CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Skopje Cogeneration Project

Version number: 1.0

Date: 14 March 2008

A.2. Description of the project activity:

The project aims to construct a new Combined Heat and Power Plant (CHPP) which will ensure combined generation of electricity and heat in the form of dry-saturated steam and hot water. Due to the fact that the approved CDM methodology AM0029 is only covering production of electricity from natural gas, the heat and steam production will not be subject of this PDD.

The project envisages installation of gas engine cogeneration generation sets (gensets) with the heat of exhaust gases being utilized in recovery boilers for production of steam which is further supplied to industrial consumers. Heat recovered from cooling systems of the gas engines will be used for preheating of feed water supplied to recovery boilers and also for heating of delivery water for the Skopje district heating system. Natural gas is the main fuel.

Currently steam and hot water are supplied from Energetika CHPP[1] (ECHPP) which was put in operation in 1967. Electricity generation was stopped at the plant in 1981 and it is now operating as a large boiler house. Natural gas is the main fuel at the plant.

Construction of the new CHPP will not result in ECHPP closure as the thermal capacity of the new plant will be sufficient to cover only some part of the consumers' load. Moreover these plants have different owners. All the heat and electric energy generated at the new plant will be sold on a competitive basis.

The main part of electricity in the Republic of Macedonia is generated by steam-turbine power plants working in condensation mode (TPP). Lignite is the main fuel at these plants. Their net efficiency factor of power generation does not exceed 38%.

Combined heat and electricity generation by gas engine cogeneration gensets will allow to increase efficiency of fossil fuel use. The amount of electricity generated at the new plant will replace grid electricity generated at TPPs. The following main energy equipment will be installed at the new CHPP:

- ten gas engine cogeneration gensets of JMS 620 GS-N.LC type with the total installed electric power of 30.41 MW;
- five steam recovery boilers of SG-33.7-1000-2000/4000-1H-1AX-V-9 type with the total steam production of about 20 t/h;
- heat-exchangers for water heating.

The project implementation will result in:

- additional electricity generation;
- reduction of steam and hot water supply from ECHPP;

[1] http://www.elem.com.mk/index.php?id=147

- increase of fossil fuel use efficiency;
- reduction of GHG emissions from fossil fuel combustion by 54 800 tonnes of CO_2e per year;
- decrease of emissions of polluting substances into the atmosphere;
- increase of local employment (about 14 new jobs).

The construction began in November 2007 and is planned to be completed by 15th of August 2008. The estimated total investment cost of the project is about €14.34 million.

The investment proposal and pre-feasibility study for the new CHPP construction project prepared by European Energy Investments Limited and Balkan Advisory Company in 2007 was used for PDD preparation. Revenues from the sale of CERs were included into the calculation of economic viability of the project on the assumption that the project will be developed in accordance with the requirements of the Clean Development Mechanism (CDM) procedures.

A.3. Project participants:

Party involved	Legal entity project participant (as applicable)	Please indicate if the Party involved wishes to be considered as project participant (Yes/No)
Party A: The Former Yugoslav Republic of Macedonia (host Party)	Legal entity A1: Share holding company "ENERGOUSLUGI DOO"	No
Party B: EU countries	Legal entity B1: Private company "Camco International Ltd"	No

ENERGOUSLUGI DOO is an industrial services company supplying electricity and providing other services to several businesses in the industrial park close to Skopje.

Camco International Ltd is a Jersey based public company listed at AIM in London. Camco International is the world leading carbon asset developer and projects promoter under both joint implementation and clean development mechanism of the Kyoto Protocol. Camco's project portfolio consists of more than 100 projects, generating altogether about 150 Mt CO_2e of GHG reductions all over the world. Camco operates in Eastern Europe, Africa, China, Russia and Southeast Asia.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

The Former Yugoslav Republic of Macedonia

A.4.1.2. Region/State/Province etc.:

A.4.1.3. City/Town/Community etc:

City of Skopje

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

Skopje is the capital of the Republic of Macedonia (Fig. A.4-1). The population of the city is about 600 000 people.

The project activity is located at the site owned by ENERGOUSLUGI DOO within the Zelezara industrial complex (Iron & Steel Works) located on the northern outskirts of Skopje (Fig. A.4-2). The Zelezara complex contains a steel works, a hot roll mill, a cold roll mill, a technical gases facility and several other smaller factories.

Geographic latitude: 42°00'32"N. Geographic longitude: 21°28'00"E. Time zone: GMT +1:00.

Fig. A.4-1. The Republic of Macedonia

Fig. A.4-2. The Google Earth map indicating the location of the project activity

A.4.2. Category (ies) of project activity:

Sectoral Scope 1: Energy industries (renewable/non renewable sources)

A.4.3. Technology to be employed by the project activity:

The project envisages installation of gas engine cogeneration gensets with the total installed electric power of 30.41 MW together with heat recovery boilers and heat exchangers to recover heat from the gas engine units in the form of dry-saturated steam and hot water.

Electricity will be generated by ten gas engines cogeneration gensets of JMS 620 GS-N.LC type manufactured by GE Jenbacher (Fig. A.4-3).

The main element of a gas engine cogeneration genset is a four-stroke external combustion engine which generates capacity by converting chemical energy of fuel to mechanical work. The engine runs on natural gas. Generated mechanical energy is used for the generator drive that generates electric power. Exhaust gases from the engine with the temperature of about 425 °C are directed to recovery boiler.

Five steam recovery boilers (SRB) of SG-33.7-1000-2000/4000-1H-1AX-V-9 type manufactured by APROVIS Energy Systems GmbH are the main process equipment for dry-saturated steam production (Fig. A.4-4). Total steam production of the recovery boilers is about 20 t/h. Dry-saturated steam generated in recovery boilers is supplied to the steam main of ECHPP via a new steam line, 200 m long.

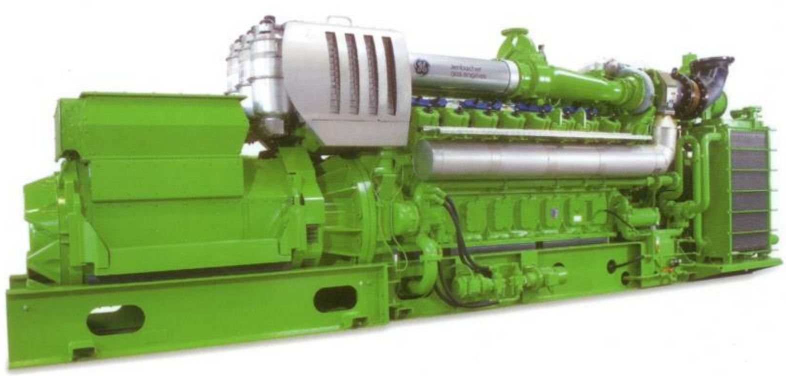

Fig. A.4-3. General view of gas engine cogeneration gensets of JMS 620 GS-N.LC type

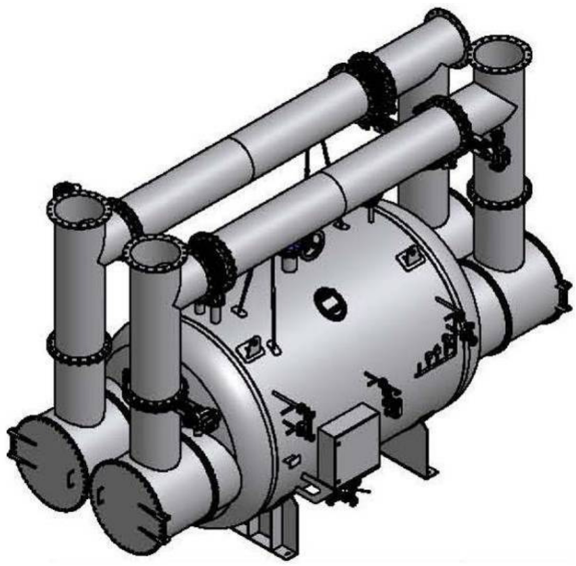

Fig. A.4-4. General view of SRB of SG-33.7-1000-2000/4000-1H-1AX-V-9 type (computer image)

Heat recovered from cooling systems of gas engines will be used for preheating of feed water supplied to SRBs and for heating of delivery water for the Skopje district heating system.

The main advantage of cogeneration against separate generation is lower fossil fuel consumption for generation of the same amount of heat and electricity. Large amount of heat escapes into the atmosphere through steam condensers, cooling towers, etc. during operation of TPPs, this is associated with technological peculiarities of the process. Energy efficiency of these plants is 30-50%. Energy generation efficiency increases up to 80-90% when gas engines cogeneration gensets are operated due to utilization of heat of exhaust gases, engine jacket water, air/fuel mixture and lube oil.

A.4.4 Estimated amount of emission reductions over the chosen crediting period:

The 7-years crediting period with a possibility of renewal was selected for this project.

Year	Estimate of annual emission reductions in tonnes of CO_2 equivalent
2008 (15 August 2008 – 31 December 2008)	20 551
2009	54 802
2010	54 802
2011	54 802
2012	54 802
2013	54 802
2014	54 802
2015	61 851
2016	61 851
2017	61 851
2018	61 851
2019	61 851
2020	61 851
2021	61 851
2022	61 851
2023	61 851
2024	61 851
2025	61 851
2026	61 851
2027	61 851
Total estimated emission reductions over the first crediting period (tonnes of CO_2 equivalent)	**349 364**
Total estimated emission reductions over the second crediting period (tonnes of CO_2 equivalent)	**432 959**
Total estimated emission reductions over the third crediting period (tonnes of CO_2 equivalent)	**371 107**
Total number of crediting years	**20**
Annual average of estimated emission reductions over the first crediting period (tonnes of CO_2 equivalent)	49 909
Annual average of estimated emission reductions over the second crediting period (tonnes of CO_2 equivalent)	61 851
Annual average of estimated emission reductions over the third crediting periods (tonnes of CO_2 equivalent)	61 851

A.4.5. Public funding of the project activity:

No public funding will be applied to the project.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

Of the approved CDM methodologies available the most appropriate is AM0029: "Baseline methodology for grid connected electricity generation plants using natural gas" (Version 03, 30 May 2008)[1].

"Tool to calculate the emission factor for an electricity system" (Version 01, 19 October 2007)[2] is used to estimate the emission factor for the grid electricity.

"Tool for the demonstration and assessment of additionality" (Version 05, 16 May 2008)[3] is used for additionality demonstration.

B.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The AM0029 methodology is applied to the project because it complies with all the conditions necessary for the applicability of the methodology (see Table B.2-1).

Table B.2-1 Applicability of AM0029 methodology to the project

Applicability criteria of AM0029 methodology	Applicability	Comments
The project activity is the construction and operation of a new natural gas fired grid-connected electricity generation plant.	Applicable	The project envisages construction of a new CHPP with the total installed electric power of 30.41 MW. All generated electricity will be supplied to the grid. The main and standby fuel of the new CHPP is natural gas.
The geographical/physical boundaries of the baseline grid can be clearly identified and information pertaining to the grid and estimating baseline emissions is publicly available.	Applicable	Geographical and physical boundaries of the power grid in the Republic of Macedonia can be clearly identified (see Annex 3-1). Basic information on the Republic's power plants is posted at the web-sites of Joint Stock Company Macedonian Power Plants (AD ELEM)[4] and AD TPP Negotino[5].
Natural gas is sufficiently available in the region or country, e.g. future natural gas based power capacity additions, comparable in size to the project activity, are not constrained	Applicable	There are no limitations to natural gas use in the Republic of Macedonia. The gas is delivered to the country from Russia by Gazprom. AD GAMA a public company for transport of natural gas in Macedonia supplies

[1] http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_15YH7UTNQ40J8MGMVX62CGNE0K49Y0

[2] http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf

[3] http://cdm.unfccc.int/methodologies/PAmethodologies/AdditionalityTools/Additionality_tool.pdf

[4] http://www.elem.com.mk/index.php?id=15

[5] http://www.tecnegotino.com.mk/

by the use of natural gas in the project activity.		the natural gas within Macedonia. The main energy fuel is lignite. Residual fuel oil is used as a startup and standby fuel at lignite-fired thermal power plants, and as a primary fuel at the Negotino TPP. Natural gas is currently not used for power generation. The main gasmain is built for capacity of 800 million m^3 gas. (800 x 10^6 m^3 / annual I pressure 52 bars). To this manifold system for transportation of gas, only ca. 20 companies are connected, engaging around 10-12% of the installed capacity (82 x 10^6 m³ in 2006 and 103 x 10^6 m³ in 2007). The distribution network for the needs of the individual consumers is still not built, although this is expected to happen in the near future. But even in that case, the expected consumption of this sector is at a level of 100 million m^3 gas annually, which is still far away from the projected capacity of the distribution manifold. Natural gas combustion at the new CHPP will not lead to reduction of natural gas combustion at other power plants.

