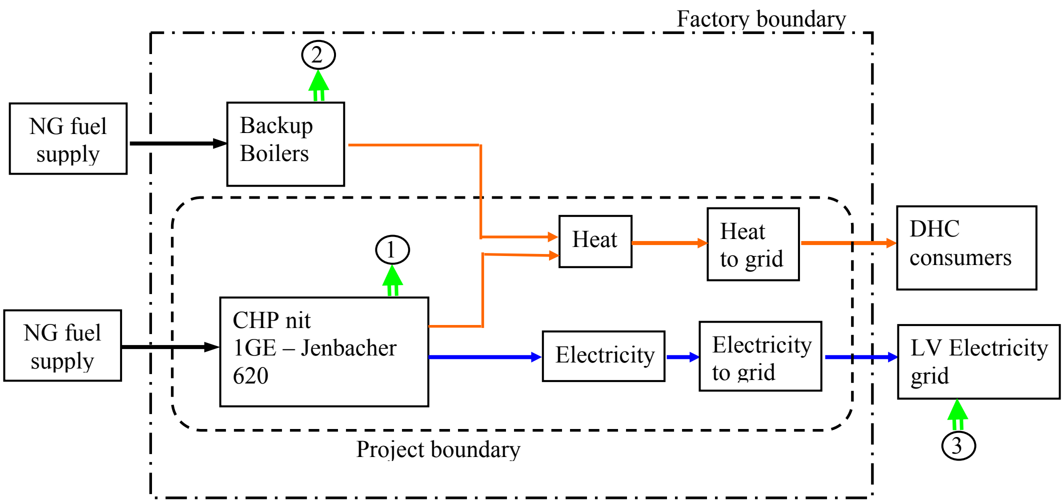


Fig. 3.4.3.1 Project boundary for natural gas fired in CHP

1 – Direct on-site CO_2 emissions (comb in CHP)
2 – Direct off-site CO_2 emissions (comb in back up boilers)
3 – Indirect off-site CO_2 avoided emissions (electricity to grid)

The project is the installation of CHP whose input is natural gas (NG) from gas pipeline, and whose outputs are electricity and heat supplied to the relevant grids in DHC Yambol. Back up boilers are also connected to the NG gas pipeline system. Although the project will be installed at the factory site, the project boundary is strictly the CHP and heat and power connected grids in DHC Yambol. . That is why CO_2 emissions, caused by NG combustion in CHP are direct on-site emissions.
The co-generation system is sized to provide base heat load to the DHC.
Prior to project installation, DHC acquires all of electricity from the power grid and meets all of its heat requirements by combustion in boilers. Once the project is realized, the plant acquires heat and electricity from CHP to meet some of its heat and all electricity needs. The remaining heat demand is met by existing (back up) boilers at the plant with natural gas from NG pipeline. CO_2 emissions, caused by NG combustion in back up boilers in order to cover heat demand, are in the factory boundary, but out of the project boundary. They are directly influenced by the project. That is why they are direct off-site emissions. The produced by CHP electricity will cover the whole DHC Yambol electricity demand and the rest will be sold to the power grid. At this case it will shift power load in the grid. It will reduce CO_2 emissions – indirect avoided off-site emissions.
The baseline emissions are determined by the electricity and fuel purchases by the plant.

The project emissions depend on gas input to the CHP, back up boilers and electricity sold by the plant, while emissions avoided can be determined from the difference between baseline emissions and the project ones. The associated monitoring determines both project and baseline emissions.

3.4.4 Direct and indirect emissions

With this definition of the project boundary, the Project and Baseline emissions, both *On-site and Off-site* are as shown in Table 3.4.1:

Table 3.4.1. Project and baseline emissions, direct and indirect, on and off-site

On-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in CHP	CO_2 emissions from HFO combustion in boilers	Direct	Include
Off-site emissions			
Project	Current situation	Direct or indirect	Include or exclude
CO_2 emissions from NG combustion in back - up boilers		Direct	Include
	CO_2 emissions from electricity grid	Indirect	Include
CO_2 avoided emissions to Electricity grid		Indirect	Include

4. KEY FACTORS

4.1 Internal key factors

4.1.1 Variability of the thermal load

The variability of the thermal loads leads to variability of the efficiency. Normally the decreasing of the load leads to decreasing of the efficiencies of the boilers and cogeneration sets. The companies lack the flexibility to adapt their production to the demands while keeping efficiency at acceptable levels. This is more important for Toplofikatsia Kazanlak and Toplofikatsia Yambol and less for Polymeri and Kostenets HHI. Especially cogeneration sets have the functionality of being flexible to the users while keeping efficiencies at acceptable levels.

4.1.2 Activity level

The Bulgarian economy is in period of growing with appreciable and stable rate of positive development. The expectations foresee the that the growth of the factories inside the project will be positive, this is depicted in Annex 2, Prognostication Table. Especially Kostenets and Polimeri have been increasing and will increase their activity levels with increasing demand. The district heating facility of Kazanlak will focus on cost reductions in order to maintain competitiveness with alternatives heat sources for customers, Yambol will increase the activity level as depicted in their growth plans in chapter 6.

The long term outlook for Bulgaria is related to the accession to the European Union and can be considered very positive. This also applies for companies that invest in expansion and efficiency. The projections for Kostenets and Polimeri correspond with this expectation, but in the longer term the reliability of these projections decreases. Therefore, the projections in the longer term for these companies show very conservative growth from 2010 onwards. As described above, growth levels for the district heating companies will be moderate to small.

4.1.3 Availability of working capital

In general the factories have a continuous shortage of working capital. Due to the history of the factories and in general of the Bulgarian economy, most balance sheets of companies are not in good shape. They have little working capital, and in most cases short/long term debt instead. However, in this period of significant growth of the Bulgarian economy companies have difficulties matching the production increase with the increasing demand. The lack of working capital restricts them in to invest in production expansion, efficiency projects and other structural reforms to increase capacity and competitiveness. This leads to a vicious circle where the lack of performance will result in loss of customers, resulting in even less availability of working capital.

4.2 External key factors

4.2.1 Legislation development

As quoted above in item 1.3.1, the main law affecting the development of highly efficient combined production of electric and thermal power is the newly voted Energy Act (published in State Gazette No. 107 dated December 2003), Chapter XI part I and Part II of which concerns primarily the encouragement of energy production based on renewable energy sources/RES/ and combined energy production /CHP/. In accordance with the quoted above

Art. 162, upon the commissioning of the installations, the surplus produced electric power will by compulsory purchased at preferential prices.
The producers of thus produced energy will be issued green certificates for the produced and sold by them energy from 01.01.2006 (Regulation for certification of the origin of electric power generated by renewable and/or combined generation sources, issuance of green certificates and their trading-2004). For estimation of the quantity produced electricity from CHP was issued "Regulation for estimation of the quantity electrical energy produced by combined generation sources -2004. In addition to the above, on the basis of the new legislation with reference to the liberalization of the gas market and, more specifically, to the quoted above Energy Act, Part. III, Art. 176, clause 1 , the factories Polymeri, Kostenets HHI, Toplofikatsia Kazanlak and Toplofikatsia Yambol shall be allowed to purchase natural gas directly from Bulgargaz, which will provide for lower prices.

4.2.2 Sect oral reform projects

The foreseen reforms of the energy sector provide for the reconstruction and modernization of certain coal-fuelled TPP's, as follows:

- "Maritsa Iztok 3" TPP – updating of 4 blocks of 210 MW each with sulphur filter installations, investment value 518 millon Euro. EURO, completion term 36 months;
- "Maritsa Iztok 1" TPP – construction of replacement facilities, i.e. 2 blocks of 330 MW each with sulphur filter installations, investment value 1056 millon Euro. EURO;
- "Maritsa Iztok 2" TPP – updating of 4 blocks of 150 MW each with sulphur filter installations and of 2 blocks of 210 MW each, investment value 230 million. EURO;

The high costs of the quoted investments for the reforms of the energy sector will inevitably lead to a price hike for the conventionally produced electric power. This will make the investments for the construction of Cogeneration Stations economically more feasible, as is the case with this specific project.

4.2.3 Economic, demographic and social factors

The forecast macro-economic parameters for Bulgaria up to the year 2007 (General National Plan for the Economic Development of Bulgaria as of 2007), according to the State Agency for Economic Analyses and Prognoses dated April 2002 are the following:

- Gross Domestic Product (real growth) - 5.5%
- Inflation rate - 3.5%
- Unemployment rate - 10.0%

AKB Fores PLC and its companies are included with reference to the quoted development rates for the country's economy. However, the growth in the four factories is different, biggest in Kostenets HHI and Toplofikatsia Yambol.
The demographic factors concern mainly the fluctuation of the human resources at the companies. The situation is different for the four companies. Polymeri has no problems with the quality of the staff because Varna is a big town and industrial centre. Toplofikatsia Kazanlak is in the same situation, because Kazanlak was one from the centres of the military industry and the hydraulics. Big part from this industry does not work now. In Toplofikatsia Yambol and Kostenets HHI the external situation is not so good, but the staff of the factories has big experience.

4.2.4 Fuel prices and availability

The efficiency and payback potential of the investments for this project are mainly determined

by the prices of natural gas in the long term.
The only official forecast on the fluctuation of the gas prices up to the year 2015 has been published in the "REVIEW OF THE ENERGY SECTOR AND THE ENVIRONMENT" in November 2001 by the World Bank team with the cooperation of the State Agency on Energy and Energy Resources. According to this forecast, the gas prices can be expected to fluctuate according to basic and pessimistic scenarios, as shown on the table below. In order to facilitate the analysis, the table has been supplemented by the current prices for the years 2000, 2003,2004 and the beginning of 2005.

Scenario	Actual [USD /1000N m³]					Expected [USD/1000N m³]			
In years	1999	2000	2003	2004	2005	2000	2005	2010 г.	2015
Main	92,60	118,2	128,5	129,8	157	129,95	79,92	74,61	74,61
Pessimistic	92,60	118,2	128,5	129,8	157	147,25	138,98	142,29	150,67

The analysis of the gas prices shows that the forecast of their future fluctuations is very difficult. The big different between the prices during 2004 and the beginning of 2005 is for the relation between $/EURO and the increasing of the gas price from 112.9 EURO/1000 Nm³ to 118.5 EURO/1000 Nm³.During the years 2002, 2003, and 2004, the prices remained comparatively stable, but for 2005 the prices are over of the pessimistic scenario for 2005. This means that independently from the relation between $/EURO the prices of the gas are on the upper level and should be expected decreasing of the price in the future. The financial calculations in the project are done by price of 118.5 EURO/1000 Nm³ or 157 $/1000 Nm³.

4.2.5 Capital availability

The climate on the Bulgarian credit market is improving every year as a result of the stabilization of the country's economy, but still remains risky. See also 5.2. The investment climate is expressed in a credit rating, which is BB- for Bulgaria.
The corresponding normal interest rates for credits (including fees and commissions) provided in Bulgaria vary within the range of 9% to 13% primarily depending on the size of the credit and the projected payback time, and the corresponding future cash flow projections of the lending company.
The table below shows the interest rates for long term credits (excluding fees and commissions) provided in Bulgaria by the Bulgarian banks. These credits are up to 5 to maximum 7 years and rarely exceed several millions of Euros, but again this depends on the underlying cash flow projections and payback time.

Years	Mean annual interest rate for long-term credits to corporate clients [%]	
Credits in foreign currencies	BGN	EURO
2001	13.153	12.795
2002	12.594	10.947
2003	10.998	9.975
2004	10.888	9.083
2005	11.082	7.245

4.2.6 Permits

In accordance with the provisions of Paragraph. I, Art. 39 of the Energy Act, the production Of electric and thermal power is subject to licensing. In addition to the above, in accordance

with the provisions of Regulation for Certification of the Origin of Electrical Power Generated from
Renewable and /or Combined Generation Sources – 2004, a certificate of origin will also have to be obtained. The certificate for origin , is a base for obtaining the green certificates trading. The market of green certificates will be open from 01.01.2006.
The licensing and the obtaining of the certificate of origin are foreseen to be achieved after the elaboration of the working design. According to the implementation plan for the project execution, it is forecast to be achieved during the period from 01.01.2006 till 01.10.2006 for all local projects.

5. ADDITIONALITY TEST

Note: Demonstration of additionality has been based on EB 16 guidance "Tool for the demonstration and assessment of additionality"

Step 0: Preliminary screening

a) The projects have not yet been implemented and therefore the starting date of the JI project activity falls after 1 January 2000. The start of the each JI project activity is projected from around June / July 2005 of all the projects. In absence of a JI Supervisory Committee the project cannot be forwarded for registration yet;
b) The incentive of JI is being considered since middle of 2004 by all project participants and the Supplier. This is finally demonstrated in the submitted Expression in Interest to ERUPT 5 in which project participants stated its interest to obtain the JI incentive for their envisaged project activity. The Expression of Interest was submitted October 2004 to the Dutch agency SenterNovem.