B.3. Description of the sources and gases included in the project boundary

According to the selected methodology (AM0029/version 03) the implementation of the project will result in GHG emissions reduction from fossil fuel combustion. CO_2 is the main greenhouse gas produced from fuel combustion. CH_4 and N_2O emissions from fuel combustion are negligibly small compared to CO_2 emissions and were not taken into account in the development of the project.

Table B.3-1 illustrates which emission sources are included in or excluded from the project and baseline boundaries.

Table B.3-1. Emission sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Combustion of fossil fuels for electricity generation	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project Activity	On-site natural gas combustion due to project activity	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.

According to AM0029, the project boundary will include the new power plant and all power plants connected physically to the grid that it is connected to the energy systems of Serbia, Bulgaria and Greece (see Annex 3-1).

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to the selected methodology (AM0029/version 03) the following steps were used to choose the baseline scenario:

Step 1: Identification of plausible baseline scenarios

According to AM0029, these alternatives need not consist solely of power plants of the same capacity (i.e. several smaller plants, or the share of a larger plant may be a reasonable alternative to the project activity), but that they should: 1) deliver similar services (e.g. peak vs. baseload power); 2) include all relevant power plant technologies that have recently been constructed or are under construction or are being planned; and 3) exclude baseline scenarios that are not in compliance with all applicable legal and regulatory requirements.

All the identified alternatives envisage various baseline scenario options, which could ensure power supply similar to the project activity by means of existing or new energy-generating facilities, various technologies and fuels (see Table B.4-1).

Table B.4-1. Identified alternatives of baseline scenario

Alternative	Possibility
1. The project activity not implemented as a CDM project:	
1.1. Power generation using gas engine cogeneration gensets.	This alternative is possible but unlikely due to low economic performance (see Section B.5).
2. Power generation using natural gas, but technologies other than the project activity:	
2.1. Natural gas open-cycle power unit.	This alternative is unlikely and not economically attractive. When developing “The investment proposal and pre-feasibility study” for construction of a new CHPP this option was considered as an alternative to the project activity, however it was excluded from further consideration. Thus, Alternative 2.1 is excluded from further consideration.
2.2. Natural gas steam turbine power unit.	This alternative is unlikely due to low economic performance, low energy efficiency and high price of natural gas. For purposes of estimation, the capacity of the power unit was assumed at 210 MW, construction period – 3 years, operating life – 25 years.
2.3. Natural gas combined-cycle power unit.	This alternative is unlikely due to low economic

	performance and high price of natural gas. For purposes of estimation, the capacity of the power unit was assumed at 150 MW, construction period – 2 years, operating life – 20 years.
3. Power generation technologies using energy sources other than natural gas:	
3.1. Coal subcritical power unit.	This alternative is quite realistic due to high price of natural gas and low price of lignite. For purposes of estimation, the capacity of the power unit was assumed at 210 MW, construction period – 3 years, operating life – 25 years. The possibility of additional power generation at the existing coal subcritical power units was assessed in the analysis of alternative 4.1.
3.2. Coal supercritical power unit.	This alternative is quite realistic due to high price of natural gas and low price of lignite. For purposes of estimation, the capacity of the power unit was assumed at 300 MW, construction period – 3 years, operating life – 25 years.
3.3. Residual fuel oil steam turbine power unit.	This alternative is unlikely due to low economic performance caused by high price of residual fuel oil, which is approximately 1.4 times higher than the price of natural gas as converted to energy units, and low efficiency of power unit as compared with combine-cycle power unit. Thus, Alternative 3.3 is excluded from further consideration.
3.4. Nuclear power unit.	This alternative is unfeasible. Currently there are no nuclear power plants in the energy system of Macedonia. Construction of a new plant requires large capital investments. Thus, Alternative 3.4 is excluded from further consideration.
3.5. Renewable power generation.	This alternative is unfeasible. The total share of renewable power generation in the Macedonian energy system does not exceed 25%, all power plants operating at the top of their capacity. Further, construction of new renewable power units is not a plausible alternative: • According to the Macedonian "National Strategy Kyoto for the CDM", page 9, 15 to 18% of the annual electricity production comes from hydro power plants. There are six big

	hydro power plants and some small ones with the total net capacity of 441 MW. While the potential for large scale hydro power plants is already tapped, new small scale hydro power plants face the problem of low full load hours. Due to specific hydrological conditions in the Republic of Macedonia, the full load hours are between 1000 and 2000 hours per year. Therefore the potential for new small scale hydropower plants is negligible considering the needs in Macedonia. An additional problem for a fast effectuation of the small scale hydro potential is the long period needed for the preparation of the documents, where one of the main problems is the ownership problem with the land. • For wind, the intermittent nature of electricity generated by wind power means that it could not supply a similar service to the proposed project • Biomass as a source of energy in the Republic of Macedonia participates in the total energy balance with over 10%. But it is used only as wood for heating and it is a primary resource for heating in the households. Studies show that the waste wood mass from the woods and agriculture (especially from cutting out vineyards and orchards) has an important potential, but only if it is being used in a small radius, about 5 km from the place of origination. Due to this fact it is currently not economically justified to use this biomass for the production of electricity. • In Macedonia farms keeping small capacities of livestock prevail, hence the production of biogas and its use for production of electricity does not have economical justification. Even if it would get conducted, the capacity of the power plant would be negligible considering the needs for electricity in the country. Thus, Alternative 3.5 is excluded from further consideration.
4. Import of electricity from connected grids, including the possibility of new interconnections:	
4.1 Electricity import from the power grids of the	To check the possibility of implementation of this

neighboring states.	alternative a special analysis was carried out, it was aimed at identifying the possibility of additional electricity generation by the existing power plants connected to the Macedonian energy system (see Annex 3-1). The analysis was based on the net electricity generation data over the period of 2004-2006 (see Table B.5-3). The bulk of electricity was generated by the operating Bitola complex, which consists of three large TPP (Bitola 1, Bitola 2 and Bitola 3), 210 MW of installed capacity each, main fuel – lignite. Hours of operation at full capacity varied in the range of 6250-7650 (on average 7037 hours), which is a fairly high rate for power plants of this type. It is most likely that the plant is already generating maximum possible amount of electricity and additional electricity generation similar to the project activity is unfeasible. Negotino TPP (installed capacity – 210 MW, main fuel – residual fuel oil) practically did not contribute to electricity generation. Hours of operation at full capacity in 2006 amounted to around 1000 hours (in 2004-2005 the plant did not generate any electricity). This could be explained by the soaring price of residual fuel oil which is approximately 1.4 times higher than the price of natural gas as converted to energy units. Generation of additional electricity by Negotino TPP is theoretically possible, however, it is unlikely due to enormous costs of purchasing residual fuel oil. Hours of operation at full capacity at Oslomej TPP (installed capacity – 125 MW, main fuel – lignite) varied in the range of 2950-3250 (on average 3047 hours). Underloading of the plant is explained by seeking to generate as much power as possible by means of Bitola complex. Additional generation of the required amount of power at Oslomej TPP is possible if the hours of operation at full capacity increase to 4300. Hydro Power Plants are referred to as low-cost and must-run resources, they already generate maximum possible amount of electricity, and additional generation of electricity is not feasible. Except its own generation Macedonia imports

	small amount of electricity that is stipulated by historic circumstances. Macedonia grid was part of energy system of the Federal Republic of Yugoslavia till 1991 and old relations established for years remained after the separation. However in spite of the existing import the energy system of Macedonia has enough possibilities to generate the required amount of electricity by the existing power plants; therefore Alternative 4.1 is excluded from further consideration.

For further consideration the following principal alternatives which ensure supply of the required amount of power to the grid will be identified:

Alternative 1.1: Power generation using gas engine cogeneration gensets.

Alternative 2.2: Power generation using natural gas steam turbine power unit.

Alternative 2.3: Power generation using natural gas combine-cycle power unit.

Alternative 3.1: Power generation using coal subcritical power unit.

Alternative 3.2: Power generation using coal supercritical power unit.

Step 2: Identification of the most attractive baseline scenarios

According to Version 3 of AM0029, the economically most attractive baseline scenario alternative is identified using levelized cost as a financial indicator. The levelized cost is therefore calculated for the alternatives identified above (see Table B.4-2).

The basic levelized cost methodology used in this PDD is based on Annex 5 of 'Projected Costs of Generation Electricity: 2005 update' published by IEA[1]. The formula applied to calculate the levelized electricity generation cost (EGC) is the following:

$$EGC = \frac{\sum_y (((I_y + M_y + F_y)(1+r))^{-y})}{\sum_y (E_y(1+r)^{-y})}, \qquad \text{(B.4-1)}$$

where I_y is the capital costs in the year *y*, 000 EUR;

M_y is the operational and maintenance costs in the year *y*, 000 EUR;

F_y is the fuel costs in the year *y*, 000 EUR;

E_y is the net electricity generation in the year *y*, MWh;

r is the discount rate.

[1] IEA, Projected Costs of Generating Electricity, 2005 update

The discount rate was assumed at 15%[1].

Table B.4-2. Electricity generation cost calculation

Indicator	Gas engine cogeneration gensets	Natural gas steam turbine power unit	Natural gas combine-cycle power unit	Coal subcritical power unit	Coal supercritical power unit
Construction period, year	1	3	2	3	3
Lifetime, year	20	25	20	25	25
Hours of operation at full capacity[2], hour	5 260	7 000	7 000	7 000	7 000
Installed capacity, MW	30	210	150	210	300
Specific construction cost[3], USD/kW	472	800	1 000	1 400	1 700
Capital costs, 000 EUR	14 340	115 385	103 022	201 923	350 275
Net efficiency factor of power generation[4]	0.410	0.375	0.600	0.390	0.450
Net electricity generation, MWh	159 960	1 470 000	1 050 000	1 470 000	2 100 000
Fuel consumption, GJ	1 406 160	14 112 000	6 300 000	13 569 231	16 800 000
Natural gas consumption, thousand m^3	39 060	392 000	175 000	-	-
Lignite consumption, t	-	-	-	2 258 527	2 796 272
Fuel costs, 000 EUR	8 875	89 068	39 763	36 136	44 740
Operational and maintenance costs[5], 000 EUR	717	4 615	5 151	8 077	14 011
EGC, 000 EUR/MWh	**0.071**	**0.078**	**0.059**	**0.055**	**0.058**

From the economic point of view, the most attractive baseline scenario which ensure supply of the required amount of power to the grid is power generation using coal subcritical power unit (Alternative 3.1), because even with fluctuation of fuel costs within the range of 20% (see results of sensitivity analysis in Tables B.4-3), this alternative has the lowest value of EGC.

[1] See the Investment analysis below.

[2] For alternative 1.1 the number of hours of operation at full capacity was assumed as per the project owner's plans. For other alternatives, the hours of operation at full capacity are assumed equal to the average number of hours of operation at full capacity at Bitola complex (2004-2006).

[3] Source: "Ecology Of Energy". Textbook. Edited by V.Y.Putilov. M., MEI Publishing House, 2003.

[4] Conservative values according to "Tool to calculate the emission factor for an electricity system" (Version 01).

[5] Source: "Industrial thermal power plants". Textbook for colleges. Edited by E.Y.Sokolov. M., "Energia", 1967.

Table B.4-3. Analysis of EGC sensitivity to fluctuation of fuel cost

Technology	EGC, 000 EUR/MWh				
	-20%	-10%	0%	+10%	+20%
Gas engine cogeneration gensets	0.060	0.065	0.071	0.076	0.082
Natural gas steam turbine power unit	0.066	0.072	0.078	0.084	0.090
Natural gas combine-cycle power unit	0.051	0.055	0.059	0.062	0.066
Coal subcritical power unit	**0.050**	**0.052**	**0.055**	**0.057**	**0.060**
Coal supercritical power unit	0.054	0.056	0.058	0.060	0.062

Summarizing the results of the above analysis, Alternative 3.1 "Power generation using coal subcritical power unit" is chosen as the most plausible baseline scenario, energy efficiency of the coal subcritical power unit is assumed at 39%.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

According to the chosen methodology (AM0029/version 03) for demonstration of additionality, benchmark investment and common practice analyses were carried out by applying the last version of "Tool for the demonstration and assessment of additionality" (Version 05). Step 3 (Impact of CDM registration) was not applied, because this is not required by the last version of this tool.

<u>Step 1: Benchmark investment analysis</u>

This step consists of the additionality tool step 2, sub-step 2b (Option III: Apply benchmark analysis); sub-step 2c (Calculation and comparison of financial indicators) and sub-step 2d (Sensitivity analysis).

The equity IRR and NPV are calculated for the proposed project (see Annex 3-8). NPV benchmark was used.

According to the preliminary estimate the amount of investments in the new CHPP construction project is about €14.34 million. The above mentioned amount is necessary for the project implementation in 2007-2008. It is not possible to implement the project solely with ENERGOUSLUGI DOO's own funds, as it does not have the necessary capital. ENERGOUSLUGI DOO plans to obtain bank loans at an interest rate of about 8% per annum.

The parameters of the project without and with the sale of emission reductions are provided in Table B.5-1.

Prices for the fuel, electricity and heat in the Republic of Macedonia are regulated by the state. The data of Energy Regulatory Commission of the Republic of Macedonia[1] were used for the analysis of economic viability of the project.

Discount rate was determined with the help of one of the most commonly used methods, which is the cumulative method of risk premium assessment[2]. This method is based on the following formula:

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[1] http://www.erc.org.mk/DefaultEn.asp

[2] http://www.fd.ru/article/1716.html

$$R = R_f + R_1 + ... + R_n , \qquad (B.4-2)$$

where R is the sought discount rate;

R_f is the risk-free rate of return;

$R_1,...,R_n$ is the risk premiums for different risk factors.

Generally, government securities are considered to be (conditionally) risk-free assets. There are no such securities in Macedonia. Bulgarian Eurobonds - Bulgaria, Republic 8 1/4% due 15 - were considered as risk-free assets. As of the beginning of December 2007 the return rate for these bonds was just over 5.1% p.a.[1].

Potential risk factors could be country risk, risk of partner disloyalty and project profitability risk. Thus, if a project envisages investments in production development on the basis of exploited technology, then the recommended risk premium is between 3% and 5%. Other risk premiums are generally estimated at 5%.

Following the conservative approach, the final discount rate was assumed at 15%. This is in line with the reasonable benchmark, mentioned in Macedonia National Strategy for Clean Development Mechanism in respect of another power sector project[2].

Table. B.5-1. Investments, NPV and IRR

Indicator	Units	Project activity not as CDM	Project activity as CDM
Investments	000 EUR	14 340	14 340
NPV	000 EUR	-902	2 379
IRR	%	12.79	21.25

Economic parameters of the project without CDM mechanism are unacceptably low (NPV<0). Revenues received from CERs sale during the first crediting period are making about 25.7% of the total amount of investments, during the second and third crediting periods – about 56.2%. These funds will help to significantly improve commercial attractiveness of the project and NPV becomes positive. Moreover, the project becomes less sensitive to risks (see the results of sensitivity analysis in Table B.5-2).

Table. B.5-2. Sensitivity analysis of economic parameters

Indicator	Units	Project activity not as CDM	Project activity as CDM
1) Increase of investment costs by 5%			
NPV	000 EUR	-1 511	1 769
IRR	%	11.50	19.34
2) Reduction of net heat and electricity generation by 5%			
NPV	000 EUR	-1 926	1 190

[1] http://www.cbonds.info/all/eng/quotes/index.php

[2] http://www.undp.org.mk/datacenter/files//files13/nskp.pdf

IRR	%	10.36	18.02
2) Increase of fuel costs by 5%			
NPV	000 EUR	-3 181	99
IRR	%	7.47	15.24

Thus, the project can not be implemented under common commercial practice without selling CERs

Step 2: Common practice analysis

Sub-step a: Analyze other activities similar to the proposed project activity

Tables B.5-3 contains data on net electricity generation at the power plants connected to the power grid of the Republic of Macedonia (see Annex 3-1) over the period of 2004-2006[1]. The bulk of electricity (around 77%) was generated at subcritical TPPs, which primarily rely on lignite as energy fuel.

Table B.5-3. Net electricity generation at power plants connected to the power grid of the Republic of Macedonia over the period of 2004-2006

Name of power plant/unit	Type	Main fuel	Net electricity generation, MWh		
			2004	2005	2006
Bitola 1	subcritical TPP	lignite	1 585 200	1 478 200	1 472 300
Bitola 2	subcritical TPP	lignite	1 313 400	1 524 400	1 462 300
Bitola 3	subcritical TPP	lignite	1 463 500	1 600 700	1 400 500
Oslomej	subcritical TPP	lignite	372 600	404 200	365 900
Negotino	subcritical TPP	Residual fuel oil	0	0	214 077
Vrutok	HPP	-	447 500	425 900	422 900
Raven	HPP	-	45 400	46 600	48 300
Vrben	HPP	-	41 100	38 000	34 400
Tikves	HPP	-	150 200	128 700	226 700
Spilje	HPP	-	366 600	326 700	362 200
Globocica	HPP	-	232 800	212 800	231 900
Kozjak	HPP	-	44 400	165 800	179 600

The energy system of Macedonia has no combined heat and power plants and until now natural gas is not used for electricity generation.

[1] Source: internal data of AD ELEM and AD TPP Negotino.

Sub-steps b: Discuss any similar options that are occurring

According to Tables B.5-3 the project activity is not common practice in Macedonia and there are no similar activities to the proposed project activity.

As shown above the reductions obtained as a result of the project are additional to any that would otherwise occur.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

In compliance with the chosen methodology (AM0029/version 03), the emission reductions can be calculated using the following steps:

Step 1: Calculating project emissions

The project activity is on-site combustion of natural gas to generate electricity. Steam and heat will be generated by utilizing waste heat without additional combustion of fossil fuel. GHG emissions from natural gas combustion are calculated as follows:

$$PE_y = FC_{NG,PJ,y} \times COEF_{NG,y}, \quad \text{(B.6-1)}$$

where $FC_{NG,PJ,y}$ is the volume of natural gas consumed at the new CHPP under the project in the year *y*, thousand m^3;

$COEF_{NG,y}$ is the CO_2 emission coefficient of natural gas in year *y*, t CO_2e/thousand m^3,

$$COEF_{NG,y} = NCV_{NG,y} \times EF_{CO2,NG,y} \times OXID_{NG}, \quad \text{(B.6-2)}$$

where $NCV_{NG,y}$ is the net calorific value of natural gas in year *y*, GJ/thousand m^3;

$EF_{CO2,NG,y}$ is the CO_2 emission factor of natural gas in the year *y*, t CO_2e/GJ;

$OXID_{NG}$ is the oxidation factor of natural gas.

Step 2: Calculating baseline emissions

GHG emissions under the baseline will be connected with out-site combustion of fossil fuel to generate the required amount of electricity. Baseline emissions are calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{BL,CO2,y}, \quad \text{(B.6-3)}$$

where $EG_{PJ,y}$ is the net electricity generation at the new CHPP in the year *y*, MWh;

$EF_{BL,CO2,y}$ is the baseline CO_2 emission factor in the year *y*, t CO_2e/MWh.

In order to allow for all potential uncertainties, relating to which type of other power generation is substituted by the power generation of the project plant, the baseline CO_2 emission factor is determined in a conservative manner as the lowest among the following three options:

Option 1: The build margin, calculated according to "Tool to calculate emission factor for an electricity system";

Option 2: The combined margin, calculated according to "Tool to calculate emission factor for an electricity system";

Option 3: The emission factor of the technology (and fuel) identified as the most likely baseline scenario.

According to AM0029, the determination of the build margin and the combined margin will be made based on an ex ante assessment at validation and again at the start of each crediting period. Further, according to AM0029, if either option 1 (BM) or option 2 (CM) are selected as the baseline, they will be estimated ex post, as described in the tool to calculate the emission factor of an electricity system.

Sub-step 2.1: Calculating the operation margin emission factor (EF_{OM})

The simple operation margin (OM) emission factor is calculated as the generation-weighted average CO_2 emissions per unit net electricity generation of all generating power plants serving the system, not including low-cost/must-run power plants/units.

"Tool to calculate emission factor for an electricity system" envisages the following methods of calculating the operation margin emission factor:

(a) Simple OM;

(b) Simple adjusted OM;

(c) Dispatch data analysis OM;

(d) Average OM.

To calculate EF_{OM} simple OM method was used, because:

1) Dispatch data analysis OM and simple adjusted OM can not be calculated as hourly dispatch data for all power plants is not made publicly available in the Republic of Macedonia;
2) The low-cost/must-run resources constitute less than 50% of the total grid generation as demonstrated in Table B.6-1.

Table B.6-1. Share of net power generation from various sources in the energy system of the Republic of Macedonia (2002-2006)

Power plants	Share, %				
	2002	2003	2004	2005	2006
Thermal power plants	86.56	78.17	78.10	78.83	76.55
Hydro power plants	13.44	21.83	21.90	21.17	23.45

The simple OM emission factor was calculated using ex-ante option based on the most recent data available at the time of PDD preparation, as follows:

$$EF_{OM} = \frac{\sum_{i,j,y} FC_{i,j,y} \times NCV_{i,j,y} \times EF_{CO2,i,y}}{\sum_{j,y} EG_{j,y}}, \quad \text{(B.6-4)}$$

where $FC_{i,j,y}$ is the amount of fossil fuel type *i* consumed by power plant/unit *j* in year *y*, t;

$NCV_{i,j,y}$ is the net calorific value of fossil fuel type *i* consumed by power plant/unit *j* in year *y*, GJ/t;

$EF_{CO2,i,y}$ is the CO_2 emission factor of fossil fuel type *i* in the year *y*, t CO_2e/GJ;

$EG_{j,y}$ is the net electricity generated and delivered to the grid by power plant/unit *j* in year *y*, MWh (see Table B.5-3);

j is all power plants/units serving the grid in year *y* except low-cost/must-run power plants/units, and including import to the grid (see Annex 3-2);

y is the three most recent years for which data is available (2004÷2006).

Since at the time of the PDD development for Negotino TPP only data on net electricity generation were known, consumption of fossil fuel was determined on the basis of energy efficiency of power plant, using the following formula:

$$FC_{i,j,y} = \frac{EG_{j,y} \times 3.6}{\eta_j \times NCV_{i,j,y}}, \qquad \text{(B.6-5)}$$

where η_j is the energy efficiency of power plant/unit *j* in year *y*. According to Annex 1 of "Tool to calculate emission factor for an electricity system" for Negotino TPP the following is assumed: $\eta_{Negotino\_TPP} = 0.375$.