5.1 Step 1: Identification of alternatives to the project activity

Sub-step 1a. Define alternatives to the project activity

There are three realistic alternatives (or alternative scenarios) for the project activities:

Alternative I: Cogeneration without selling the carbon credits under the JI mechanism:
The first alternative is identical to the proposed JI project activity but is excluding the JI incentive.

Alternative II: Rehabilitation of the existing installations without large investments:
The second alternative would entail a rehabilitation of the existing heat and electricity generation equipment (at Kazanlak only) plus other repair works to improve efficiency of the energy generation.

Alternative III: Continuation of the existing situation:
The third alternative is a continuation of the current situation without any project activities or alternatives undertaken. In this alternative the factories would continue to purchase electricity from the regional grid and would continue to purchase thermal energy from other sources. Also the existing heat generation boilers will remain in operation. Maintenance costs are made to maintain the old equipment in operation until 2012.

Sub-step 1b: Enforcement of applicable laws and regulations

Alternative I :
The Bulgarian government has several instruments in place to promote energy efficiency projects, cogeneration and other clean energy activities. The main law in this case is the new Energy Act (published in State Gazette No. 107 dated December 2003). Chapter XI of this document primarily concerns the encouragement of energy production based on renewable energy sources and from combined energy production. According to the provisions of Art. 162, clause 1 and clause 2, item 1, the public supplier of electric power, the National Electric Company (NEC) is obliged to purchase at preferential prices the whole surplus quantity of electric power produced by highly efficient combined power production plants with power capacities of up to 50 MW. This system will be replaced by a green certificate system the

Bulgarian government is developing for the renewable sector including the cogeneration sector. The producers of thus produced energy will be issued green certificates for the produced and sold by them energy from 01.01.2006 (Regulation for certification of the origin of electric power generated by renewable and/or combined generation sources, issuance of green certificates and their trading-2004). For estimation of the quantity produced electricity from CHP was issued "Regulation for estimation of the quantity electrical energy produced by combined generation sources -2004.

In addition to this legislation which supports the investment in cogeneration facilities, the Bulgarian law also requires new projects to elaborate on Environmental Impact Studies and other related matters. It is clear that cogeneration project activities are in full compliance with the laws and regulations Bulgaria.

<u>Alternative II:</u>
Rehabilitation of the existing heat and electricity generation equipment will enhance the efficiency of these installations. Related activities will be minor compared to the suggested project activities.
It is clear that rehabilitation activities which are aimed at increasing the efficiencies of existing heat generation facilities is in full compliance with laws and regulations in Bulgaria, provided that these activities comply with environmental standards imposed by regional and national legislation.

<u>Alternative III:</u>
The plants have all necessary licences to operate the existing equipment. There are no laws under development that prevent operating of the existing equipment nor the purchasing of electricity from the grid.

5.2 Step 2: Investment analysis

Sub-step 2a: Determination of analysis method

The project, besides a JI incentive, would generate financial benefits by reducing the energy costs and by selling excess generated electricity to the National Distribution company NEK. Therefore the simple costs analysis cannot be used. The investment comparison analysis requires the comparison of the IRR (Internal Rate of Return) of the different project activity alternatives. However, alternative II and III are not realistic long term alternatives and not considered seriously by the plants owners as long term solutions because of the expected significant increase in energy prices in the future. Therefore the benchmark analysis is the most appropriate method for the investment analysis. The financial needs of the project activities can best be analyzed using parameters such as IRR and payback time against common benchmarks for the energy sector in Bulgaria.

Sub-step 2b: Application of benchmark analysis

Bulgaria is working towards its accession to the European Union which is projected to take place in 2007. Although the Bulgarian government is making a lot of progress with reforming the energy and financial sector, with decreasing its governmental debt and with improving the credibility of its fiscal policy, there are also many challenges and obstacles for the Bulgarian government to work on. Especially the high unemployment rate and low wage structure, issues concerning the privatisation of the energy sector and big openings in certain pieces of

Bulgarian legislation prevent Standard and Poors[1] from putting a the credit rating of not more than BB- on the country compared with BB- for
Romania but A- for Hungary and Czech Republic and A+ for neighbouring Greece.
The credit rating reflects the uncertainties concerning the future of the country related to investments and it is only a little more positive than neighbouring Ukraine with B+. This means that business circumstances a still more comparable to Eastern European standards then to EU standards. This results in a very modest and slow increase of investments into sectors like the energy sector.

The best way to analyze investments into the energy sector in which the project activities all take place, is to compare project payback times or project IRR's of the project activities and other benchmark projects. However, due to the significant differences in calculating methods of these parameters and the differences in fundamental parameters for comparable projects (differences in purchase price for natural gas, or selling price for electricity) a more realistic and objective approach will the use of an indirect benchmark such as the payback time required by commercial institutions and banks for comparable projects in the energy sector in Bulgaria.

To consider commercial bank loans financing possibilities, we can regard commercial banks loans and financing by EBRD credit lines via some commercial banks. From commercial banks in Bulgaria such as the biggest Bulbank (www.bulbank.bg, recently acquired by Unicredit from Italy), Biochim bank (www.biochim.com, recently acquired by Hypovereinsbank) and DSK bank (www.dskbank.bg), information on repayment times for capital needs for investments is easily found on the internet but standard offers are very restricted on amount (maximum 3 million) and restricted on payback time (maximum 3 years) while interest rates for project financing vary between 9 to 13%.
Individual telephone calls with project financing representatives of big commercial banks in Bulgaria confirm the focus on payback time rather than IRR. Although there a not many examples of investments in cogeneration in the energy sector / industry, project capital payback time for commercial bank loans can be estimated at between 5 to 7 years depending on the presented cash flow model and future expectations of the investing company and project. Energy efficiency funds made available through these banks by the EBRD for projects in the energy sector and industry offer comparable conditions[2].

It becomes clear that for significant investments in the energy sector, comparable with the project activities in the plants, the benchmark for repayment of loans provided to the plants owner a maximum of 7 years.

Sub-step 2c: Calculation and comparison of financial indicators
When we include all costs for equipment and services, all revenues from the generation of heat and electricity, excluding revenues from carbon credits, but including and all other related costs for installing and operating the project activities, the payback times are calculated in the Business plan as follows:

Company	Pay back period
Polymeri JSC	9
Kostenets HHI JSC	8
Toplofikatsia Kazanlak JSC	8
Toplofikatsia Yambol JSC	9

[1] www.standardandpoors.com
[2] See www.eva.ac.at/publ/pdf/**bul_energietage_eea2_e**.pdf

<u>Sub-step 2d: Sensitivity analysis</u>

Selection of variables:

Within the investment analysis the gas and electricity price are the most influential parameters to the financial results of the project activities. Within the sensitivity analysis the evidence will be given of the robustness of the investment analysis. The variables are correlated to each other in this respect that an increased gas price will lead to an increased electricity price. Both variables will be varied in the range of 2 to 10 % increase with respect to the project activity scenario.

Sensitivity per project activity

We assume that the increase of the electricity price and natural gas price takes place in the period prior to project commissioning. We perform the sensitivity analysis for the projects in the portfolio with the lowest payback time: Kostenets and Kazanlak. It is also important to perform this analysis for both of the types of projects / factories that are included in this project portfolio: Kostenets is a pulp and paper factory installing a gas turbine set and Kazanlak is a district heating installing a gas engine with heat exchanger module. The calculation for both projects function as example projects for the other project in the portfolio in Polimeri and Yambol.

The calculation results are shown in the diagram below:

Kostenets

Elec tricity Price	**PBP**	**PBP**	**PBP**	**PBP**
	Years	Years	Years	Years
10 %	>7	>7	>7	8
5 %	>7	8	8	8
2 %	8	8	8	9
0 %	8	8	9	10
Gas price	**0%**	**2%**	**5%**	**10%**

Kazanlak

Elec tricity Price	**PBP**	**PBP**	**PBP**	**PBP**
	Years	Years	Years	Years
10 %	8	8	8	9
5 %	8	8	9	9
2 %	8	9	9	10
0 %	8	9	9	10
Gas price	0%	2%	5%	10%

Unfortunately the used software does not enable to provide more detail than described in the tables, but from the tables it becomes clear that the impact of the increase of the electricity price on the Kostenets project is not so significant, the impact of the increase of the gas price has more impact. This is mainly due to the large consumption of the Kostenets facility for cogeneration and for the boilers that are switched from oil to gas.

The project in Kazanlak is not very sensitive to a price increase for electricity, but does see an increase on the payback time from the increase in gas price.
It is important to acknowledge that in reality an increase in gas price will always involve an increase in electricity price. Therefore the outcomes in the upper left and lower right side of the tables should be considered with some guidance.

The sensitivity analysis shows that the projects payback time is influenced by the increase of the two variables although not much for electricity price increase, but more on the gas price increase. It is important to see, that also in extreme (unrealistic cases) the payback time of the projects never become below the acceptable level for commercial financing.

5.3 Step 3: Barrier analysis

Sub-step 3a: Identification of barriers preventing the implementation of type of the proposed project activity

The following barriers are identified:

Investment barriers:

- lack of capital and debt funding provided to the market because of perceived risks of large investments in this sector.

In general in Bulgaria for investments not more than 3 million Euros for coverage of project debt for investments is provided from commercial banks to companies. Also not the energy efficiency funds, as made available by the EBRD[3], provide for more than these amounts. In addition, provided debt is significantly smaller than 65% which means that the lending companies needs to provide more equity.
For the energy sector Banks are averse of project financing because of the future uncertainties for many companies in this sector in Bulgaria. The reasons for this uncertainty is the ongoing privatization in the energy sector and the closing of the nuclear power plant in order to comply with EU regulations and the possible construction of a new nuclear power plant, the Bulgarian capacity expansion plan is not clear on this.
This has an impact on the amount of capital to be provided and the collateral that should cover the bank's exposure. Banks do offer alternatives such as credit over drafting and leasing constructions, but these financial solutions are even more expensive for the lending companies.

Equity barrier:

- Equity constraints at investing companies

Companies themselves want to use the available equity for expanding or rehabilitating of their core business to prepare for increased competition and to increase market share and revenue streams. Therefore, there is a big constraint on equity available for investments outside their core business, such as in energy generation equipment or electricity generation equipment for district heating installations. In addition, Banks tend to ask between 40 and 50% of the project capital on equity from the companies, which is considerably more than 30% in Western type Economies. Therefore, the impact on the equity requirements are even more.

Technological barriers:

[3] See www.eva.ac.at/publ/pdf/**bul_energietage_eea2_e**.pdf

- lack of proper infrastructure to implement the technology
- lack of experienced and trained labour to operate the new technology.

In three of the project locations, the pipeline to supply the projects with natural gas needs to be constructed. The lack of an infrastructure to perform the proposed project activities is a significant barrier since it increases project development time and the project costs.
In addition, at none of the project locations there is experience with the operation and maintenance of the described technology of gas turbines with steam generators and gas engines with steam generators. There are only a few recent comparable projects in the country. The technology is rather new to the country and is definitely new to the personnel at the project activity locations, who are inexperienced and untrained.

Sub-step 3b: Explanation that barriers would not prevent implementation of the other alternatives

The other two alternatives do not experience an investment barrier since they do not involve large one-time investments for the technology. Alternative III would not involve any large investment, other than small maintenance costs, since it is a continuation of the existing situation. Alternative II involves small capital expenditures on certain parts of the existing installations.
Also the technological barrier does not comply with the project activity alternatives II and III since these alternatives do not require for additional infrastructure neither they demand new knowledge and operational skills. Alternative III does not represent a change from the existing situation, so no barriers are experienced. Alternative II does not require new technology only small adjustments and replacements of existing parts.

5.4 Step 4: Common practice analysis

Sub-step 4a: Analysis of other activities similar to the proposed project activity

Although there are many opportunities identified in recent studies by authorities such as the EBRD[4] or the EVA from Austria[5] just to mention a few, virtually no cogeneration system has been really installed in Bulgaria. There are a few investment projects under way in the industrial and energy sector various stages of development such as a CHP at Biovet pharmaceutical factory[6] which will install the first western type gas turbine and heat recovery boiler in Bulgaria and a CHP investment project under construction at Toplofikatsia Varna. Also in Sofia long-term investment projects are under way developed by Horizon and Mitsubishi, but they have not materialized yet.
We have to take into account that only since recently, the Bulgarian government has accelerated the privatisation process of the energy sector which should attract investors with investment programs that should contain the installation of CHPs. Until so far, Bulgarian industry did not have a need for competitive cogeneration since existing supply of electricity from the nuclear dominated Bulgarian grid (50%), together with coal or gas fuelled heat generation equipment was suitable to meet the demands.
The energy sector was government owned and are supplied with Bulgarian or Russian technology, mostly boilers and turbo sets.
Small cogeneration for industry and district heating is totally new to the country and has only come into development because of strong support by the government through the Energy Act

[5] http://www.eva.ac.at/publ/pdf/bul_study.pdf
[6] http://www.senternovem.nl/carboncredits/projects/eru0433.asp

from 2003 where electricity from renewable and cogeneration will be treated with preferential price and dispatch.

Sub-step 4b: Discussion of similar options that are occurring
Since similar projects are hardly observed in Bulgaria, there is no basis for an analysis of similar activities.

5.5 Step 5: Impact of JI registration

The incentive of JI registration is discussed in the form of an ERPA with the Dutch ERUPT program. This governmental tender program has a deadline of April 5, 2005 and offers the following most relevant payment options:

- 50% prepayment of the value of the carbon contract paid after closing the ERPA and commissioning of the project activities.
- Payment of the rest of the contract on verification report and delivery of the emission reductions at the end of each delivery year.

We assume the amount of capital to be required as equity in the project financing is 60%. This results in the following data table where the impact on the payback time and equity needs is depicted (a price of 6 Euro is used):

Project	**Parameter**		**Without JI**	**With JI**	
Polimeri	Payback time	Year	9	6	-3
	Equity capital required	Million euro	3.2	2.2	-1
Kostenets	Payback time	Year	8	6	-2
	Equity capital required	Million euro	3.5	2.7	-0.8
Kazanlak	Payback time	Year	8	6.8	-1.2
	Equity capital required	Million euro	2.5	2	-0.5
Yambol	Payback time	Year	9	6.8	-2.2
	Equity capital required	Million euro	2.6	2	-0.6

Step 5a: Impact on the pay back time
For all the four project activities the carbon revenue brings the payback time within the required 7 years to be eligible for financing.

Step 5b: Impact on the identified barriers

Investment barrier
The additional JI revenue helps to improve the payback time of the project and therefore it increases the changes for the companies to obtain significant more project capital for the investment.

Equity barrier

Thanks to the 50% prepayment of the contract value in the construction period of the projects, the amount of equity to be provided from the companies into the investment is considerable lower.

Technological barrier

Western type technology is much more expensive than Eastern European technology. Therefore the JI revenue enables especially Yambol and Kazanlak to invest in gas engines which are new to the country of Bulgaria.

The construction of a gas pipeline infrastructure is expensive and increases the costs for the projects with 10% or more. Therefore, the JI revenue enables especially Kostenets and Polimeri to construct the pipeline to be able to invest in efficient gas turbine technology with heat exchangers.

5.6 Step 6: Conclusion

The JI incentive leads to reduction of the payback time within required limits, it involves a reduction of the required equity for project capital which helps to overcome the investment barrier. In addition, the JI incentive helps to improve the cash flow of the projects which make them less sensitive to price increases for fuel. Also the JI incentive helps the projects to foresee in their own infrastructure and acquire technological expertise from abroad, which was otherwise not possible because the total costs of the project would increase payback time above acceptable level by financing banks.

The above mentioned impact of JI leads to the conclusion that the project activity is additional.

6. IDENTIFICATION OF THE MOST LIKELY BASELINE SCENARIO AND THE ASSOCIATED GREENHOUSE GAS EMISSIONS

6.1 Polymeri associated greenhouse gas emissions

6.1.1 Construction of the baseline scenario

Baseline CO_2 emissions correspond to those emissions that are both produced by existed boilers in TPS and electricity, supplied to the plant, before CHP project implementation. Baseline emissions can be collected in the "direct on-site" and "direct off-site" categories and comprise the following components:

- **CO_2 combustion** existed boilers provided heat to the plant.
- **CO_2 electricity –** emission associated with the electricity that would have to be purchased from the power grid in order to cover power demand of the plant

In order to estimate the importance of the project realisation upon the CO_2 emissions, the following estimation are prepared:

- estimation of the baseline CO_2 emissions scenario;
- estimation of the CO_2 emissions from the CHP project;
- reduction of the CO_2 emissions as a result from the project realisation.

The quantity of CO_2 emissions may be expressed by multiplication of emission factor and corresponded energy consumption. Emission factors are determined by:

1) For the first baseline emission component: **CO_2 combustion** is associated with the combustion of coal in existed boilers in TPS; the emission factor for coal is EFmg =0.0983 Kton/TJ – source: "Operational guidelines for Project Design Document of JIP" – Ministry of Economic Affairs of the Netherlands, June 2003
2) For the second baseline emission component: **CO_2 electricity –** these emissions associated with the electricity from the power grid depend on annually estimated CO_2 emission factor in Bulgaria. The predicted values - BEF_{el} are presented in Table E 1. (source: "Operational guidelines for Project Design Document of JIP" – Ministry of Economic Affairs of the Netherlands, June 2003

Table E 1 Annually CO_2 emission factors in Bulgaria at:

1) Generation of power;
2) Generation of power including distribution and transmission losses to the power grid

		Years							
BG	**item**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Generated EFel.gen	gCO_2/kWh	814	797	779	761	743	725	707	689
Generated included grid losses BEF_{el}	gCO_2/kWh	957	934	912	890	867	845	822	800

6.1.2 Estimation of the baseline emissions

Predicted annual baseline heat energy consumption in POLIMERI Devnja - ABHEC [TJ/y] up to 2012 are presented in Tabl.B. Annual heat consumption in boilers – ABNG in order to cover expected heat demand ABHEC is given by:

ABNG = ABHEC/ e_b, TJ/y -1

where: e_b – boiler efficiency, determined from engineer's analyses.
ABHEC – annual heat consumption in POLIMERI, TJ/y

The estimations of annual baseline CO_2 **emissions – BE_{th} from boilers are given by**:

BE_{th} = ABNG * EFng, t CO_2/y -2

where: EFng = 0.0983 Kton CO_2/TJ – emission factor for coal combustion in boilers

The estimations of annual CO_2 emissions from electricity supplied by power grid – BEl are given by:

BEl = ABEC * BEF $_{el}$ / 1*10^^{6} t CO_2/y -3

where: ABEC [MWh/y]– annual baseline electricity consumption in POLIMERI (Tabl. B)
BEF el [gCO_2/kWh] – annual baseline emission factor for electricity from grid – Table E1

Total baseline emissions are:

BE_{total} = BE_{th} + BEl -4

The results are presented in Table. B.

6.1.3 Estimation of the heat and electricity rate in the Project boundary

The project consist of the chosen natural gas fired gas turbine for combined heat and power production type UGT 100000 S1 – STIG version – 1 unit. The main characteristics in a base load operation of CHP, concerning CO_2 emissions, are:

- Q_f = 30.5 - heat NG fuel input, MWth;
- Q_{el} = 9.87- power capacity of the CHP, MWe;
- Q_{th} = 14 - thermal capacity of CHP, MWth;
- Average fuel to electricity efficiency - η = 32.3%;
- Overall GT efficiency - η = 78.3 %;

.

Annual average CHP characteristics for operational hours - 8200 h/y

Q_f^a, TJ/y	Q_{el}^a, MWh/y	Q_{th}^a, TJ/y
900	80934	413

The following equations are used:

Q_f^a = Qf * 3,6 * 8200 / 10^6, TJ/y

Q_{el}^a = Qel * 8200 / 10^3, MWh

Q_{th}^a = Qth * 3,6 * 8200 / 10^6, TJ/y

6.2 Kostenets HHI associated greenhouse gas emissions

6.2.1 Construction of the baseline scenario

Baseline CO_2 emissions correspond to those emissions that are both produced by existed boilers and electricity, supplied to the plant, before CHP project implementation.
Baseline emissions can be collected in the “direct on-site” and “direct off-site” categories and comprise the following components:

- **CO_2 combustion** existed boilers provided heat to the plant.
- **CO_2 electricity –** emission associated with the electricity that would have to be purchased from the power grid in order to cover power demand of the plant

In order to estimate the importance of the project realisation upon the CO_2 emissions, the following estimation are prepared:

- estimation of the baseline CO_2 emissions scenario;
- estimation of the CO_2 emissions from the CHP project;
- reduction of the CO_2 emissions as a result from the project realisation.

The quantity of CO_2 emissions may be expressed by multiplication of emission factor and corresponded energy consumption. Emission factors are determined by:

3) For the first baseline emission component: **CO_2 combustion** is associated with the combustion of HFO in existed boilers; the emission factor for HFO is EFmg =0.073Kton/TJ – source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003

4) For the second baseline emission component: **CO_2 electricity –** these emissions associated with the electricity from the power grid depend on annually estimated CO_2 emission factor in Bulgaria. The predicted values - BEF_{el} are presented in Table E 1. (source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003

Table E 1 Annually CO_2 emission factors in Bulgaria at:

3) Generation of power;
4) Generation of power including distribution and transmission losses to the power grid

		Years							
BG	**item**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Generated EFel.gen	gCO_2/kWh	814	797	779	761	743	725	707	689
Generated included grid losses BEF_{el}	gCO_2/kWh	957	934	912	890	867	845	822	800

6.2.2 Estimation of the baseline emissions

Predicted annual baseline heat energy consumption in Kostenets Plant - ABHEC [TJ/y] up to 2012 are presented in Tabl.B. Annual NG consumption in boilers – ABNG in order to cover expected heat demand ABHEC is given by:

$$ABNG = ABHEC / e_b, \quad TJ/y \qquad -1$$

where: e_b – boiler efficiency, determined from engineer’s analyses.

ABHEC – annual heat consumption in Kostenets Plant, TJ/y

The estimations of annual baseline CO_2 emissions – BE_{th} from boilers are given by:

BE_{th} = ABNG * EFng, t CO_2/y -2

where: EFng = 0.0733 Kton CO_2/TJ – emission factor for HFO combustion in boilers

The estimations of annual CO_2 emissions from electricity supplied by power grid – BEl are given by:

BEl = ABEC * BEF_{el} / 1*10^6 t CO_2/y -3

where: ABEC [MWh/y]– annual baseline electricity consumption in Kostenets Plant (Tabl. B)
BEF el [gCO_2/kWh] – annual baseline emission factor for electricity from grid – Table E1

Total baseline emissions are:

$BE_{total} = BE_{th}$ + BEl -4

The results are presented in Table. B.

6.2.3 Estimation of the heat and electricity rate in the Project boundary

The project consist of the chosen natural gas fired gas turbine for combined heat and power production type UGT 10000 S1 – STIG version. The main characteristics in a base load operation of CHP, concerning CO_2 emissions, are:

- Q_f = 30.5 - heat NG fuel input, MWth;
- Q_{el} = 9.87- power capacity of the CHP, MWe;
- Q_{th} = 14 - thermal capacity of CHP, MWth;
- Average fuel to electricity efficiency - η = 32.3 %;
- Average fuel to heat efficiency - η = 78.31 %;

In this particular case this machine will be normally worked in STIG regime, i.e. by using part of the produced steam passing by the fuel chamber and than in the inlet of the gas turbine in order to prevent extraordinary production of heat. For prevention of this was calculated that 4 MWth capacity will be implemented as steam in the gas turbine. It will resulted in increased electricity capacity, which value is evaluated according to the GT producer as:

4 MWth * 0.31 Mwe/MWth = 1,24 MW e – additionally.

The new heat and power capacity at the outlet of CHP in this regime will be:

Qf = 30.5 MWth;
Qel = 11.11 MW e;
Qth = 10 Meth;
Average fuel to electricity efficiency - - η = 36.4 %;

Annual average CHP characteristics for operational hours - 8200 h/y

Q_f^a, TJ/y	Q_{el}^a, MWh/y	Q_{th}^a, TJ/y
206	24376	91

The following equations are used:

Q_f^a = Qf * 3,6 * 8200 / 10^6, TJ/y

Q_{el}^a = Qel * 8200 / 10^3, MWh

Q_{th}^a = Qth * 3,6 * 8200 / 10^6, TJ/y

6.3 Toplofikatsia Kazanlak associated greenhouse gas emissions

6.3.1 Construction of the baseline scenario

Baseline CO_2 emissions correspond to those emissions that are both produced by existed boilers and electricity, supplied to the plant, before CHP project implementation.