Sub-step 2.2: Calculating the build margin emission factor (EF_{BM})

The build margin (BM) emission factor is the generation-weighted average emission factor of a sample group of power plants/units *m* consisting of either:

(a) The set of five power units that have been built most recently, or

(b) The set of power capacity additions in the electricity system that comprise 20% of the system generation and that have been built most recently.

The build margin emission factor was calculated using ex-ante option based on the most recent data available on the five most recently built plants in the Macedonian grid (the sample plants comprise 78.7% of total electricity generation in Macedonia), as follows:

$$EF_{BM} = \frac{\sum_{m,y} EG_{m,y} \times EF_{EL,m,y}}{\sum_{m,y} EG_{m,y}}, \qquad \text{(B.6-6)}$$

where $EG_{m,y}$ is the net electricity generated and delivered to the grid by power plant/unit *m* in year *y* (see Table B.5-3), MWh;

$EF_{EL,m,y}$ is the CO_2 emission factor of power plant/unit *m* in year *y*, t CO_2e /MWh,

$$EF_{EL,m,y} = \frac{\sum_{i} FC_{i,m,y} \times NCV_{i,m,y} \times EF_{CO2,i,y}}{EG_{m,y}}, \qquad \text{(B.6-7)}$$

where $FC_{i,m,y}$ is the amount of fossil fuel type *i* consumed by power plant/unit *m* in year *y*, t;

$NCV_{i,m,y}$ is the net calorific value of fossil fuel type *i* consumed by power plant/unit *m* in year *y*, GJ/t;

m is the power plants/units included in the build margin (see Annex 3-3).

Power plant capacity additions and power plants registered as CDM project activities were excluded from the sample group of power plants/units m.

Sub-step 2.3: Calculating the combined margin emission factor (EF_{CM})

The combined margin emission factor is calculated as follows:

$$EF_{CM} = EF_{OM} \times w_{OM} + EF_{BM} \times w_{BM}\ , \tag{B.6-8}$$

where w_{OM} is the weighting of operation margin emission factor. According to "Tool to calculate emission factor for an electricity system" the following is assumed: w_{OM} = 0.5 for the first crediting period and w_{OM} = 0.25 (preliminarily assumed for estimation) for the second and third crediting periods;

w_{BM} is the weighting of build margin emission factor. According to "Tool to calculate emission factor for an electricity system" the following is assumed: w_{BM} = 0.5 for the first crediting period and w_{BM} = 0.75 (preliminarily assumed for estimation) for the second and third crediting periods.

Sub-step 2.4: Calculating the emission factor of the baseline technology ($EF_{BL\_technology,CO2}$)

The most likely baseline scenario is power generation using coal subcritical power unit (see Section B.4). In compliance with the chosen methodology (AM0029/version 03), the emission factor of the baseline technology is calculated as follows:

$$EF_{BL\_technology,CO2} = \frac{COEF_{BL}}{\eta_{BL}} \times 3.6\ , \tag{B.6-9}$$

where $COEF_{BL}$ is the CO_2 emission coefficient of lignite, t CO_2e/GJ. According to 2006 IPCC Guidelines for National GHG Inventories the following is assumed: $COEF_{BL} = 0.101$ t CO_2e/GJ;

η_{BL} is the energy efficiency of the baseline technology.

<u>Step 3: Calculating leakage</u>

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. For this project fugitive CH_4 emissions associated with fuel extraction, processing, transportation and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity was considered. Since LNG is not used in the project plant no leakage from this source is considered here.

Leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} = \left[FC_{NG,PJ,y} \times EF_{NG,upstream,CH4} - EG_{PJ,y} \times EF_{BL,upstream,CH4} \right] \times GWP_{CH4}\ , \tag{B.6-10}$$

where $LE_{CH4,y}$ is the leakage emissions due to fugitive upstream CH_4 emissions in the year y, t CO_2e;

$EF_{NG,upstream,CH4}$ is the emission factor for upstream fugitive methane emissions of natural gas from production, processing, transportation and distribution, t CH_4/thousand m^3;

$EF_{BL,upstream,CH4}$ is the emission factor for upstream fugitive methane emissions occurring in the absence of the project activity, t CH_4/MWh;

GWP_{CH4} is the global warming potential of methane.

Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity are calculated consistent with the baseline emission factor (see Step 1 above), as follows:

Option 1: The build margin:

$$EF_{BL,upstream,CH4} = \frac{\sum_{i,m,y} FF_{i,m,y} \times EF_{i,upstream,CH4}}{\sum_{m,y} EG_{m,y}}, \qquad \text{(B.6-11)}$$

where $FF_{i,m,y}$ is the quantity of fuel type i combusted at power plant/unit m in the year y, mass or volume unit;

$EF_{i,upstream,CH4}$ is the emission factor for upstream fugitive methane emissions from production of the fuel type i, t CH_4/(mass or volume unit).

Option 2: The combined margin:

$$EF_{BL,upstream,CH4} = 0.5 \times \frac{\sum_{i,m,y} FF_{i,m,y} \times EF_{i,upstream,CH4}}{\sum_{m,y} EG_{m,y}} + 0.5 \times \frac{\sum_{i,j,y} FF_{i,j,y} \times EF_{i,upstream,CH4}}{\sum_{j,y} EG_{j,y}}, \qquad \text{(B.6-12)}$$

where $FF_{i,j,y}$ is the quantity of fuel type i combusted at power plant/unit j in the year y, mass or volume unit.

Option 3: The baseline technology:

$$EF_{BL,upstream,CH4} = \frac{EF_{coal,upstream,CH4}}{\eta_{BL}} \times 3.6. \qquad \text{(B.6-13)}$$

Methodology AM0029/version 03 envisages using emission factors for fugitive CH_4 upstream emissions which have been derived from 1996 Revised IPCC Guidelines for National GHG Inventories. As new guidelines have appeared since, namely 2006 IPCC, it is worth using up to date data.

Tables B.6-2 and B.6-3 show factors for fugitive CH_4 upstream emissions taken from 2006 IPCC Guidelines for National GHG Inventories, volume 2, chapter 4 Fugitive Emissions, Table 4.2.5.

Fugitive CH_4 upstream emissions factor of lignite production was assumed equal to 0.8 t CH_4/kt according to 2006 IPCC Guidelines for National GHG Inventories, volume 2, chapter 4 Fugitive Emissions, Equation 4.1.7.

Table B.6-2. Emission factors for fugitive CH_4 upstream emissions from natural gas operation

Category	Sub-category	CH4 Minimum value	CH4 Maximum value	CH4 Average value	Unit of measure
Gas production	Fugitives	0.00038	0.024	0.01219	t $CH_4/10^3$ m³
	Flaring	0.00000076	0.000001	8.8E-07	t $CH_4/10^3$ m³
Gas processing	Fugitives	0.00015	0.00035	0.00025	t $CH_4/10^3$ m³
	Flaring	0.000002	0.0000028	0.0000024	t $CH_4/10^3$ m³
Gas transmission	Fugitives	0.000166	0.0011	0.000633	t $CH_4/10^3$ m³
	Venting	0.000044	0.00074	0.000392	t $CH_4/10^3$ m³
Gas distribution	All	0.0011	0.0025	0.0018	t $CH_4/10^3$ m³
Total	-		**0.0287**	**0.0153**	t $CH_4/10^3$ m³

Table B.6-3. Emission factors for fugitive CH4 upstream emissions from residual fuel oil operation

Category	Sub-category	CH4 Minimum value	CH4 Maximum value	CH4 Average value	Unit of measure
Oil production	Fugitives	0.0022	0.037	0.0196	t CH_4/m³
	Ventling	0.0087	0.012	0.01035	t CH_4/m³
	Flaring	0.000021	0.000029	0.000025	t CH_4/m³
Oil transport	All	0.000025	0.000025	0.000025	t CH_4/m³
Oil refining	All	ND*	ND	ND	t CH_4/m³
Oil storage	All	ND	ND	ND	t CH_4/m³
Total	-		**0.0491**	**0.0300**	t CH_4/m³

*No data

Step 4: Calculating emission reductions

To calculate the emission reductions the following equation are applied:

$$ER_y = BE_y - PE_y - LE_y \, , \qquad \text{(B.6-14)}$$

where ER_y is the emission reduction in year y, t CO_2e.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	EF_{OM}
Data unit:	t CO_2e/MWh
Description:	The operation margin emission factor
Source of data used:	Own calculation based on internal data of AD ELEM and AD TPP Negotino, 2006 IPCC Guidelines for National GHG Inventories default values
Value applied:	0.774
Justification of the choice of data or description of	Emission factor was calculated based on simple OM method using ex-ante option according to “Tool to calculate the emission factor for an electricity system”.

measurement methods and procedures actually applied:	
Any comment:	Internal data of AD ELEM and AD TPP Negotino are private and cannot be disclosed in the PDD.

Data / Parameter:	EF_{BM}
Data unit:	t CO_2e/MWh
Description:	The build margin emission factor
Source of data used:	Own calculation based on internal data of AD ELEM and AD TPP Negotino, 2006 IPCC Guidelines for National GHG Inventories default values
Value applied:	1.004
Justification of the choice of data or description of measurement methods and procedures actually applied :	Emission factor was calculated using ex-ante option based on the most recent data available on the five most recently built plants in the Macedonian grid according to “Tool to calculate the emission factor for an electricity system”.
Any comment:	Internal data of AD ELEM and AD TPP Negotino are private and cannot be disclosed in the PDD.

Data / Parameter:	NCV_{RFO}
Data unit:	GJ/t
Description:	Net calorific value of residual fuel oil
Source of data used:	2006 IPCC Guidelines for National GHG Inventories, volume 2, chapter 1, table 1.2
Value applied:	40.4
Justification of the choice of data or description of measurement methods and procedures actually applied :	No country default value is available. IPCC default value is used.
Any comment:	-

Data / Parameter:	η_{BL}
Data unit:	-
Description:	The energy efficiency of the baseline technology
Source of data used:	“Tool to calculate the emission factor for an electricity system”, annex 1
Value applied:	0.39
Justification of the choice of data or description of measurement methods and procedures	Default value is used.

actually applied :	
Any comment:	-

Data / Parameter:	$EF^{first}_{BL,upstream,CH4}$
Data unit:	t CH_4/MWh
Description:	Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity for the first crediting period
Source of data used:	Own calculation based on internal data of AD ELEM and AD TPP Negotino, 2006 IPCC Guidelines for National GHG Inventories default values
Value applied:	0.001176
Justification of the choice of data or description of measurement methods and procedures actually applied :	Emission factor was calculated using the combined margin option according to the chosen methodology.
Any comment:	Internal data of AD ELEM and AD TPP Negotino are private and cannot be disclosed in the PDD.

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of methane
Source of data used:	Revised 1996 IPCC Guidelines for National GHG Inventories
Value applied:	21
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC default value is used.
Any comment:	-

B.6.3 Ex-ante calculation of emission reductions:

Step 1: Calculating project emissions

According to the plans of the project owner, net electricity generation in 2008 will amount to 79 980 MWh, with the begin of 2009 annual net electricity generation will amount to 159 960 MWh. GHG emissions under the project will become due to on-site combustion of natural gas to generate the required amount of electricity. The amount of natural gas combusted at the new CHPP was defined based on electrical efficiency of the gas engines gensets as follows:

$$FC_{NG,PJ,y} = \frac{EG_{PJ,y}}{NCV_{NG,y} \times \eta_{gas\_engine}} \times \left(1 + SEC_{auxiliary,PJ}\right) \times 3.6, \quad \text{(B.6-15)}$$

where η_{gas_engine} is the electrical efficiency of the gas engines cogeneration genset. According to project documentation the following is assumed: $\eta_{gas\_engine} = 0.43$;

$SEC_{auxiliary,PJ}$ is the specific auxiliary electricity consumption at the new CHPP. For the purposes of calculation the following is assumed: $SEG_{auxiliary,PJ} = 0.05$.