Baseline emissions can be collected in the “direct on-site” and “direct off-site” categories and comprise the following components:

- **CO_2 combustion** existed boilers provided heat to the plant.
- **CO_2 electricity –** emission associated with the electricity that would have to be purchased from the power grid in order to cover power demand of the plant

In order to estimate the importance of the project realisation upon the CO_2 emissions, the following estimation are prepared:

- estimation of the baseline CO_2 emissions scenario;
- estimation of the CO_2 emissions from the CHP project;
- reduction of the CO_2 emissions as a result from the project realisation.

The quantity of CO_2 emissions may be expressed by multiplication of emission factor and corresponded energy consumption. Emission factors are determined by:

5) For the first baseline emission component: **CO_2 combustion** is associated with the combustion of HFO in existed boilers; the emission factor for HFO is EFmg =0.073Kton/TJ – source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003

6) For the second baseline emission component: **CO_2 electricity –** these emissions associated with the electricity from the power grid depend on annually estimated CO_2 emission factor in Bulgaria. The predicted values - BEF_{el} are presented in Table E 1. (source: “Operational guidelines for Project Design Document of JIP” – Ministry of Economic Affairs of the Netherlands, June 2003

Table E 1 Annually CO_2 emission factors in Bulgaria at:

5) Generation of power;
6) Generation of power including distribution and transmission losses to the power grid

		Years							
BG	**item**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Generated EFel.gen	gCO_2/kWh	814	797	779	761	743	725	707	689
Generated included grid losses BEF_{el}	gCO_2/kWh	957	934	912	890	867	845	822	800

6.3.2 Estimation of the baseline emissions

Predicted annual baseline heat energy consumption in DHC Kazanlak - ABHEC [TJ/y] up to 2012 are presented in Tabl.B. Annual NG consumption in boilers – ABNG in order to cover expected heat demand ABHEC is given by:

$$ABNG = ABHEC/ e_{b,}\ TJ/y \qquad -1$$

where: e_b – boiler efficiency, determined from engineer's analyses.
ABHEC – annual heat consumption in DHC Kazanlak, TJ/y

The estimations of annual baseline CO_2 **emissions – BE_{th} from boilers are given by**:

$$\mathbf{BE_{th} = ABNG * EFng, t\ CO_2/y \qquad -2}$$

where: EFng = 0.0733 Kton CO_2/TJ – emission factor for HFO combustion in boilers

The estimations of annual CO_2 emissions from electricity supplied by power grid – BEl are given by:

$$\mathbf{BEl = ABEC * BEF_{el} / 1*10^{6}\ t\ CO_2/y \qquad -3}$$

where: ABEC [MWh/y]– annual baseline electricity consumption in DHC Kazanlak (Tabl. B)
BEF el [gCO_2/kWh] – annual baseline emission factor for electricity from grid – Table E1

Total baseline emissions are:

$$\mathbf{BE_{total} = BE_{th} + BEl \qquad -4}$$

The results are presented in Table. B.

6.3.3 Estimation of the heat and electricity rate in the Project boundary

The project consist of the chosen natural gas fired diesel engine for combined heat and power production type "Jenbacher" 620 GS – 2 units. The main characteristics in a base load operation of CHP, concerning CO_2 emissions, are:

- Q_f = 2 x 7.152 - heat NG fuel input, MWth;
- Q_{el} = 2 x 3.047- power capacity of the CHP, MWe;
- Q_{th} = 2 x 3.173 - thermal capacity of CHP, MWth;
- Average fuel to electricity efficiency - η = 42.6 %;
- Average fuel to heat efficiency - η = 43.1 %;

.

Annual average CHP characteristics for operational hours - 6250 h/y

Q_f^a, TJ/y	Q_{el}^a, MWh/y	Q_{th}^a, TJ/y
321.9	38086	143

The following equations are used:

$$Q_f^a = Qf * 3,6 * 6250 / 10^6,\ TJ/y$$

$$Q_{el}^a = Qel * 6250 / 10^3,\ MWh$$

$$Q_{th}^{a} = Qth * 3,6 * 6250 / 10^6, TJ/y$$

6.4 Toplofikatsia Yambol associated greenhouse gas emissions

6.4.1 Construction of the baseline scenario

Baseline CO_2 emissions correspond to those emissions that are both produced by existed boilers and electricity, supplied to the plant, before CHP project implementation.
Baseline emissions can be collected in the "direct on-site" and "direct off-site" categories and comprise the following components:

- **CO_2 combustion** existed boilers provided heat to the plant.
- **CO_2 electricity –** emission associated with the electricity that would have to be purchased from the power grid in order to cover power demand of the plant

In order to estimate the importance of the project realisation upon the CO_2 emissions, the following estimation are prepared:

- estimation of the baseline CO_2 emissions scenario;
- estimation of the CO_2 emissions from the CHP project;
- reduction of the CO_2 emissions as a result from the project realisation.

The quantity of CO_2 emissions may be expressed by multiplication of emission factor and corresponded energy consumption. Emission factors are determined by:

7) For the first baseline emission component: **CO_2 combustion** Emission Factor is associated with the combustion of Different type of fuels in domestic boilers, electricity for heating and tap hot water installation as well as existed DHC Yambol. The method for estimation is already presented. The different emission factors for different fuels are determined in source: "Operational guidelines for Project Design Document of JIP" – Ministry of Economic Affairs of the Netherlands, June 2003

8) For the second baseline emission component: **CO_2 electricity –** these emissions associated with the electricity from the power grid depend on annually estimated CO_2 emission factor in Bulgaria. The predicted values - BEF_{el} are presented in Table E 1. (source: "Operational guidelines for Project Design Document of JIP" – Ministry of Economic Affairs of the Netherlands, June 2003

Table E 1 Annually CO_2 emission factors in Bulgaria at:

7) Generation of power;
8) Generation of power including distribution and transmission losses to the power grid

		Years							
BG	**item**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Generated EFel.gen	gCO_2/kWh	814	797	779	761	743	725	707	689
Generated included grid losses BEF_{el}	gCO_2/kWh	957	934	912	890	867	845	822	800

6.4.2 Estimation of the baseline emissions

Predicted annual baseline heat energy consumption in DHC Yambol - ABHEC [TJ/y] up to 2012 are presented in Tabl.B. Annual NG consumption in boilers – ABNG in order to cover expected heat demand ABHEC is given by:

$$ABNG = ABHEC / e_b, \quad TJ/y \qquad -1$$

where: e_b – boiler efficiency, determined from engineer's analyses.
ABHEC – annual heat consumption in DHC Yambol, TJ/y

The estimations of annual baseline CO_2 emissions – BE_{th} from boilers are given by:

$$\mathbf{BE_{th} = SUM\ (ABDF * Efng),\ t\ CO_2/y} \qquad \mathbf{-2}$$

where: EFng = 0.043677 Kton CO_2/TJ – average emission factor for presented in Table 1 different fuel use in the existed domestic boilers.
ABDF – determined by percentage of the used fuel predicted annual heat consumption.

The estimations of annual CO_2 emissions from electricity supplied by power grid – BEl are given by:

$$\mathbf{BEl = ABEC * BEF_{el} / 1*10^{6}\ t\ CO_2/y} \qquad \mathbf{-3}$$

where: ABEC [MWh/y]– annual baseline electricity consumption in DHC Yambol (Tabl. B)
BEF el [gCO_2/kWh] – annual baseline emission factor for electricity from grid – Table E1

Total baseline emissions are:

$$\mathbf{BE_{total} = BE_{th} + BEl} \qquad \mathbf{-4}$$

The results are presented in <u>Table. B</u>.

6.4.3 Estimation of the heat and electricity rate in the Project boundary

The project consist of the chosen natural gas fired diesel engine for combined heat and power production type "Jenbacher" 620 GS – 1 unit. The main characteristics in a base load operation of CHP, concerning CO_2 emissions, are:

- Q_f = 7.152 - heat NG fuel input, MWth;
- Q_{el} = 3.047- power capacity of the CHP, MWe;
- Q_{th} = 3.173 - thermal capacity of CHP, MWth;
- Average fuel to electricity efficiency - η = 42.6 %;
- Average fuel to heat efficiency - η = 43.1 %;

.

Annual average CHP characteristics for operational hours - 8000 h/y

Q_f^a, TJ/y	Q_{el}^a, MWh/y	Q_{th}^a, TJ/y
206	24376	91

The following equations are used:

$$Q_f^a = Qf * 3,6 * 8000 / 10^6, \ TJ/y$$

Q_{el}^{a} = Qel * 8000 / 10^3, MWh

Q_{th}^{a} = Qth * 3,6 * 8000 / 10^6, TJ/y

7. ESTIMATION OF CO_2 EMISSIONS FROM THE PROJECT

7.1 Estimation of CO2 emissions from the Polymeri project

The main characteristics of CHP, presented in chapter 5.3, are used in the calculation of CO_2 project emission. The following estimation procedure is used for estimation of CO_2 emission in the project boundary:

- Direct on-site emissions into the project boundary are caused by NG combustion in CHP.
  Annual NG energy consumption from CHP, AEC ng, is given by:

$$AECng = EIR_{CHP} * AOH/1000, \; TJ/y \qquad -5$$

Where: EIR_{CHP} is CHP energy NG impute rate (GJ/h) and AOH – annual operational hours (h/y) CHOR is taken from the specification of the CHP. AOH is determined equipment and characteristics of the demand for heat and electricity at the plant.

Direct on-site CO_2 emission from NG combustion in CHP - PE_{CHP}

$$PE_{CHP} = AEC\ ng * EFng \qquad -6$$

- Direct off-site emission according to project boundary are:
  - CO_2 emissions caused by NG combustion in back up boilers –PE_{bb}, are estimated as:

Annual baseline heat energy consumption in POLIMERI- ABHEC, are presented in Tabl.B and respectively in Tabl.P too. The difference between ABHES and annual heat energy output from CHP - CAHO is equal to annual back up boilers heat energy output – BBH

$$BBH = ABHES – CAHO, \; TJ/y \qquad -7$$

CAHO is estimated by equation:

$$CAHO = CHOR * AOH/1000 \; TJ/y \qquad -8$$

AOH – annual operational hours – 8200 (h/y)
CHOR is taken from the specification of the CHP. AOH is determined by equipment, demand characteristics for heat and electricity of the plant and the possibilities for annual maintenance of CHP installation.

PE_{bb} is caused by NG combustion in back up boilers – BBEC:

$$BBEC = BBH/ e_b, \; TJ/y; \qquad -9$$

where: e_b – back up boiler efficiency, determined from engineer's analysis.

Direct off-site CO_2 emission from NG combustion in back up boilers - PE_{bb}

$$PE_{bb} = BBEC * EFng \qquad -10$$

- CO_2 emissions caused by additional electricity from grid, in order to cover base line electricity consumption of POLIMERI–PE $_{grid}$, are estimated as:

The positive difference between annual baseline electricity consumption of POLIMERI - ABEC and annual electricity output of CHP – CEO [MWh/y] is equal to the additional electricity coming from grid in order to cover baseline electricity consumption of POLIMERI – AEl [MWh/y].

AEI = ABEC – CEO, MWh/y -11

The annual electricity output of CHP – CEO is estimated as:

CEO = CPO * AOH, MWh -12

where: CPO is CHP net power rate (capacity), MW_e
CPO is taken from the specification of CHP.

Total CO_2 emissions from the project implementation are:

$PE_{total} = PE_{CHP} + PE_{bb} + PE_{rgrid}$, t CO_2/y -17

The project emissions results are presented in Table P.

7.2 Estimation of CO2 emissions from the Kostenets HHI project

The main characteristics of CHP, presented in chapter 5.3, are used in the calculation of CO_2 project emission. The following estimation procedure is used for estimation of CO_2 emission in the project boundary:

- Direct on-site emissions into the project boundary are caused by NG combustion in CHP.
  Annual NG energy consumption from CHP, AEC ng, is given by:

  $AECng = EIR_{CHP}$ * AOH/1000, TJ/y -5

  Where: EIR_{CHP} is CHP energy NG impute rate (GJ/h) and
  AOH – annual operational hours (h/y)
  CHOR is taken from the specification of the CHP. AOH is determined equipment and characteristics of the demand for heat and electricity at the plant.