Net calorific value of natural gas on the basis of its composition was assumed equal to 36 GJ/thousand m^3.

The predicted annual natural gas consumption and results of calculations of project GHG emissions are presented in Annex 3-4.

Step 2: Calculating baseline emissions

The pattern of additional electricity generation by grid connected power plants will be identical to the pattern of net power generation at the new CHPP. GHG emissions under the baseline will be due to out-site combustion of fossil fuel to generate the required amount of electricity.

On the basis of the above method (see Section B.6.1), using internal data of AD ELEM and AD TPP Negotino (the data are private and can not be disclosed in the PDD), following results were obtained: $EF_{OM} = 0.774$ t CO_2e/MWh, $EF_{BM} = 1.004$ t CO_2e/MWh.

The combined margin emission factor for the first crediting period:

$$EF_{CM}^{first} = 0.774 \times 0.5 + 1.004 \times 0.5 = 0.889 \text{ t } CO_2\text{e/MWh.} \qquad (B.6\text{-}16)$$

The combined margin emission factor for the second and third crediting periods:

$$EF_{CM}^{second} = EF_{CM}^{third} = 0.774 \times 0.25 + 1.004 \times 0.75 = 0.947 \text{ t } CO_2\text{e/MWh.} \qquad (B.6\text{-}17)$$

The emission factor of the baseline technology:

$$EF_{BL\_technology,CO2} = \frac{0.101}{0.39} \times 3.6 = 0.932 \text{ t } CO_2\text{e/MWh.} \qquad (B.6\text{-}18)$$

For the first crediting period the baseline CO_2 emission factor is conservatively assumed equal to 0.889 t CO_2e/MWh (option 2, the combined margin) as the lowest among the above described options (see Section B.6.1), for the second and the third crediting periods preliminarily assumed – 0.932 t CO_2e/MWh (option 3, the baseline technology).

The results of calculations of baseline GHG emissions are presented in Annex 3-5.

Step 3: Calculating leakage

Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity for the first crediting period is assumed equal to 0.001176 t CH_4/MWh according to own calculation based on using internal data of AD ELEM and AD TPP Negotino (data are private and cannot be disclosed in the PDD). The calculation uses the combined margin option. For the second and third crediting periods upstream fugitive methane emission factor was preliminarily assumed using option 3 (the baseline technology):

$$EF_{BL,upstream,CH4}^{second} = EF_{BL,upstream,CH4}^{third} = \frac{0.8}{0.39 \times 6.008 \times 1000} \times 3.6 = 0.001229 \text{ tCH}_4/\text{MWh} . \qquad (B.6\text{-}19)$$

The results of calculations of leakage GHG emissions are presented in Annex 3-6.

Step 4: Calculating emission reductions

The results of calculations of GHG emission reductions are presented in Annex 3-7.

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimated project emissions (tons of CO_2 equivalent)	Estimated leakage (tons of CO_2 equivalent)	Estimated baseline emissions (tons of CO_2 equivalent)	Estimated emission reductions (tons of CO_2 equivalent)
2008	29 582	3 215	53 348	20 551
2009	78 886	8 573	142 261	54 802
2010	78 886	8 573	142 261	54 802
2011	78 886	8 573	142 261	54 802
2012	78 886	8 573	142 261	54 802
2013	78 886	8 573	142 261	54 802
2014	78 886	8 573	142 261	54 802
2015	78 886	8 395	149 132	61 851
2016	78 886	8 395	149 132	61 851
2017	78 886	8 395	149 132	61 851
2018	78 886	8 395	149 132	61 851
2019	78 886	8 395	149 132	61 851
2020	78 886	8 395	149 132	61 851
2021	78 886	8 395	149 132	61 851
2022	78 886	8 395	149 132	61 851
2023	78 886	8 395	149 132	61 851
2024	78 886	8 395	149 132	61 851
2025	78 886	8 395	149 132	61 851
2026	78 886	8 395	149 132	61 851
2027	78 886	8 395	149 132	61 851
Total (tons of CO_2 equivalent) during the first crediting period (2008-2014)	**502 896**	**54 652**	**906 911**	**349 364**
Total (tons of CO_2 equivalent) during the second crediting period (2015-2021)	**552 199**	**58 766**	**1 043 924**	**432 959**
Total (tons of CO_2 equivalent) during the third crediting period (2022-2027)	**473 313**	**50 371**	**894 792**	**371 107**

B.7 Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	***$FC_{NG,PJ,y}$***
Data unit:	thousand m^3
Description:	Volume of natural gas consumed at the new CHPP under the project in the year *y*
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	14 648 (for 2008) 39 060 (for other years)
Description of measurement methods and procedures to be applied:	Readings of gas meters installed at each gas engine cogeneration genset will be used to determine natural gas consumption.
QA/QC procedures to be applied:	Gas meters are subject to regular calibration in compliance with the manufacturer's specifications. Readings of gas meters will be cross-checked with the invoices of the fuel supplier.
Any comment:	-

Data / Parameter:	***$NCV_{NG,y}$***
Data unit:	GJ/thousand m^3
Description:	Net calorific value of natural gas in year *y*
Source of data to be used:	Certificates of the fuel suppliers
Value of data applied for the purpose of calculating expected emission reductions in section B.5	36
Description of measurement methods and procedures to be applied:	Net calorific value of natural gas will be provided by fuel supplier.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	The average value is determined at the end of the year

Data / Parameter:	***$OXID_{NG}$***
Data unit:	-
Description:	Oxidation factor of natural gas

Source of data to be used:	IPCC Guidelines for National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1
Description of measurement methods and procedures to be applied:	IPCC default value will be used.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	$EF_{CO2,NG,y}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor of natural gas in the year *y*
Source of data to be used:	IPCC Guidelines for National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0561
Description of measurement methods and procedures to be applied:	IPCC default value will be used.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	$EG_{PJ,y}$
Data unit:	MWh
Description:	Net electricity generation at the new CHPP in the year *y*
Source of data to be used:	On-site measurement
Value of data applied for the purpose of calculating expected emission reductions in section B.5	59 985 (for 2008) 159 960 (for other years)
Description of measurement methods	To determine net electricity generation reading of the electricity meter will be used.

and procedures to be applied:	
QA/QC procedures to be applied:	Electricity meter is subject to regular calibration in compliance with the manufacturer's specifications.
Any comment:	-

Data / Parameter:	$FC_{coal,j,y}$
Data unit:	t
Description:	Amount of lignite consumed by power plant/unit *j* in year *y*
Source of data to be used:	AD ELEM (internal data)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Data on lignite consumption are private and cannot be disclosed in the PDD. The list of plants which comprise the group *j* is given in Annex 3-2.
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	$NCV_{coal,j,y}$
Data unit:	GJ/t
Description:	Net calorific value of lignite consumed by power plant/unit *j* in year *y*
Source of data to be used:	AD ELEM, internal data provided by the coal laboratories in Bitola and Oslomej TPPs
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Data on net calorific value of lignite are private and cannot be disclosed in the PDD. The list of plants which comprise the group *j* is given in Annex 3-2.
Description of measurement methods and procedures to be applied:	Local net calorific value for lignite
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	$FC_{RFO,j,y}$
Data unit:	t
Description:	Amount of residual fuel oil consumed by power plant/unit *j* in year *y*

Source of data to be used:	AD ELEM (internal data) and AD TPP Negotino (internal data)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Data on residual fuel oil consumption are private and cannot be disclosed in the PDD. The list of plants which comprise the group *j* is given in Annex 3-2.
Description of measurement methods and procedures to be applied:	In case annual fuel consumption at power plant/unit *j* is not available it will be estimated, using the equation B.6-5 on the basis of the data on annual net electricity generation, net calorific value of residual fuel oil (set as default, see Section B.6-2) and default energy efficiency of power plant according to the latest version of “Tool to calculate the emission factor for an electricity system”.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	Residual fuel oil is used as a startup and auxiliary fuel at lignite-fired thermal power plants in Macedonia, and as a primary fuel at the Negotino TPP.

Data / Parameter:	$EF_{CO2,coal,y}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor of lignite in the year *y*
Source of data to be used:	IPCC Guidelines for National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.101
Description of measurement methods and procedures to be applied:	IPCC default value will be used.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	$EF_{CO2,RFO,y}$
Data unit:	t CO_2e/GJ
Description:	CO_2 emission factor of residual fuel oil in the year *y*
Source of data to be used:	IPCC Guidelines for National GHG Inventories
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0774

Description of measurement methods and procedures to be applied:	IPCC default value will be used.
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

Data / Parameter:	***$EG_{j,y}$***
Data unit:	MWh
Description:	Net electricity generated and delivered to the grid by power plant/unit *j* in year *y*
Source of data to be used:	The Macedonia dispatching centre, internal data of AD ELEM and AD TPP Negotino.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	The list of plants which comprise the group *j* is given in Annex 3-2. Net power generation over the period of 2004-2006 is given in Table B.5-3. Electricity import to the grid <table><tr><td>Year</td><td>Imported electricity</td></tr><tr><td>2004</td><td>1 176 198</td></tr><tr><td>2005</td><td>1 652 704</td></tr><tr><td>2006</td><td>1 958 345</td></tr></table>
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	No additional QA/QC procedures may need to be planned
Any comment:	-

B.7.2 Description of the monitoring plan:

The emission reduction achieved by the project activity will be calculated according to the monitoring methodology AM0029 "Grid connected electricity generation plant using non-renewable and less GHG intensive fuel". Monitoring shall involve:

1. Data required for calculation of project emissions (annual natural gas consumption at the new CHPP, net calorific value of natural gas consumed at the new CHPP, oxidation factor and the CO_2 emission factor for natural gas);
2. Data required for calculation of baseline emissions:
   - 2.1. Annual net electricity generation at the new CHPP;
   - 2.2. Annual performance data for power plants/units *j* (see Annex 3-2) serving the grid (net electricity generated and delivered to the grid, fuel consumption, net calorific value of consumed fuel and the CO_2 emission factor of the consumed fuel).

The baseline CO_2 emission factor and emission factor for upstream fugitive methane emissions occurring in the absence of the project activity will be updated annually.

All calculations are performed as per method described in Section B.6

The project does not envisage any changes in the structure of collection and analysis of data on fuel consumption and net electricity generation at the new CHPP and at the power plants/units *j* serving the grid. Data will be collected in any case.

EnergoUslugi is responsible for collection and accuracy of data required for monitoring. GHG emission reductions will be calculated annually by specialists of Camco Global on the basis of the data received from EnergoUslugi. In case of any doubts about accuracy of the initial data, specialists of EnergoUslugi will check and revise the data. Draft version of the Monitoring Report will be submitted to specialists of EnergoUslugi for review. If any mistakes in calculations of GHG emission reductions are found, specialists of Camco Global shall correct the calculations accordingly.

Detailed description of the monitoring plan is presented in Annex 4.