Direct on-site CO_2 emission from NG combustion in CHP - PE_{CHP}

PE_{CHP} = AEC ng * EFng -6

- Direct off-site emission according to project boundary are:
  - CO_2 emissions caused by NG combustion in back up boilers –PE_{bb}, are estimated as:

Annual baseline heat energy consumption in Kostenets Plant- ABHEC, are presented in Tabl.B and respectively in Tabl.P too. The difference between ABHES and annual heat energy output from CHP - CAHO is equal to annual back up boilers heat energy output – BBH

BBH = ABHES – CAHO, TJ/y -7

CAHO is estimated by equation:

$$CAHO = CHOR * AOH/1000 \ TJ/y \qquad -8$$

AOH – annual operational hours – 8200 (h/y)
CHOR is taken from the specification of the CHP. AOH is determined by equipment, demand characteristics for heat and electricity of the plant and the possibilities for annual maintenance of CHP installation.
PE_{bb} is caused by NG combustion in back up boilers – BBEC:

$$BBEC = BBH/ e_{b}, \ TJ/y; \qquad -9$$

where: e_b – back up boiler efficiency, determined from engineer's analyses

Direct off-site CO_2 emission from NG combustion in back up boilers - PE_{bb}

$$\mathbf{PE_{bb} = BBEC * EFng \qquad -10}$$

Indirect off-site avoided CO_2 emission - replaced electricity to grid - PE_{grid}

$$\mathbf{(-)\ PE_{grid} = AEI * EFel_{,gen} \qquad -11}$$

where: Feel,gen – is emission factor for generated electricity in Bulgaria (Tabl. E1)

Total CO_2 emissions from the project implementation are:

$$\mathbf{PE_{total} = PE_{CHP} + PE_{bb} + (-)\ PE_{rgrid},\ t\ CO_2/y \qquad -12}$$

The project emissions results are presented in Table P.

7.3 Estimation of CO2 emissions from the Toplofikatsia Kazanlak project

The main characteristics of CHP, presented in chapter 5.3, are used in the calculation of CO_2 project emission. The following estimation procedure is used for estimation of CO_2 emission in the project boundary:

- Direct on-site emissions into the project boundary are caused by NG combustion in CHP.
  Annual NG energy consumption from CHP, AEC ng, is given by:

$$AECng = EIR_{CHP} * AOH/1000, \ TJ/y \qquad -5$$

Where: EIR_{CHP} is CHP energy NG impute rate (GJ/h) and
AOH – annual operational hours (h/y)
CHOR is taken from the specification of the CHP. AOH is determined equipment and characteristics of the demand for heat and electricity at the plant.

Direct on-site CO_2 emission from NG combustion in CHP - PE_{CHP}

$$\mathbf{PE_{CHP} = AEC\ ng * EFng \qquad -6}$$

- Direct off-site emission according to project boundary are:
    - o CO_2 emissions caused by NG combustion in back up boilers –PE $_{bb}$, are estimated as:

Annual baseline heat energy consumption in DHC Kazanlak- ABHEC, are presented in Tabl.B and respectively in Tabl.P too. The difference between ABHES and annual heat energy output from CHP - CAHO is equal to annual back up boilers heat energy output – BBH

BBH = ABHES – CAHO, TJ/y -7

CAHO is estimated by equation:

CAHO = CHOR * AOH/1000 TJ/y -8

AOH – annual operational hours – 6250 (h/y)

CHOR is taken from the specification of the CHP. AOH is determined by equipment, demand characteristics for heat and electricity of the plant and the possibilities for annual maintenance of CHP installation.

PE $_{bb}$ is caused by NG combustion in back up boilers – BBEC:

BBEC = BBH/ $e_{b,}$ TJ/y; -9

where: e_b – back up boiler efficiency, determined from engineer's analyses

Direct off-site CO_2 emission from NG combustion in back up boilers - PE $_{bb}$

PE $_{bb}$ = BBEC * EFng -10

- o CO_2 emissions caused by additional electricity from grid, in order to cover base line electricity consumption of DHC Kazanlak if needed–PE $_{grid}$, are estimated as:

The positive difference between annual baseline electricity consumption of BIOVET - ABEC and annual electricity output of CHP – CEO [MWh/y] is equal to the additional electricity coming from grid in order to cover baseline electricity consumption of BIOVET – AEl [MWh/y].

AEI = ABEC – CEO, MWh/y -11

The annual electricity output of CHP – CEO is estimated as:

CEO = CPO * AOH, MWh -12

where: CPO is CHP net power rate (capacity), MW_e
CPO is taken from the specification of CHP.

Indirect off-site avoided CO_2 emission - replaced electricity to grid - PE $_{grid}$

(-) PE $_{grid}$ = AEI * EFel$_{,gen}$ -16

where: Feel,gen – is emission factor for generated electricity in Bulgaria (Tabl. E1)

<u>Total CO_2 emissions from the project implementation are:</u>

$$PE_{total} = PE_{CHP} + PE_{bb} + (-) PE_{rgrid}, t CO_2/y \qquad -17$$

The project emissions results are presented in <u>Table P</u>.

<u>7.4 Estimation of CO2 emissions from the Toplofikatsia Yambol project</u>

The main characteristics of CHP, presented in chapter 5.3, are used in the calculation of CO_2 project emission. The following estimation procedure is used for estimation of CO_2 emission in the project boundary:

- Direct on-site emissions into the project boundary are caused by NG combustion in CHP.
  Annual NG energy consumption from CHP, AEC ng, is given by:

$$AECng = EIR_{CHP} * AOH/1000, TJ/y \qquad -5$$

Where: EIR_{CHP} is CHP energy NG impute rate (GJ/h) and
AOH – annual operational hours (h/y)
CHOR is taken from the specification of the CHP. AOH is determined equipment and characteristics of the demand for heat and electricity at the plant.

<u>Direct on-site CO_2 emission from NG combustion in CHP - PE_{CHP}</u>

$$PE_{CHP} = AEC\ ng * EFng \qquad -6$$

- Direct off-site emission according to project boundary are:
  - CO_2 emissions caused by NG combustion in back up boilers –PE_{bb}, are estimated as:

Annual baseline heat energy consumption in DHC Yambol- ABHEC, are presented in Tabl.B and respectively in Tabl.P too. The difference between ABHES and annual heat energy output from CHP - CAHO is equal to annual back up boilers heat energy output – BBH

$$BBH = ABHES – CAHO, TJ/y \qquad -7$$

CAHO is estimated by equation:

$$CAHO = CHOR * AOH/1000\ TJ/y \qquad -8$$

AOH – annual operational hours – 8000 (h/y)
CHOR is taken from the specification of the CHP. AOH is determined by equipment, demand characteristics for heat and electricity of the plant and the possibilities for annual maintenance of CHP installation.
PE_{bb} is caused by NG combustion in back up boilers – BBEC:

$$BBEC = BBH/ e_b, TJ/y; \qquad -9$$

where: e_b – back up boiler efficiency, determined from engineer's analyses

Direct off-site CO_2 emission from NG combustion in back up boilers - PE_{bb}

$$PE_{bb} = BBEC * EFng \qquad -10$$

- CO_2 emissions caused by additional electricity from grid, in order to cover base line electricity consumption of DHC Yambol if needed–PE_{grid}, are estimated as:

Indirect off-site avoided CO_2 emission - replaced electricity to grid - PE_{grid}

$$(-)\ PE_{grid} = AEI * EFel_{.gen} \qquad -11$$

where: Feel,gen – is emission factor for generated electricity in Bulgaria (Tabl. E1)

Total CO_2 emissions from the project implementation are:

$$PE_{total} = PE_{CHP} + PEbb + (-)\ PE_{rgrid},\ t\ CO_2/y \qquad -12$$

The project emissions results are presented in Table P.

8. ESTIMATION OF CO_2 EMISSION REDUCTIONS

8.1 Estimation of Polymeri CO2 emissions reduction

The difference between total baseline emissions and total project emissions (eq. 4–eq.17) represent the emission reduction from the project activity**:**

$$ER = BE_{total} - PE_{total}\text{, t } CO_{2-eq}/y \qquad -18$$

CO_2 emission reductions from the project activity are presented in Table. R.

REPORTING FORM FOR A BASE LINE STUDY FOR A CHP PROJECT

Table B. Calculation of the baseline emissions

B		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
	Emission factors - EF									
B1	CO2 EF from coal-anthracite comb.	Kton/TJ	0.0983	0.0983	0.0983	0.0983	0.0983	0.0983	0.0983	H
B3	CO2 EF from el. generation in BG	gCO2/kWh	779	761	743	725	707	689	725	H
B4	CO2 EF from electricity grid	gCO2/kWh	912	890	867	845	822	800	844.8	H
	Additional data									
B5	Natural gas density at 20 C	kg/Nm3	0.68	0.68	0.68	0.68	0.68	0.68	0.68	H
B6	Natural gas calorific value	kJ/Nm3	33321	33321	33321	33321	33321	33321	33321	
B7	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	16.5	H
B8	Efficiency of existed boilers		0.85	0.85	0.85	0.85	0.85	0.85	0.85	H
	Annual steam consumption at 6bar	MWh,th	43000	42000	41000	41000	41000	41000	41500	
	Annual steam consumption at 15bar	MWh,th	84000	83000	82000	80000	80000	80000	81500	
	Annual steam consumption at 36bar	MWh,th	3500	3500	3500	3500	3500	3500	3500	
	Annual steam consumption SUM	MWh,th	130500	128500	126500	124500	124500	124500	126500	H
B9	steam enthalpy-H", P=6 bar;t=205	kJ/kg	2860.6	2860.6	2860.6	2860.6	2860.6	2860.6	2860.6	
	steam enthalpy-H", P=15 bar;t=320	kJ/kg	3081.3	3081.3	3081.3	3081.3	3081.3	3081.3	3081.3	
	steam enthalpy-H", P=36 bar;t=360	kJ/kg	3125.5	3125.5	3125.5	3125.5	3125.5	3125.5	3125.5	
	steam enthalpy-H", average	kJ/kg	3008.6	3009.2	3009.8	3008.6	3008.6	3008.6	3009.0	H
	On-site consumptions									
B10	On-site el. consumption	MWh	148000	145000	142000	142000	142000	142000	142600	H
B11	On-site heat consumption	TJ	470	463	455	448	448	448	453	H

	Heat production									
B12	LHV Heat - boilers on-site	TJ	553	544	536	527	527	527	532	H
	Electricity production									
B13	El. produced by sources on site	MWh	0	0	0	0	0	0	0	
B14	CO_2 EF of electricity on site	Kton/MWh								
B15	Electricity coming from grid	MWh	148000	145000	142000	142000	142000	142000	142600	H
B16	CO_2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.0008	0.001	0.001	H
	Indirect off-site baseline emissions									
B17	CO2 combustion in boiler	Kton	54	53	53	52	52	52	52	H
B18	Emissions from electricity grid	Kton	135	129	123	120	117	114	120.5	H
B19	**Total CO2 baseline emission**	**Kton**	**189**	**183**	**176**	**172**	**169**	**165**	**173**	H
B20	**Total CO2 emission - monitoring**	**Kton**	**189**	**865**						H

REPORTING FORM FOR A CHP PROJECT

Description of functional units

1	Purposes for which heat is produced	To cover steam demand for technological purposes
2	Number of functional units produced or services	1 boiler TP 300/140 (capacity 160 t/h) - fuel:Donbas coal
3	Temperature and pressure of heat	P=100 bar; T= 540 C
4	Expected annual heat demand within the system boundary for all years for the start of the project	450 TJ
5	95% confidence interval range for annual heat demand within system boundary (TJ)	430 to 475 TJ
6	Annual pattern of heat demand	almost constant, increased negligible
7	Other connected heat generation equipment	

Description of equipment

1	**CHP plant**			
	Brand and model type of CHP device	Package Cogeneration-gas turbine UGT-10000S1-Zorja Mashproekt - Ukraine, STIG version		
	LHV of NG fuel capacity for CHP, MW	30.5	MW	
	Electricity generated capacity, MWe	9.87	MW e	
	Heat generated capacity, MWth	14	MWth	
	Average fuel to electricity efficiency, %	32.3	%	
	Overall efficiency, %	78.3	%	
2	**Heat transport and distribution**			
	Efficiency of heat distribution	5-8%		
	Annual working hours, h	8200	h/y	
	Start of the project 01.01.2007			

Table P. Estimation of the project emissions: **Average**

P		Unit	2007	2008	2009	2010	2011	2012	2008-12	Prec
P1	LHV of NG fuel capacity for CHP	MW	31	31	31	31	31	31	31	
P2	On-site fuel heat	TJ	900	900	900	900	900	900	900	H
P3	CO_2 eq. emission factor of fuel used	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.056	H
	Heat production									
P4	On-site heat consumption	TJ		463	455	448	448	448	453	H
P5	Heat produced by CHP	TJ		413	413	413	413	413	413	H
P6	Heat produced by other sources	TJ	57	49	42	35	35	35	39	
P7	CO_2 eq. EFof fuel used from other sources	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	H
	Electricity production									
P8	On-site electricity consumption	MWh		145000	142000	142000	142000	142000	142600	H
P9	Average power rate of CHP	MW e	10	10	10	10	10	10	10	
P10	Electricity produced by CHP	MWh		80934	80934	80934	80934	80934	80934	H
P11	Electricity from other sources on-site	MWh	0	0	0	0	0	0	0	
P12	Electricity coming from grid	MWh	67066	64066	61066	61066	61066	61066	61666	H
P13	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	17	H
P14	CO2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.001	0.001	0.001	H
	Direct on-site emissions									
P15	CO2 emissions from combustion in CHP	Kton	51	51	51	51	51	51	51	H
	Direct off-site emissions									
P16	CO2 emissions from combustion in back up boilers	Kton	4	3	3	2	2	2	3	H
P17	CO2 emissions from electricity grid		61	57	53	52	50	49	52	
	Indirect off-site emissions									
P18	CO2 avoided emissions due to load shift of el. grid	Kton	0	0	0	0	0	0	0	H
P19	**Total CO2 emission**	**Kton**	**115**	**111**	**106**	**104**	**103**	**102**	105	H
P20	**Total emission during monitoring period**	**Kton**	**115**			**526**				H

Table R. Estimation of emission reduction

R		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
R1	Heat and electricity production	Kton	51	51	51	51	51	51	51	H
R2	Heat from grid	Kton							52	H
R3	Electricity from grid	Kton	135	129	123	120	117	114	120	H
R4	Replaced heat to grid	Kton	0	0	0	0	0	0	0	H
R5	Replaced electricity to grid	Kton	0	0	0	0	0	0	0	H
R6	Other direct emissions from back up boilers	Kton	4	3	3	2	2	2	3	H
R7	Other indirect emissions from add. El. from grid	Kton	61	57	53	52	50	49	52	H
R8	**Annual emissions TOTAL reduction**	Kton	74	72	70	67	66	64	68	H
R9	**TOTAL CO2 reduction - monitoring period**	Kton	**74**	**338**						H

8.2 Estimation of Kostenets HHI CO2 emissions reduction

The difference between total baseline emissions and total project emissions (eq. 4– eq.12) represent the emission reduction from the project activity:

$$ER = BE_{total} - PE_{total}, \ t \ CO_{2-eq}/y \qquad -13$$

CO_2 emission reductions from the project activity are presented in Table. R.

B		Unit	2007	2008	2009	2010	2011	2012	2008-12	Prec
	Emission factors - EF									
B1	CO2 EF from mazut combustion	Kton/TJ	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	H
B3	CO2 EF from el. generation in BG	gCO2/kWh	779	761	743	725	707	689	725	H
B4	CO2 EF from electricity grid	gCO2/kWh	912	890	867	845	822	800	844.8	H
	Additional data									
B5	Natural gas density at 20 C	kg/Nm3	0.68	0.68	0.68	0.68	0.68	0.68	0.68	H
B6	Natural gas calorific value	kJ/Nm3	33320.56	33320.56	33320.56	33320.56	33320.56	33320.56	33320.56	
	Mazut annual consumption	tons	9157.151	9484.935	9812.719	9976.611	10304.39	10304.39	9976.611	
	Mazut calorific value	GJ/t	39.805	39.805	39.805	39.805	39.805	39.805	39.805	
B7	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	16.5	H
B8	Efficiency of existed boilers		0.89	0.89	0.89	0.89	0.89	0.89	0.89	H
	Annual average temperature in Kostenets	º C	12.5	12.5	12.5	12.5	12.5	12.5	12.5	
	Annual steam production	t/y	116216	120376	124536	126616	130776	130776	126616	H
B9	steam enthalpy-H", P=15 bar=198,3	kJ/kg	2791.4	2791.4	2791.4	2791.4	2791.4	2791.4	2791.4	H
	On-site consumptions									
B10	On-site el. consumption	MWh	53295	53852	56530	57911	60615	60685	57919	H
B11	On-site heat consumption	TJ	324	336	348	353	365	365	353	H
	Heat production									

B12	LHV Heat - boilers on-site	TJ	365	378	391	397	410	410	397	H
	Electricity production									
B13	El. produced by sources on site	MWh	0	0	0	0	0	0	0	
B14	CO_2 EF of electricity on site	Kton/MWh								
B15	Electricity coming from grid	MWh	53295	53852	56530	57911	60615	60685	57919	H
B16	CO_2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.0008	0.001	0.001	H
	Indirect off-site baseline emissions									
B17	CO2 combustion in boiler	Kton	27	28	29	29	30	30	29	H
B18	Emissions from electricity grid	Kton	49	48	49	49	50	49	48.8	H
B19	**Total CO2 baseline emission**	**Kton**	**75**	**76**	**78**	**78**	**80**	**79**	**78**	H
B20	**Total CO2 emission - monitoring**	**Kton**	**75**	**391**						H

REPORTING FORM FOR A CHP PROJECT

Description of functional units

1	Purposes for which heat is produced	1. To cover steam demand for technological purposes
		2. To cover heat demand for heating and tap water
2	Number of functional units produced or services	2 boilers DE25/24 , 1x12 (capacity 2 x 12 t/h)
3	Temperature and pressure of heat	Superheated steam P=15 bar,g; t=198 C
4	Expected annual heat demand within the system boundary for all years for the start of the project	350 TJ
5	95% confidence interval range for annual heat demand within system boundary (TJ)	320 to420 TJ

6	Annual pattern of heat demand	almost constant, increased negligible	
7	Other connected heat generation equipment	no	

Description of equipment

1	**CHP plant**		
	Brand and model type of CHP device	Package Cogeneration-gas turbine UGT 10000S1 - ZORJA Mashproekt - Ukraine - STIG version	
	Heat generation capacity-steam, MWth	14	MWth
	Electricity generated capacity, MWe	9.87	Mwe
	NG fuel capacity (LHV base) for CHP, MW	30.5	MW
	Average fuel to electricity efficiency, %	32.3	%
	Overall fuel efficiency, %	78.3	%
	Annual working hours, h/y	8200.0	h/y
Remark: It is assumed during the CHP work 4 MWth from the produced heat to be implemented as steam (STIG system) in the gas turbine. It will resulted in increased electricity capacity, which value is evaluated according to the GT producer: 4 MWth *0.31MWe/MWth = 1.24 MWe. The new heat and power capacity at the outlet of CHP in this regime of operation wail be:			
	New heat generation capacity, MWth	10	MWth
	New electricity generation capacity, Mwe	11.11	MWe
	New fuel to electricity efficiency, %	36.4	%
2	**Heat transport and distribution**		
	Efficiency of heat distribution	6-8%	
3	Start of the project 01.01.2007		

Table P. Estimation of the project emissions: **Average**

P		Unit	2007	2008	2009	2010	2011	2012	2008-12	Prec
P1	LHV mean value of NG fuel for CHP	MW	30.5	30.5	30.5	30.5	30.5	30.5	30.5	
P2	On-site fuel heat	TJ	900	900	900	900	900	900	900	H

P3	CO_2 eq. emission factor of fuel used	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.056	H
	Heat production									
P4	On-site heat consumption	TJ	324	336	348	353	365	365	353	H
	Heat produced by CHP	TJ	295	295	295	295	295	295	413	
P6	Heat produced by other sources	TJ	29	41	52	58	70	70	58	
P7	CO_2 eq. EFof fuel used from other sources	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	H
	Electricity production									
P8	On-site electricity consumption	MWh	53295	53852	56530	57911	60615	60685	57919	H
P9	Average power rate of CHP	MW e	11.1	11.1	11.1	11.1	11.1	11.1	11.1	
P10	Electricity produced by CHP	MWh	91102	91102	91102	91102	91102	91102	91102	H
P11	Electricity from other sources on-site	MWh	0	0	0	0	0	0	0	
P12	Electricity coming from grid	MWh	0	0	0	0	0	0	0	H
P13	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	17	H
P14	CO2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.001	0.001	0.001	H
	Direct on-site emissions									
P15	CO2 emissions from combustion in CHP	Kton	51	51	51	51	51	51	51	H
	Direct off-site emissions									
P16	CO2 emissions from combustion in back up boilers	Kton	2	3	3	4	4	4	4	H
P17	CO2 emissions from electricity grid		0	0	0	0	0	0	0	
	Indirect off-site emissions									
P18	CO2 avoided emissions due to load shift of el. grid	Kton	-29	-28	-26	-24	-22	-21	-24	H
P19	**Total CO2 emission**	**Kton**	**23**	**25**	**28**	**30**	**33**	**34**	30	H
P20	**Total emission during monitoring period**	**Kton**	**23**			**150**				H

Table R. Estimation of emission reduction

R		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec

R1	Heat and electricity production	Kton	51	51	51	51	51	51	51	H
R2	Heat from grid	Kton	27	28	29	29	30	30	29	H
R3	Electricity from grid	Kton	49	48	49	49	50	49	49	H
R4	Replaced heat to grid	Kton	0	0	0	0	0	0	0	H
R5	Replaced electricity to grid	Kton	-29	-28	-26	-24	-22	-21	-24	H
R6	Other direct emissions from back up boilers	Kton	2	3	3	4	4	4	4	H
R7	Other indirect emissions from add. El. from grid	Kton	0	0	0	0	0	0	0	H
R8	**Annual emissions TOTAL reduction**	Kton	52	51	50	48	47	45	48	H
R9	**TOTAL CO2 reduction - monitoring period**	Kton	**52**	**239**						H

8.3 Estimation of Toplofikatsia Kazanlak CO2 emissions reduction

The difference between total baseline emissions and total project emissions (eq. 4– eq.17) represent the emission reduction from the project activity:

$$ER = BE_{total} - PE_{total},\ t\ CO_{2-eq}/y \qquad -18$$

CO_2 emission reductions from the project activity are presented in Table. R.

REPORTING FORM FOR A BASE LINE STUDY FOR A CHP PROJECT

At the moment in DHC Kazanlak used heavy fuel oil (mazut)

Table B. Calculation of the baseline emissions

B		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
	Emission factors - EF									
B1	CO2 EF from mazut combustion	Kton/TJ	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	0.0733	H
B3	CO2 EF from el. generation in BG	gCO2/kWh	779	761	743	725	707	689	725	H
B4	CO2 EF from electricity grid	gCO2/kWh	912	890	867	845	822	800	844.8	H
	Additional data									
B5	Natural gas density at 20 C	kg/Nm3	0.68	0.68	0.68	0.68	0.68	0.68	0.68	H
B6	Natural gas calorific value	kJ/Nm3	33321	33321	33321	33321	33321	33321	33321	
	Heavy fuel oil (mazut) calorific value	kJ/kg	39767	39767	39767	39767	39767	39767	39767	
B7	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	16.5	H
B8	Efficiency of existed boilers		0.83	0.83	0.83	0.83	0.83	0.83	0.83	H
B9	steam enthalpy-H", P=8,5 bar,a	kJ/kg	2771	2771	2771	2771	2771	2771	2771	H
	On-site consumptions									
B10	On-site el. Consumption (own	MWh	7713	7555	7467	7588	7588	7588	7557	H

	needs)									
	On-site heat consumption-steam	MWh	16810	16810	16810	16810	16810	16810	16810	
	On-site heat consumption-hot water	MWh	68304	69740	70335	70793	70335	70793	70399	
	On-site heat consumption	MWh	85114	86550	87145	87603	87145	87603	87209	
B11	On-site heat consumption	TJ	306	312	314	315	314	315	314	H
	Heat production									
	Heat production	MWh	101939	103934	104417	105274	105274	105274	104835	
	Heat production	TJ	367	374	376	379	379	379	377	
	Mazut razhod	t/y	9228	9321	9414	9508	9603	9699	9509	
B12	LHV Heat - boilers on-site	TJ	367	374	376	379	379	379	377	H
	Electricity production									
B13	El. produced by sources on site	MWh								
B14	CO_2 EF of electricity on site	Kton/MWh								
B15	Electricity coming from grid	MWh	7713	7555	7467	7588	7588	7588	7557	H
B16	CO_2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.0008	0.001	0.001	H
	Indirect off-site baseline emissions									
B17	CO2 combustion in boiler	Kton	27	27	28	28	28	28	28	H
B18	Emissions from electricity grid	Kton	7.0	6.7	6.5	6.4	6.2	6.1	6.4	H
B19	**Total CO2 baseline emission**	**Kton**	**33**	**34**	**34**	**34**	**34**	**34**	**34**	H
B20	**Total CO2 emission - monitoring**	**Kton**	**33**	**170**						H