B.8 Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies)

Date of completing the final draft of this baseline section: 14.03.2008

Name of person/entity determining the baseline and monitoring methodology:

Camco Global

Contact person: Ilya Goryashin

E-mail: ilya.goryashin@camco-international.com

SECTION C. Duration of the project activity / crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

November 2007 (starting new CHPP construction)

C.1.2. Expected operational lifetime of the project activity:

20 years/240 months

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

15 August 2008 (expected date of project start)

C.2.1.2. Length of the first crediting period:

7 years/84 months

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

C.2.2.2. Length:

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The bulk of electricity in the Republic of Macedonia is generated by TPPs, which use lignite as primary fuel. Residual fuel oil is used as a startup and auxiliary fuel at lignite-fired thermal power plants, and as a primary fuel at Negotino TPP. The primary and standby fuel at the new CHPP is natural gas, which is a clearer kind of fossil fuel regarding SO_2 and CO_2 emissions as compared with residual fuel oil and lignite. The project implementation will result in reduction of net electricity generation at the grid power plants. Emissions of solid particles and sulphur dioxide (SO_2) into the atmosphere will be reduced through decrease of fossil fuel consumption at the TPPs.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

According the law in Macedonia an Environmental Impact Assessment has to be performed for this project. The EIA can be found in the Annex 6. The required seal of approval for the environmental impact assessment had been obtained before the construction works began. The environmental impacts of the project activity are not considered to be significant. Implementation of the project will result in reduced emissions of SO_2 and CO_2 into the atmosphere.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

On December 25, 2007 the public presentation of the new CHPP was held. The presentation took place in the Macedonian Centre for Energy Efficiency (MACEF). The event was advertised through direct invitations over the telephone, as well as by e-mail. Also, an invitation (see Annex 5-1) was posted at the entrance of the MACEF and in Gazibaba municipality (where the cogeneration plant is located) two weeks before the meeting. Furthermore, the meeting was advertised through the website of MACEF (see Annex 5-2). The total number of attendees of the meeting was 22 persons. It is important to note that the presentation was attended by an official representative of the local authorities, the Deputy Mayor of Skopje, PhD. Professor K. Dimitrov.

During the meeting the project was presented to the attendants and various issues related to environmental impacts of the project activity were discussed at the meeting.

E.2. Summary of the comments received:

No comments were received

E.3. Report on how due account was taken of any comments received:

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	RZ Uslugi AD Skopje
Street/P.O.Box:	Bul 16 makedonska brigada 18
Building:	
City:	Skopje
State/Region:	
Postfix/ZIP:	
Country:	Macedonia
Telephone:	00389 02 3288 081
FAX:	00389 02 3288 080
E-Mail:	dk@ri.com.mk
URL:	www.rzu.com.mk
Represented by:	
Title:	
Salutation:	
Last Name:	Krstevski
Middle Name:	
First Name:	Dimitar
Department:	
Mobile:	00389 71 230 098
Direct FAX:	
Direct tel:	
Personal E-Mail:	dk@ri.com.mk

Organization:	Camco International Limited
Street/P.O.Box:	Green Street,
Building:	Channel House
City:	St. Helier,
State/Region:	
Postfix/ZIP:	JE2 4UH
Country:	Jersey
Telephone:	+44 (0) 207 121 6100
FAX:	+44 (0) 207 121 6101
E-Mail:	
URL:	www.camco-international.com
Represented by:	
Title:	
Salutation:	
Last Name:	Graham
Middle Name:	
First Name:	James
Department:	
Mobile:	
Direct FAX:	+44 (0) 207 121 6100
Direct tel:	+44 (0) 207 121 6101
Personal E-Mail:	Cdm.projectparticipant.cee@camcoglobal.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There are no public funds involved in the project activity.

Annex 3

BASELINE INFORMATION

Annex 3-1. Basic scheme of power grid in the Republic of Macedonia

Annex 3-2. List of power plants/units serving the grid except low-cost/must-run power plants/units

Name of power plant/unit	Type of fuel
Bitola 1 TPP	lignite
Bitola 2 TPP	lignite
Bitola 3 TPP	lignite
Oslomej TPP	lignite
Negotino TPP	Residual fuel oil
Import	-

Annex 3-3. Five most recently built power plants/units in the Macedonian grid

Name of power plant/unit	Type of fuel	Share in total power generation, %	Year of commissioning
Kozjak HPP	-	2.1	2004
Oslomej TPP	lignite	6.1	1989
Bitola 3 TPP	lignite	23.7	1988
Bitola 2 TPP	lignite	22.8	1984
Bitola 1 TPP	lignite	24.1	1982

Annex 3-4. Project calculations

Indicator	Units	Years (the first crediting period)							2008-2014
		2008	2009	2010	2011	2012	2013	2014	
Net generation									
Electricity	MWh	59 985	159 960	159 960	159 960	159 960	159 960	159 960	1 019 745
Fuel consumption at the new CHPP									
Natural gas	thousand m^3	14 648	39 060	39 060	39 060	39 060	39 060	39 060	249 008
	GJ	527 310	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	8 964 270
GHG emissions									
Total GHG emissions	**tCO2e**	**29 582**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**502 896**

Indicator	Units	Years (the second crediting period)							2015-2021
		2015	2016	2017	2018	2019	2020	2021	
Net generation									
Electricity	MWh	159 960	159 960	159 960	159 960	159 960	159 960	159 960	1 119 720
Fuel consumption at the new CHPP									
Natural gas	thousand m^3	39 060	39 060	39 060	39 060	39 060	39 060	39 060	273 420
	GJ	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	9 843 120
GHG emissions									
Total GHG emissions	**tCO2e**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**552 199**

Indicator	Units	Years (the third crediting period)						2022-2027
		2022	2023	2024	2025	2026	2027	
Net generation								
Electricity	MWh	159 960	159 960	159 960	159 960	159 960	159 960	959 760
Fuel consumption at new the CHPP								
Natural gas	thousand m^3	39 060	39 060	39 060	39 060	39 060	39 060	234 360
	GJ	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	1 406 160	8 436 960
GHG emissions								
Total GHG emissions	**tCO2e**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**78 886**	**473 313**

Annex 3-5. Baseline calculations

Indicator	Units	Years (the first crediting period)							2008-2014
		2008	2009	2010	2011	2012	2013	2014	
Net generation									
Consumption of grid electricity	MWh	59 985	159 960	159 960	159 960	159 960	159 960	159 960	1 019 745
GHG emissions									
Total GHG emissions	**tCO2e**	**53 348**	**142 261**	**142 261**	**142 261**	**142 261**	**142 261**	**142 261**	**906 911**

Indicator	Units	Years (the second crediting period)							2015-2021
		2015	2016	2017	2018	2019	2020	2021	
Net generation									
Consumption of grid electricity	MWh	159 960	159 960	159 960	159 960	159 960	159 960	159 960	1 119 720
GHG emissions									
Total GHG emissions	**tCO2e**	**149 132**	**149 132**	**149 132**	**149 132**	**149 132**	**149 132**	**149 132**	**1 043 924**

Indicator	Units	Years (the third crediting period)						2022-2027
		2022	2023	2024	2025	2026	2027	
Net generation								
Consumption of grid electricity	MWh	159 960	159 960	159 960	159 960	159 960	159 960	959 760
GHG emissions								
Total GHG emissions	**tCO2e**	**149 132**	**149 132**	**149 132**	**149 132**	**149 132**	**149 132**	**894 792**

Annex 3-6. Leakage calculations

Indicator	Units	Years (the first crediting period)							2008-2014
		2008	2009	2010	2011	2012	2013	2014	
GHG emissions									
Baseline upstream fugitive emissions	tCO2e	1 482	3 951	3 951	3 951	3 951	3 951	3 951	25 188
Project upstream fugitive emissions from natural gas production, processing, transportation and distribution	tCO2e	4 696	12 524	12 524	12 524	12 524	12 524	12 524	79 840
Leakage of greenhouse gases	**tCO2e**	**3 215**	**8 573**	**8 573**	**8 573**	**8 573**	**8 573**	**8 573**	**54 652**

Indicator	Units	Years (the second crediting period)							2015-2021
		2015	2016	2017	2018	2019	2020	2021	
GHG emissions									
Baseline upstream fugitive emissions	tCO2e	4 129	4 129	4 129	4 129	4 129	4 129	4 129	28 902
Project upstream fugitive emissions from natural gas production, processing, transportation and distribution	tCO2e	12 524	12 524	12 524	12 524	12 524	12 524	12 524	87 668
Leakage of greenhouse gases	**tCO2e**	**8 395**	**8 395**	**8 395**	**8 395**	**8 395**	**8 395**	**8 395**	**58 766**

Indicator	Units	Years (the third crediting period)						2022-2027
		2022	2023	2024	2025	2026	2027	
GHG emissions								
Baseline upstream fugitive emissions	tCO2e	4 129	4 129	4 129	4 129	4 129	4 129	24 773
Project upstream fugitive emissions from natural gas production, processing, transportation and distribution	tCO2e	12 524	12 524	12 524	12 524	12 524	12 524	75 144
Leakage of greenhouse gases	**tCO2e**	**8 395**	**8 395**	**8 395**	**8 395**	**8 395**	**8 395**	**50 371**

Annex 3-7. Emission reductions

Indicator	Units	Years (the first crediting period)							2008-2014
		2008	2009	2010	2011	2012	2013	2014	
GHG emissions									
Baseline emissions	tCO2e	53 348	142 261	142 261	142 261	142 261	142 261	142 261	906 911
Project emissions	tCO2e	29 582	78 886	78 886	78 886	78 886	78 886	78 886	502 896
Leakage	tCO2e	3 215	8 573	8 573	8 573	8 573	8 573	8 573	54 652
Emission reductions	**tCO2e**	**20 551**	**54 802**	**54 802**	**54 802**	**54 802**	**54 802**	**54 802**	**349 364**

Indicator	Units	Years (the second crediting period)							2015-2021
		2015	2016	2017	2018	2019	2020	2021	
GHG emissions									
Baseline emissions	tCO2e	149 132	149 132	149 132	149 132	149 132	149 132	149 132	1 043 924
Project emissions	tCO2e	78 886	78 886	78 886	78 886	78 886	78 886	78 886	552 199
Leakage	tCO2e	8 395	8 395	8 395	8 395	8 395	8 395	8 395	58 766
Emission reductions	**tCO2e**	**61 851**	**61 851**	**61 851**	**61 851**	**61 851**	**61 851**	**61 851**	**432 959**

Indicator	Units	Years (the third crediting period)						2022-2027
		2022	2023	2024	2025	2026	2027	
GHG emissions								
Baseline emissions	tCO2e	149 132	149 132	149 132	149 132	149 132	149 132	894 792
Project emissions	tCO2e	78 886	78 886	78 886	78 886	78 886	78 886	473 313
Leakage	tCO2e	8 395	8 395	8 395	8 395	8 395	8 395	50 371
Emission reductions	**tCO2e**	**61 851**	**61 851**	**61 851**	**61 851**	**61 851**	**61 851**	**371 107**

Annex 3-8. Tables with IRR and NPV calculations

Input

Indicator	Units	Value
Cost of electricity	MKD/MWh	3 374,1
Cost of steam	MKD/MWh	2 325,5
Cost of heat	MKD/MWh	1 456,7
Cost of natural gas	MKD/10^3 m^3	14 178,2
Exchange rate	MKD/EUR	62,4
Cost of electricity	EUR/MWh	**54,07**
Cost of steam	EUR/MWh	**37,27**
Cost of heat	EUR/MWh	**23,34**
Cost of natural gas	EUR/10^3 m^3	**227,21**
Property tax rate	%	0,1
Profit tax rate	%	10
Credit interest rate	%	8
Discount	%	15
Price of CERs	EUR/t CO2e	10

Annex 3-8. Tables with IRR and NPV calculations (continuation)