REPORTING FORM FOR A CHP PROJECT

Description of functional units

1	Purposes for which heat is produced	1. To cover steam demand for technological purposes
		2. To cover heat demand for heating and tap water
2	Number of functional units produced or services	boilers:2xKM12+1xPKM12 (3x12t/h steam capacity)
3	Temperature and pressure of heat	Saturated steam with 8,5 bar,a
4	Expected annual heat demand within the system boundary for all years for the start of the project	315 TJ
5	95% confidence interval range for annual heat demand within system boundary (TJ)	300 to 332 TJ
6	Annual pattern of heat demand	almost constant
7	Other connected heat generation equipment	

Description of equipment

1	**CHP plant**			
	Brand and model type of CHP device	Package Cogeneration-2 GDE- Jenbacher 620 GS		
	Heat generation capacity, MWth	2*3.173	MWth	
	Electricity generated capacity, MWe	2*3.047	MW e	
	Average fuel to heat efficiency, %	43.1	%	h
	Average fuel to electricity efficiency, %	42.6	%	
	Overall efficiency, %	85.9	%	
	Annual working hours, h	6250.0	h/y	
2	**Heat transport and distribution**			
	Efficiency of heat distribution	5-8%		

Table P. Estimation of the project emissions:

P		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
P1	LHV mean value of NG fuel for CHP	MWth	14	14	14	14	14	14	14	
P2	On-site fuel heat	TJ							322	H
P3	CO_2 eq. emission factor of fuel used	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.056	H
	Heat production									
P4	On-site heat consumption	TJ		312	314	315	314	315	314	H
P5	Heat produced by CHP	TJ		143	143	143	143	143	143	H
P6	Heat produced by other sources	TJ	164	169	171	173	171	173	171	
P7	CO_2 eq. EFof fuel used from other sources	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	H
	Electricity production									
P8	On-site electricity consumption	MWh		7555	7467	7588	7588	7588	7557	H
P9	Average power rate of CHP	MW e		6	6	6	6	6	6	
P10	Electricity produced by CHP	MWh		38088	38088	38088	38088	38088	38088	H
P11	Electricity from other sources on-site	MWh		0	0	0	0	0	0	
P12	Electricity coming from grid	MWh		0	0	0	0	0	0	H
P13	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	17	H
P14	CO2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.001	0.001	0.001	H
	Direct on-site emissions									
P15	CO2 emissions from combustion in CHP	Kton	18	18	18	18	18	18	18	H
	Direct off-site emissions									
P16	CO2 emissions from combustion in back up boilers	Kton	11	11	12	12	12	12	12	H
P17	CO2 emissions from electricity grid		0	0	0	0	0	0	0	
	Indirect off-site emissions									

P18	CO_2 avoided emissions due to load shift of el. grid	Kton		-23	-23	-22	-22	-21	-22	H
P19	**Total CO_2 emission**	**Kton**	**5**	**6**	**7**	**8**	**8**	**9**	7	H
P20	**Total emission during monitoring period**	**Kton**	**5**	**37**						H

Table R. Estimation of emission reduction

R		Unit	2007		2009	2010	2011	2012	Average 2008-12	Prec
R1	Heat and electricity production	Kton	18	18	18	18	18	18	18	H
R2	Heat from grid	Kton	27	27	28	28	28	28	28	H
R3	Electricity from grid	Kton	7	7	6	6	6	6	6	H
R4	Replaced heat to grid	Kton	0	0	0	0	0	0	0	H
R5	Replaced electricity to grid	Kton	-24	-23	-23	-22	-22	-21	-22	H
R6	Other direct emissions from back up boilers	Kton	11	11	12	12	12	12	12	H
R7	Other indirect emissions from add. El. from grid	Kton	0	0	0	0	0	0	0	H
R8	**Annual emissions TOTAL reduction**	Kton	28	28	27	27	26	25	27	H
R9	**TOTAL CO_2 reduction - monitoring period**	Kton	**28**	**133**						H

8.4 Estimation of Toplofikatsia Yambol CO2 emissions reduction

The difference between total baseline emissions and total project emissions (eq. 4– eq.17) represent the emission reduction from the project activity**:**

$$ER = BE_{total} - PE_{total}, \ t\ CO_{2-eq}/y \qquad -13$$

CO_2 emission reductions from the project activity are presented in Table. R.

B		Unit	2007		2009	2010	2011	2012	2008-12	Prec
	Emission factors - EF									
B1	CO2 EF from gas combustion	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	H
	CO2 EF from coal combustion	Kton/TJ	0.1012	0.1012	0.1012	0.1012	0.1012	0.1012	0.1012	
B4	CO2 EF from electricity grid	gCO2/kWh	912	890	867	845	822	800	844.8	H
	Additional data									
B5	Natural gas density at 20 C	kg/Nm3	0.68	0.68	0.68	0.68	0.68	0.68	0.68	H
B6	Natural gas calorific value	kJ/Nm3	33321	33321	33321	33321	33321	33321	33321	H
B7	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	16.5	H
B8	Efficiency of existed boilers		0.80	0.80	0.80	0.80	0.80	0.80	0.80	H
	On-site consumptions									
	Total working hours per year	h	8000	8000	8000	8000	8000	8000	8000	
	Winter working hours-5months	h	3600	3600	3600	3600	3600	3600	3600	
	Summer working hours-7months	h	4400	4400	4400	4400	4400	4400	4400	
	winter-heat demand -mean value	MWh	48600	48600	48600	48600	48600	48600	48600	
	Summer heat demand	MWh	13400	13400	13400	13400	13400	13400	13400	
	Annual heat demand	MWh/y	62000.2	62000.2	62000.2	62000.2	62000.2	62000.2	62000.2	

	Annual heat by NG **Annual heat by electricity** **Annual heat by different fuels**	MWh/y MWh/y MWh/y	3540 42767 15693.1	3540 42767 15693.11	3540 42767 15693.1	3540 42767 15693.1	3540 42767 15693.1	3540 42767 15693.1	3540 42767 15693.1	
	On-site heat consumption -total	TJ	223	223	223	223	223	223	223	H
	On-site heat consumption by NG	TJ	13	13	13	13	13	13	13	
	On-site heat consumption by electricity	MWh	42767	42767	42767	42767	42767	42767	42767	
	On-site heat consumption by coal	TJ	56	56	56	56	56	56	56	
	Heat production									
	Efficiency of existed domestic boilers	%	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
B12	LHV Heat - domestic boilers on-site	TJ	94	94	94	94	94	94	94	H
	LHV Heat - NG boilers on-site	TJ	16	16	16	16	16	16	16	
	Electricity production									
B13	El. produced by sources on site	MWh	0	0	0	0	0	0	0	
B15	Electricity coming from grid	MWh	42767	42767	42767	42767	42767	42767	42767	H
B16	CO_2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.0008	0.001	0.001	H
	Indirect off-site baseline emissions									
B17	CO2 combustion in domestic boiler	Kton	5	5	5	5	5	5	5	H
B18	Emissions from electricity grid	Kton	39.0	38.1	37.1	36.1	35.2	34.2	36.1	H
B19	**Total CO2 baseline emission**	**Kton**	**44**	**43**	**42**	**41**	**40**	**39**	**41**	H
B20	**Total CO2 emission - monitoring**	**Kton**	**44**			**205**				H

FUEL	%	Kton/TJ
coal	11	0.1012
electricity	62	Rep. Form
wood	15	0
DHC	5	Rep Form

no answer	2.5	_
pr./butane	2	0.0631
light oil	0.5	0.0733
NG	1	0.0561
no heating	1	0

REPORTING FORM FOR A CHP PROJECT

Description of functional units

1	Purposes for which heat is produced	
		2. To cover heat demand for heating and tap water
2	Number of functional units produced or services	4boilers KM12 (4x12 t/h)
3	Temperature and pressure of heat	hot water for heating and DHW
4	Expected annual heat demand within the system boundary for all years for the start of the project	222 TJ
5	95% confidence interval range for annual heat demand within system boundary (TJ)	211 to 234 TJ
6	Annual pattern of heat demand	almost constant, increased negligible
7	Other connected heat generation equipment	

Description of equipment

1	**CHP plant**		
	Brand and model type of CHP device	CHP Jenbacher gas engine 620- 1 unit	
	Heat generation capacity, MWth	3.173	MWth
	Electricity generated capacity, MWe	3.047	Mwe

	Average fuel to heat efficiency, %	44.4	%	
	Average fuel to electricity efficiency, %	42.6	%	
	Annual working hours, h/y	8000	h/y	
2	**Heat transport and distribution**			
	Efficiency of heat distribution	5-8%		
	Start of the project 01.07.2005			

Table P. Estimation of the project emissions:

P		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
P1	LHV mean value of NG fuel for CHP	MWth	7	7	7	7	7	7	7	
P2	On-site fuel heat	TJ	206	206	206	206	206	206	206	H
P3	CO_2 eq. emission factor of fuel used	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.056	H
	Heat production									
P4	On-site heat consumption	TJ	223	223	223	223	223	223	223	H
P5	Heat produced by CHP	TJ	91	91	91	91	91	91	91	H
P6	Heat produced by other sources	TJ	132	132	132	132	132	132	132	
P7	CO_2 eq. EFof fuel used from other sources	Kton/TJ	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	0.0561	H
	Electricity production									
P9	Average power rate of CHP	Mwe	3	3	3	3	3	3	3	
P10	Electricity produced by CHP	MWh	24376	24376	24376	24376	24376	24376	24376	H
P11	Electricity from other sources on-site	MWh	0	0	0	0	0	0	0	
P12	Electricity coming from grid	MWh		0	0	0	0	0	0	H
P13	Losses in grid	%	17.1	17.0	16.7	16.6	16.3	16.1	17	H
P14	CO2 EF of electricity from grid	Kton/MWh	0.001	0.001	0.001	0.001	0.001	0.001	0.001	H
	Direct on-site emissions									
P15	CO2 emissions from combustion in CHP	Kton	12	12	12	12	12	12	12	H
	Direct off-site emissions									
P16	CO2 emissions from combustion in back up boilers	Kton	9	9	9	9	9	9	9	H
P17	CO2 emissions from electricity grid		0	0	0	0	0	0	0	
	Indirect off-site emissions									
P18	CO2 avoided emissions due to load shift of el. grid	Kton	19	19	18	18	17	17		H
P19	**Total CO2 emission**	**Kton**	**2**	**2**	**3**	**3**	**4**	**4**	**21**	H
P20	**Total emission during monitoring period**	**Kton**	**2**			**15**				H

Table R. Estimation of emission reduction

R		Unit	2007	2008	2009	2010	2011	2012	Average 2008-12	Prec
R1	Heat and electricity production	Kton	12	12	12	12	12	12	12	H
R2	Heat from grid	Kton	5	5	5	5	5	5	5	H
R3	Electricity from grid	Kton	39	38	37	36	35	34	36	H
R4	Replaced heat to grid	Kton	0	0	0	0	0	0	0	H
R5	Replaced electricity to grid	Kton	-19	-19	-18	-18	-17	-17	-18	H
R6	Other direct emissions from back up boilers	Kton	9	9	9	9	9	9	9	H
R7	Other indirect emissions from add. El. from grid	Kton	0	0	0	0	0	0	0	H
R8	**Annual emissions TOTAL reduction**	Kton	42	41	39	38	37	35	38	H
R9	**TOTAL CO2 reduction - monitoring period**	Kton	**42**	**190**						H

9. MONITORING PLAN

Considering the project boundary, the following data need to be monitored in order to estimate project and baseline emissions, and emission reductions:

- Natural gas used by the CHP, and by the back up boilers; in m^3
- Net electricity supplied by CHP to factory, MWh
- Electricity exchange with the power grid, MWh
- Heat output supplied by CHP to the factory (steam and hot water), GJ
- Heat output supplied by back up boilers (steam and hot water), GJ
- Efficiency of the existed boilers in the plant, whose heat output would be reduced because of heat output from the CHP

CO_2 emissions within the project boundary arise from NG combustion in the CHP.

9.1 Monitoring methodology

9.1.1 Brief description of methodology

This project comprises the installation of a natural gas fired cogeneration systems at industrial plants and at district heating plants, where electricity and heat are provided separately, prior to project implementation. The Monitoring and Verification Plan is based on recording natural gas used by the cogeneration module and electricity and heat supplied by cogeneration plant to the factory, as well as heat production from back up boilers and exchanged electricity with the power grid. Data will be collected on a monthly basis for the duration of the project lifetime and crediting period (6 years). CO_2 emissions following project implementation are determined from the parameters monitored, as described above. The monitoring plan describes the procedures for data collection, and auditing required for the project, in order to determine and verify emissions reductions achieved by the project. This project will require only straightforward collection of data, described below. Considering the project boundaries, the following data need to be monitored in order to estimate project and baseline emissions, and emissions reductions:

- Natural gas used by the cogeneration plant, m3.
- Net electricity supplied by cogeneration plant to the factory, MWh
- Exchanged electricity with the power grid, MWh
- Net heat supplied by cogeneration plant to the factory, GJ
- Heat supplied by back up boilers, GJ
- Efficiency of boiler(s) providing heat to the factory.