Income		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Electricity supply	MWh	**0**	**59 985**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**
Income from electricity sale	000 EUR	0,0	3 243,5	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4
Heat (steam) supply	MWh	**0**	**25 529**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**
Income from heat (steam) sale	000 EUR	0,0	951,4	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0
Heat (hot water) supply	MWh	**0**	**29 784**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**
Income from heat (hot water) sale	000 EUR	0,0	695,3	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4
Total receipts	000 EUR	**0,0**	**4 890,2**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**
Expenditure												
Investments												
Credit facilities	000 EUR	14 340,0										
Depreciation												
Depreciation charges	000 EUR		-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6
Fixed assets value with allowance for depreciation	000 EUR		12 931,4	12 250,8	11 570,2	10 889,6	10 209,0	9 528,4	8 847,8	8 167,2	7 486,6	6 806,0
Current costs												
Natural gas consumption	10^3 m^3/year	**0**	**14 648**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**
Natural gas procurement costs	000 EUR	0,0	-3 328,1	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0
Operation and Maintenance	000 EUR	0,0	-699,8	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0
Total costs	**000 EUR**	**0,0**	**-4 027,9**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**
Taxes												
Property tax	000 EUR		-6,5	-12,6	-11,9	-11,2	-10,5	-9,9	-9,2	-8,5	-7,8	-7,1
Profit tax	000 EUR		-21,0	-142,0	-142,0	-142,1	-142,2	-142,2	-142,3	-142,4	-142,4	-142,5
Credit repayment												
Repayment of the principal	000 EUR		-2 048,6	-2 048,6	-2 048,6	-2 048,6	-2 048,6	-2 048,6	-2 048,6			
Repayment of interest	000 EUR	-573,6	-1 147,2	-983,3	-819,4	-655,5	-491,7	-327,8	-163,9			
Closing balance	000 EUR	14 340,0	12 291,4	10 242,9	8 194,3	6 145,7	4 097,1	2 048,6	0,0			
Economic performance												
Project activity not as CDM												
Net cash-flow	000 EUR	-573,6	-2 361,0	-1 073,7	-909,2	-744,7	-580,2	-415,7	-251,2	1 961,9	1 962,5	1 963,1
Cumulative cash-flow	000 EUR	-573,6	-2 934,6	-4 008,2	-4 917,4	-5 662,1	-6 242,3	-6 657,9	-6 909,1	-4 947,2	-2 984,7	-1 021,6
NPV	000 EUR	**-901,5**										
IRR	%	**12,79%**										
Project activity as CDM												
Emission reductions (CERs)	t CO2e		20 551	54 802	54 802	54 802	54 802	54 802	54 802	61 851	61 851	61 851
Carbon revenues	000 EUR		205,5	548,0	548,0	548,0	548,0	548,0	548,0	618,5	618,5	618,5
Net cash-flow with carbon revenues	000 EUR	-573,6	-2 155,4	-525,7	-361,2	-196,7	-32,2	132,3	296,8	2 580,4	2 581,0	2 581,6
Cumulated cash-flow with CERs revenues	000 EUR	-573,6	-2 729,0	-3 254,7	-3 615,9	-3 812,5	-3 844,7	-3 712,3	-3 415,5	-835,1	1 745,9	4 327,6
NPV	000 EUR	**2 378,9**										
IRR	%	**21,25%**										

Annex 3-8. Tables with IRR and NPV calculations (continuation)

Income		2018	2019	2020	2021	2022	2023	2024	2025	2026	2026
Electricity supply	MWh	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**	**159 960**
Income from electricity sale	000 EUR	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4	8 649,4
Heat (steam) supply	MWh	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**	**68 076**
Income from heat (steam) sale	000 EUR	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0	2 537,0
Heat (hot water) supply	MWh	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**	**71 424**
Income from heat (hot water) sale	000 EUR	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4	1 667,4
Total receipts	000 EUR	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**	**12 853,8**
Expenditure											
Investments											
Credit facilities	000 EUR										
Depreciation											
Depreciation charges	000 EUR	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6	-680,6
Fixed assets value with allowance for depreciation	000 EUR	6 125,4	5 444,8	4 764,2	4 083,6	3 403,0	2 722,4	2 041,8	1 361,2	680,6	0,0
Current costs											
Natural gas consumption	10^3 m^3/year	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**	**39 060**
Natural gas procurement costs	000 EUR	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0	-8 875,0
Operation and Maintenance	000 EUR	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0	-1 866,0
Total costs	**000 EUR**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**	**-10 741,0**
Taxes											
Property tax	000 EUR	-6,5	-5,8	-5,1	-4,4	-3,7	-3,1	-2,4	-1,7	-1,0	-0,3
Profit tax	000 EUR	-142,6	-142,6	-142,7	-142,8	-142,8	-142,9	-143,0	-143,0	-143,1	-143,2
Credit repayment											
Repayment of the principal	000 EUR										
Repayment of interest	000 EUR										
Closing balance	000 EUR										
Economic performance											
Project activity not as CDM											
Net cash-flow	000 EUR	1 963,7	1 964,3	1 964,9	1 965,6	1 966,2	1 966,8	1 967,4	1 968,0	1 968,6	1 969,2
Cumulative cash-flow	000 EUR	942,1	2 906,4	4 871,4	6 837,0	8 803,1	10 769,9	12 737,3	14 705,3	16 674,0	18 643,2
NPV	000 EUR										
IRR	%										
Project activity as CDM											
Emission reductions (CERs)	t CO2e	61 851	61 851	61 851	61 851	61 851	61 851	61 851	61 851	61 851	61 851
Carbon revenues	000 EUR	618,5	618,5	618,5	618,5	618,5	618,5	618,5	618,5	618,5	618,5
Net cash-flow with carbon revenues	000 EUR	2 582,2	2 582,8	2 583,5	2 584,1	2 584,7	2 585,3	2 585,9	2 586,5	2 587,1	2 587,8
Cumulated cash-flow with CERs revenues	000 EUR	6 909,8	9 492,6	12 076,1	14 660,2	17 244,9	19 830,2	22 416,1	25 002,6	27 589,7	30 177,5
NPV	000 EUR										
IRR	%										

Annex 4

MONITORING INFORMATION

Monitoring procedure for CDM project activity: "Skopje Cogeneration Project".

The procedure describes all the necessary steps required for monitoring according to the requirements of monitoring methodology AM0029 "Grid connected electricity generation plant using non-renewable and less GHG intensive fuel". All necessary data required to be collected for calculation of GHG emission reduction, source of data collection and other data required in connection with implementation of this type of projects will be registered.

1. Data and source of data to be collected during on-site monitoring.

In compliance with the manufacturer's procedures gas engine cogeneration gensets (GE Jenbacher) at the new CHPP will be fitted with an automatic acquisition system. Readings of all sensors will be transferred to the control unit for further computer processing and archiving.

A separate natural gas meter will be installed at each gas engine. Data on consumed amount of natural gas will be regularly transferred to the control unit. Volume of natural gas consumed at the new CHPP under the project in the year *y* ($FC_{NG,PJ,y}$) will be calculated as a sum of volumes of natural gas consumed by each gas engine in the year *y*. Data on monthly natural gas consumption will be regularly verified with the invoices received from the natural gas supplier.

Electricity output will be measured by electric meters installed at each genset. To determine net electricity generation at the new CHPP in the year *y* ($EG_{PJ,y}$) readings of a separately installed meter will be used, this meter will measure the amount of electricity delivered to the grid. Electricity output data will be regularly transferred to the control unit.

Net calorific value of natural gas will be analyzed by the fuel supplier. The fuel quality certificates will be provided on a monthly basis. Net calorific value of natural gas in the year *y* ($NCV_{NG,y}$) will be determined as an average value at the end of the year *y*.

2. Data and source of data required for calculation of the baseline CO_2 emission factor in the year *y* ($EF_{BL,CO2,y}$).

All data required for calculation of $EF_{BL,CO2,y}$ will be monitored annually throughout the crediting period as per "Tool to calculate the emission factor for an electricity system", namely:

Net electricity generated and delivered to the grid by power plant/unit *j* in the year *y* ($EG_{j,y}$). The source of data will be the owners of the power plants, as well as the Macedonia dispatching centre.

Amount of lignite consumed by power plant/unit *j* in the year *y* ($FC_{coal,j,y}$). The source of data will be AD ELEM.

Net calorific value of lignite consumed by power plant/unit j in the year y ($NCV_{coal,j,y}$). The source of data will be AD ELEM.

Amount of residual fuel oil consumed by power plant/unit j in the year y ($FC_{RFO,j,y}$). The source of data will be the owners of the power plants.

In case the TPP owner is not able for any reason to provide data on annual consumption of fossil fuel, this value will be estimated in a conservative manner with the help of equation B.6-5 (see Section B.6). It will be assumed that only residual fuel oil was used for power generation purposes at the plant (residual fuel oil has lower CO_2 emission factor compared to lignite), energy efficiency of power plant is equal to 0.375[1].

The baseline CO_2 emission factor and emission factor for upstream fugitive methane emissions occurring in the absence of the project activity will be updated regularly, at that the build margin emission factor will remain constant throughout the entire crediting period.

All calculations are performed as per methodology described in Section B.6.

3. Fulfillment of measures described under Items 1.1-1.3 and 2.1-2.4 should be continued for not less than two years after the end of the crediting periods.
4. Gas and electricity meters will be regularly calibrated according to the manufacturer's specifications.
5. Personnel of the new CHPP will undergo training arranged by the equipment manufacturer.

ENERGOUSLUGI is responsible for collection and accuracy of the data required for monitoring. GHG emission reductions will be calculated annually by specialists of Camco Global on the basis of the data received from ENERGOUSLUGI. In case of any doubts about accuracy of the initial data specialists of ENERGOUSLUGI will check and revise the data. Draft version of the Monitoring Report will be submitted to specialists of ENERGOUSLUGI for review. If any mistakes in calculations of GHG emission reductions are found, specialists of Camco Global shall correct the calculations accordingly.

[1] According to "Tool to calculate the emission factor for an electricity system"

Annex 5

INFORMATION REGARDING STAKEHOLDERS' COMMENTS

Annex 5-1. The invitation poster

25.12.2007

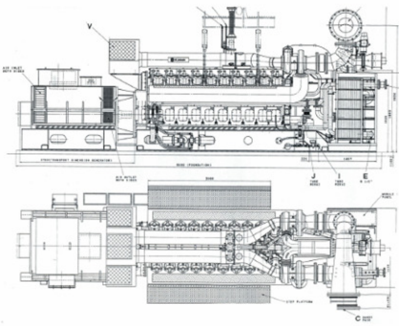
energouslugi

ПОКАНА

за јавна презентација и отворена дискусија

за новата когенеративна централа и воедно имплементирањето на CDM (Clean Development Mechanism)

По повод изградбата на новата когенеративна централа во Скопје, на 25.12.2007 (14:00ч) во просториите на Центарот за Енергетска Ефикасност на Македонија - МАЦЕФ, се одржува јавна презентација и дискусија. Презентацијата ќе го опфати процесот на изградбата на централата како и имплементирањето на CDM (Механизам за Чист Развој).
Покрај отворената дискусија, засегнатите страни ќе имаат можност и да ги испраќаат своите прашања на долунаведената адреса до 25.01.2008 година.



КОНТАКТ:

ЕНЕРГОУСЛУГИ ДОО Скопје,
Ул. 16 Македонска Бригада бр. 18 - Скопје
Е-маил: ei@ri.com.mk
Тел: 02 244 7627;
Лице за контакт: Василевски Гоце

Annex 5-2. Web-site of MACEF

Annex 6

ENVIROMENTAL IMPACT ASSESSMENT

Project for Environmental Protection

Cogeneration Gas Plant SEVER
Executive Summary

Company Profile

The company KOGEP Sever is registered as a shareholders company for production of electricity and heat, and is situated in Skopje. The company will place its product directly to its consumers in compliance with the laws and regulations in the Republic of Macedonia, or to one sole trader/(provider) with electricity and heating (for example ELEM Energetika) which is located in the surrounding of Zelezarnica Skopje, fairly close to the cogeneration plant.