For the specific project considerations in this PDD, a monitoring model has been designed. It is prepared in excel format in spreadsheets as they are presented in Annex No.14. With minimal changes in the monitoring, mainly for modifying parameter estimates to suit individual project circumstances, this model can be applied to any package cogeneration project based on natural gas.

The monitoring model takes monitored data as input, and automatically calculates both project and baseline emissions, for each year following project implementation, in a dynamic manner. As we have mentioned, baseline emissions are emissions avoided at the project activities because of heat and electricity supplied by the

cogeneration systems.
Thus, during project implementation, baseline emissions are best determined from monitored data on heat and electricity output from the cogeneration system.

The model is an electronic CO_2 monitoring and calculation worksheets for package cogeneration projects. The electronic worksheets serves as the data management and analysis system for the project managers and operators, and can be used throughout the lifetime of the project.

The staff responsible for Project monitoring should complete the electronic worksheets
on a monthly basis. The model automatically provides annual totals in terms of GHG reductions achieved through the implementation of the cogeneration system.

The excel monitoring model determines the emissions associated with cogeneration system. The model contains a series of worksheets with different functions:
Data entry sheets:
Natural gas consumption,
Cogeneration electricity supply to plant
Electricity from and to the grid
Cogeneration steam supply to plant
Back up boilers steam supply to plan

Calculation sheets:
- o *Project emissions*
- o *Electricity baseline*, and
- o *Heat baseline*

Result sheet:
- o *Emissions reduction*

9.1.2 Assumptions used in elaborating methodology:

The monitoring methodology and its application is compatible with the baseline methodology and the development of the baseline scenario for this type of project. The assumptions regarding heating value and emissions factors of fuels are the same in each case, and are unchanged throughout the project. These factors are country specific and are listed in the PDD.

Table 9.1 Data to be collected in order to monitor emission from the project activity, and how this data will be archived

№	Data type	Data variable	Data unit	Measured (m), calculated (c) or Estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data archived? (electronic/paper)	For How long is archived data to be kept?
1	Volume of natural gas	V_{NG}	Nm^3	m	Month	100%	Paper (field record)	Paper 1 years

	consumed from CHP;						Electronics (spreadsheet)	Electronics 7 years
2	Co-generation electricity to industrial plant	E_{CHP}	MWh	m	Month	100%	Paper (field record) Electronics (spreadsheet)	Electronics 7 years
3	Heat generation from CHP to industrial plant	Q_{heat}	MWh	m	Month	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
4	Efficiency of existed boilers	η_b	-	m	Year	100%	Paper (field record) Electronics (spreadsheet)	Paper 1 years Electronics 7 years
5	Lower calorific value	LHV	kJ/Nm^3	m	Month	100%	Paper (field record)	Paper 1 years
6.	Heat generation from back up boilers	Q_{heat}	MWh	m	Month	100%	Paper (field record) Electronics (spreadsheet	Paper 1 years Electronics 7 years
7	Electricity exchanged with the grid	Eg	MWh	m	Month	100%	Paper (field record) Electronics (spreadsheet	Paper 1 years Electronics 7 years

The table below describe QA/QC procedures for with each data variable together with additional relevant information on each variable

Table 9.2 Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

. Data	Uncertainty level of data (High / Medium / Low)	Are QA / QC procedures planned for these data?	Outline explanation why QA/QC procedures are or are not being planned.
1	Low	Yes	These data will be directly used for calculation of emissions reductions
2	Low	Yes	These data will be directly used for calculation of emissions reductions
3	Low	Yes	These data will be directly used for calculation of emissions reductions
4	Low	Yes	These data will be directly used for calculation of emissions reductions
5	Low	Yes	These data will be directly used for calculation of emissions reductions

9.2ential strengths and weaknesses of this methodology

Since there are no methodologies approved by the UNFCCC, at this time, specific to this type of project, the strengths and weaknesses of the methodology need to be evaluated on their own merits.
The s*trength*s of the methodology are:
Simple and easy to use, based on data that will need to be collected at the project site, for the purpose of metering and billing of heat and electricity output of the CHP and the heat and electricity grids. Complete compatibility with calculation of baseline emissions. Baseline emissions are automatically determined in the spreadsheet model, based on continuously monitored cogeneration system heat and electricity output data, and periodic measurements of efficiency of the industrial boiler. The model permits CO_2 emission reductions to be automatically calculated, taking into account the above considerations.
There are no known weaknesses of the methodology.

The Models of Monitoring are presented in Appendix No. 14

10. STAKEHOLDERS COMMENTS

With reference to the planned construction of the cogeneration gas powered installations at Polymeri, Kostenets HHI, Toplofikatsia Kazanlak and Toplofikatsia Yambol, the Municipalities, the Ministries and Agencies, the neighbouring companies, the people living in the vicinity of the projects sites, the bank were informed in detail of the planned projects. The aims and expected advantages from the realization of the projects for the future development were explained in detail. The environmental effects from the project were also discussed. Various opinions and comments were heard with reference to the realization and operation of the installations.
The comments of the interested parties on the project are positive as a whole.

Enclosed herewith are a brief summary of the comments of several interested parties on the realization of the project. The letters express their opinion are shown in Annex No.18

Letter of Bulgargas
The letter refer to the whole project and express the Bulgargas point of view about the connection of the factories to the main gas pipeline and possibility to supply the gas.
"Bulgargaz Plc states its principal positive attitude for the implementation of co-generation installations in your factories Polimeri Plc, Kostenets HHI Plc, Toplofikatsia Yambol Plc, Toplofikatsia Kazanluk Plc.
Bulgargaz Plc will consider carefully its possibilities to support the projects.
The possible points for feeding of natural gas from the high-way gas-main for the offered consumers are:

- for Polimeri Plc – gas-distribution station – Devnya
- for Kostenets HHI Plc – gas station 100 m from the high-way gas-main pipe Due 700
- for Toplofikatsia Kazanluk Plc – gas distribution station – Kalitinovo
- Toplofikatsia Yambol Plc is supplied with natural gas.

Polymeri JSC

- Letter of Devnia Invest JSC – We support your investment plan for realizing of co-generation installation that will improve the ecological balance in the region and to increase the efficiency of your chemical production.
- Letter of Corporative Commercial Bank JSC – we support the project in Polymeri like ecological, with good efficiency and appropriate for financing.

Kostenets HHI JSC

- Letter of Municipality, Kostenets – taking into account the direct benefits for the population and the business companies from the successful implementation of the gasification project, cleaner environmental and improvement of economical status of the region we do not object against the implementation of the project.
- Letter of Round seal of Belopaper Kostenets – taking in account the development prospects for the region in which our companies are located we support the project.

  - Letter of Activ Comers LTD – taking in account the development prospects for the region our partnerships and our advantages from the gasification we support the project.
- Letter of Bulcost LTD – we believe that the construction of the cogenerator facility and the gasification would not only contribute to the prosperity of your company but to prosperity of our company and of town Kostenets.
- Letter of Dimcostar LTD – we reviewed your idea for constructing of cogeneration and taking in account the development prospects for the region and our companies we do not object against the project.
- Letter of Maritza-N.I.S. LTD – we believe that the cogeneration will contribute for the prosperity of the region and help for the attainment of favourable environment for the local population.

Toplofikatsia Kazanlak JSC

- Letter of householders – after a meeting on 17.02.05 we were acquainted with the investment intention. Accordance to our consideration your intentions are positive and we the consumers will feel the effect .
- Letter of Municipality Kazanlak – the Municipality authorities are very well acquaints with your investment intention. Cogenerations on your intention as it will lead to positive effect in several directions. The Municipality will take all measures depending on its power concerning project realization.

Toplofikatsia Yambol JSC

- Letter of Municipality Yambol – the project corresponds to the Regional Strategy for development and the Municipal Plan for development-Yambol. We hereby support the project and we are convinced in its successful implementation.
- Letter of Ministry of Energy – the Ministry supports the execution of the investment activities of the “Toplofikatzia Yambol” Plc. By this there will be ensured technical and financial conditions for the development of the company and will be achieved a qualitative heat - supply and the price of the heat power for the consumers of Yambol will be kept at an acceptable level. And one substantial point – the above mentioned investments will affect positively to the preservation of the environment.
- Statement of Agency for Energy Efficiency - regarding the state policy through Agency for Energy Efficiency pointed towards encouraging and assistance of the measures for energy efficiency and realization of projects for reduction of energy expenses of the ultimate consumers I propose the implementation of the project to be supported.
- Letter of households - when make reference to that by now in the town doesn’t have a central heating and that the central heating is possibility for cheapest way for heating. As we express the opinion of large part of the citizens we support the project for heating of the town.

11. ENVIRONMENTAL IMPACT

It is an established fact that projects of the kind for construction of cogeneration plants fuelled by natural gas are not a source of hazardous air and soil pollution. In this case, in accordance with the provisions of the Environmental Protection Act of the Republic of Bulgaria, Article 93, paragraph 1, item 3, this project is subject to an assessment of the necessity for elaboration of an Assessment of the Environmental Impact Report (AEIR). This is the official position of The Ministry of Environment and Waters, expressed by the statement of the Preventive Activities Department.
In accordance with these requirements, Polimeri, Kostenets and Toplofikatsia Kazanlak have submitted the required documents for the elaboration of this assessment to the District Environmental Impact Inspection of the town of Varna, Sofia, Stara Zagora in accordance with the requirements of the Regulation on Terms and Conditions for the Elaboration of Assessment of the Environmental Impact Reports for Buildings, Activities, and Technologies (State Gazette, No. 25 dated 18.03.2003).

The following documents have been submitted:
I Information for correspondence with the investor

1. Name, PIN, residence, citizenship – a physical person, head office and unique identity number of a corporation.
2. Full post address
3. Telephone, fax, e-mail
4. Person for correspondence

II Characteristics of investment proposal

1. Proposal's summary
2. Proving the necessity of investment proposal
3. Connection with other existing approved with organization or other type of plan activities.
4. Detailed information for examined alternatives.
5. The building site, including the necessary area for temporary activities during the construction.
6. Main processes description (under catalogue data), capacity.
7. Scheme of a new or already existing road infrastructure.
8. Activity programme, including those of construction, operation and stages of closing, restoration and subsequent usage.
9. Suggested methods for construction.
10. Natural resources forecast for use during construction and operation.
11. Refuses that is expected to be generated – types, quantities and ways of treatment.
12. Information on discussed measurements and precautions for reducing negative effects on the environment.
13. Other activities, connected with investment proposal (for instance building material output, new water-supply system, output and energy transferring, residential building, treatment of sewage).
14. Necessity of other licenses, connected with investment proposal.

III Site of the investment proposal

1. Plan, mapping and photos, showing the limits of the investment proposal, giving information about physical, natural and

anthropogenius characteristics, as well information about near-situated elements from the National ecological net.

2. Existing land users and their adaptation to the building site or site trace of the investment proposal and future planned land users.
3. Zoning and land use in accordance with approved plans.
4. Sensitive territories, including sensitive zones, vulnerable zones, protected zones, sanitary-guarded zones and others; National ecological net.
5. Detailed information about all discussed alternatives for site and situation.

IV Potential affects characteristics

A brief description of the possible influences in sequence of the realization of the investment proposal):

1. Affects on people and their health, land use, material assets, atmospheric air, the atmosphere, water, soil, bowels of the Earth, landscape, natural objects, mineral diversity, biological diversity and its elements and protected territories of single and group monuments, as well the expected affects from natural and anthrop genius substances and processes, different kinds of refuse and its location, risky energy resources – noises, vibrations, radiations and some genetic modified organisms as well.
2. Influence upon elements from the National ecologic net, including elements located near the object of the investment proposal.
3. Type of the affect (direct, indirect, secondary, cumulative, momentary, middle- and long-lasting, permanent or temporary, positive or negative).
4. Affect range – geographical area; concerned population; residential sites (name, type – a town, a village, a resort, a number of population and others).
5. Durability, frequency and turn and change of the impact.
7. Precautions and measurements that is necessary to be included in the investment proposal, connected with prevention or avoidance, reducing or compensating of the considerable negative impacts upon environment.
8. Global characteristics of impacts.

Toplofikatsia Kazanlak and Toplofikatsia Yambol received official answer from Regional Inspections of Environment, with their resolution that an Assessment of the Environmental Impact Report does not have to be elaborated for these projects, see Annex No.17. The answer for Polimeri JSC and Kostenets HHI JSC will be ready to the end of March.