Function and Description of the Technological Process

The purpose of this object is simultaneous production of electrical and heating energy. For this aim an already existing construction site, in which building are the planned equipment and installations set.
The basic dimensions of the construction site are 24x30x11.8 m.
The equipment consists of ten gas engines which use natural gas as fuel. Electricity generators are connected to the gas engines, each one with an electrical power of 3041 kW.
The electricity produced is being distributed to the distribution network of MEPSO and EVN Macedonia trough two transformers.
The heating energy released trough the work of the gas engines, with the use of coolers is being put forward to the circulatory cooling circle, to which the oil cooler, engine cooler and intercooler for mixture of gas-air after turbo charger, are being connected. This heating energy, of 1358 kW, in the winter period, trough a water heater, is put forward towards the distribution network for heating part of the city (ELEM - Energetika), while in the summer period, trough cooling towers is thrown out in the air.
As an additional solution, in the case of decreased demand of heating energy for heating, an additional Freon turbine (ORC Turbine) will be installed. Exhausted gasses from the gas engines, trough a silencers for decreasing the noise, because of the high consistence of physical heat of 1140 kW, is taken in a steam generator. There are five steam generators; two gas engines supply one steam generator.
The supply with fuel, natural gas, is trough MRS custom built for the requirements of this object. The gas engines are placed on the ground zero of the construction site. Silencers are placed on a steel platform with a 5m height in the same object. On elevation 12 meters, above the roof of the building, on a separate self supported steel platform are placed the cooling towers for the first and the second circle.
The steam generators are placed on the outside of the construction building, on separate foundation. 10 chimneys are considered, one for each gas engine, positioned above the steam generators. 10 ventilators for fresh air are considered to supply the gas engines. Furthermore, 10 ventilators for subtracting the air from the object space, for the purpose of taking away the created heat with dissipation. They are placed on the roof of the building. One of them is in anti explosive performance, because it is intended to work in a case of a need for ventilation of increased concentration of gas and smoke.
A de-aerator with de-mineralized water reservoir for its thermal preparing for the steam generators is intended. It has an oil reservoir with a capacity of $5m^3$.

Installed capacity

The gas engine has a capacity for producing electricity of	3041 kW
The total capacity for electricity production is	30 410 kW
The production of heating energy by one gas engine is	1358 kW
The total capacity for heat production is	13 580 kW
The production of steam by one gas engine is	1140 kW
The total capacity for steam production is	11 400 kW
The total capacity for steam production (in kg/h) is	19 000 kg/h

Architectural and construction characteristics

The object is a combination between the previuos object with the external added envelope.

The first object is built with reinforced concrete grate. The space between the beams and the columns is left empty and is 5 meters high, just to provide fresh air in to the inside of the hall. The wall above (5-8m) is made with solid bricks, 25 cm thick and with layer of mortar on both sides.

The roof is made with sheet metal and with thermo insulation from the inner side .The floor is massive reinforced concrete slab who serves as base for the equipment, also the floor has channels in which the electrical cables are placed. Additionally, a steel platform is placed and is fixed on the execting reinforced concrete construction 5 meters height and also on 4 other steel columns. One part from the space is divided with panels (plasterboard+ thermo insulation+ plasterboard) on both floors. In this room the electrical commands are placed, and the people who manage the work of the system. The entrance in the object is provided on the both sides. There is a steel construction from the external side of the object that holds the sheet metal which serves as decoration facade. Over the roof there is a steel platform on which part of the equipment for the ventilation is placed. The sanitary connection is placed under the steel stairs that lead to the rooms where the electrical equipment is placed.

In general, the problem with polluting the environment can be divided in several areas:

Pollution of air
Pollution of water
Soil contamination
Protection from harmful and dangerous radiation / emmision
Protection from noise and vibrations and
Protection from natural disasters and technical catastrophes.

From this list it can be seen that the problem with pollution cannot be perceived and treated locally, because of the movement of the wind, the air pollutions can be taken far away from the source, as well as the movement of waters. Trough the foods from plants sources that humans consume, which product origin can be from whichever ground region in the world, it is undoubtedly that soil contamination is of broad character. Because of that, there exists an organized world movement towards environmental protection, and most of the countries that exist today have their laws and regulations for environmental protection and are members in the official and nonofficial world organizations for environmental protection.

Protection of Water

The regulations do not forbid any pollution, but they determine the intervention measurements that companies need to comply with. According to the laws and regulations, companies are obliged to:

- Ask for license from the Water Development Institute from the responsible organ in the municipality or the state for the usage of water and waste water disposal that can pollute the watercourses;

- To be secured that they do not take in into the water courses toxic materials that would not validate the bylaw value;

- To stop releasing polluted water, in respect to that to install devices that will decrease lower the pollution to be under the allowable limits;

- To keep evidence about the sort, quantity and degree of pollution of the waste water disposal;

- To prevent releasing in public system of sewage inflammable and explosive ingredients, acid, aggressive and alkaline elements, harmful gasses, hard and solid particles (ash, slag, metal waste, plastic, wood, glass, wipes, dyes and so forth).

  In the case of outflow of the oil from the oil reservoir, a metal channel is going to be installed, and from under it, with a hosepipe, the excess oil will be gathered in plastic canisters, each one with a capacity of $1m^3$. In this way, the solid contamination by the oil form the oil tank will be prevented.
  The exhausted oil from the gas engines, trough a special pump for that particular purpose and a specially designed pipeline, is collected directly in plastic canisters, each one with a capacity of $1m^3$, and after that being transported for regeneration or to landfill for this kind of oil waste, that will be determined by the Ministry of Environment and Physical Planning.
  The premises where the oil reservoir, pumps and ammonia barrels and hydrazine (each one with a capacity of 100 kg) are placed, is going to have an collecting hole for liquid industrial waste, that leads to the communal collector in the circle of Zelezarnica. This means that in case of accident of these barrels filled with chemicals, even for such negligible amounts, uncontrolled outflow will be prevented.

Protection of soil
The implementation of measurements for protection from soil contamination is established trough indirect methods in the regulations for space arrangement and usage of land for building objects, for safety at work, and protection of waters. With separate regulations on municipality level, a regulation of issues such as removal, deposit and destruction of hard and solid waste that can contaminate the soil can be achieved. From the determinants from the regulations mentioned above, the following obligations for companies occur:

- A place for removal of waste to be planned in the project documentation;

- Information about the materials that can contaminate the soil to be submitted in the request for general approval for building the object;

- Waste not to be deposited in places that are protected (springs, river-beds, channels for accumulation and so forth);

- Distribution of waste to dumps that are anticipated by municipality regulations.

Protection from increased noise and vibrations
The implementation of measurements for protection from increased noise and vibrations is regulated trough indirect methods for safety at work (building objects and space planning). Companies are obliged to ensure:

- Construction and execution of tools for work which noise and vibrations will be in the limits allowed by imposed regulations;
- Sound proofing of tools that create noise greater than permitted; this refers to sound proofing the walls where the machinery is inbuilt;
- Restraint of spreading the noise with level higher than 40 decibels out of the machinery.

The noise that is expected from the mechanical hall is generated from:

- Gas engines,
- Centrifugal pumps,
- Circulatory pumps,
- Ventilators of cooling towers
- Ventilators for air
- Ventilators for taking away the exhaust gasses

Given the reason that the level of noise is above limits in the nearby surrounding of the gas engines, according to the regulations of the hygiene-technical protection, while controlling the work of the gas engines, the personnel is obliged to use protective devices – anti-phones or other forms of protection for the hearing. Vibrations are avoided by positioning the equipment on special shock absorbers designed for this particular purpose, and the installation is connected with special links.

Protection from harmful and dangerous radiation

The implementation of measurements for protection from harmful and dangerous radiation is regulated trough indirect regulations for safety at work. This suggests that companies are obliged to:

- To secure the construction site on devices that work with sources of ionization radiation only in such places with such technical conditions that ensure the protection of the environment;
- After a certain time period to do tests about the contamination of the working environment and the accuracy of the measuring devices;
- To measure the degree of radiation of the workers (working places);
- To execute measurements for protection of the workers from radiation.

Ventilation of the mechanical hall

According to the technical experience for projecting such power plants at least a five-time change of air needs to be done, in order to avoid creation of explosive concentrate of natural gas.

However in case when the working space has large dissipation of heating energy, an analysis of the ventilation of the working space is needed, also taking into consideration the subtraction and the taking out of this quantity of heat.

It is competent for the greater quantity of air to be considered for ventilation.
The quantity of air needed for the released heat to be taken out,
when $\Delta t = 8$ °C $V_Q = 1\ 200\ 000\ m^3/h$
In this case, for dimensioning the system for ventilation of the working space the higher value is taken, by which the basic condition for five-time change of the air in the hall is fully achieved.
For this purpose, special equipment is considered, consisting of 10 roof ventilators, placed on a platform on elevation 11.8 m. They are connected with the object trough the help of vertical circle channels with a diameter 1800 mm. The ventilators are of type AVD DK 1800/10-26°, with a capacity of 120 000 m^3/h each. One ventilator is in special anti-explosive mode which secures 18 alterations of air in the space where the gas engines are situated.

Electric installation of low voltage
The basic meaning of the technical solutions in this project is the security of the constant supply of electricity to the primary consumers (the ten cogeneration gas engines) while the rules and regulations for secure and safe work when using electricity are obeyed.
For that purpose, and having in mind the building of the power plant in phases, there have been projected two separating lockers /GRT1 and GRT2/. GRT1 is supplying with electricity the first five cogenerators and all peripheral devices, while GRT2 – the other five cogeneration engines.
Besides the supply of the cogeneration gas engines /+A1÷+A10/ with electricity, as well as the steam generators /SGD1÷SGD5/, the lockers GRT1 and GRT2 additionally supply the boards TV1, TV2, TO, TSN, TSIg, TSIf.
TV1 and TV2 operate the necessary ventilation, for which purpose particle invertors are used, controlled analogously by the controllers placed in +A1÷+A10.
In the console TO the operation of lightning is concentrated. The normative lightning of the electro-generation devices is in compliance with the obligatory Macedonian standards for electro generating devices /300 lux. on a surface of 1m^2 /. The board TSN is used for executing repairing of the co-generators. Boards ***TSIg*** and ***TSIf*** are specialized devices that control the conditions for safe work of the co-generators.
TSIg is monitoring the emergence of gas /CH_4 / in the premises. For this purpose, a catalytic sensor for detection of gas is used. The technical characteristics at the usage of gas determine limits of explosiveness, including: the methane constitutes combustible explosive mixtures in the air, with concentrations between 5 ÷15%. The limitation norm is a concentration of gas from 20% from the low limit of explosiveness (1% volume). The signaling sensor for gas that has relay exits from 10% and 20% from the low limit of explosiveness, that navigate the safety- gas valve on the beginning of the gas line and safety ventilation that is in explosive mode. The signals from the signaling sensor for gas are connected to the controllers of the cogeneration modules.
TSIf is a center for reporting a fire of conventional type. A combination of differentially – thermal and optical – smoke sensors for fire are used. Furthermore, manual fire alarms are also planned. The signals for fire from the center for fire are also sent towards the master control panel.

Electrical installation for medium voltage
An electrical installation for medium voltage has been projected. This installation executes the basic function of the cogeneration plant – production and distribution of electricity. In the phase building of the power plant two trackage collecting sections consisted of five modules for each separate generator are installed. Module lockers are used from the series “SM6” of “Merlin Gerin”. “SM6” offers factory tested metal lockers that are separated into five isolated compartments for assemblage of different commutation devices.

Each section includes:
- five modules generation switches
- module supplying transformers
- module cable input

Protection from indirect contact
For protection from indirect contact, in few parts of the project the following measurements have been used:
- Automatic switch-off of the supply;
- Protective grounding;
- Balancing of potentials;
- Protective switch-off;
- Safe low-voltage supply.

Protection from over voltage contact
Lightningrod instalation and grounding

The system for protection from lightning impulse consists from an external and internal instalation.
The *Internal installation* consists of additional precautions, which would contribute towards decreasing the electromagnetic influences from the lightning impulse in the object that is being protected, as a mode for neutralization of potential.
The *External Instalation* consists of a system of catchers, lighting conductors and earth leads. Apprapriately designed system of catchers drastically decreases the probability of a strike that enters the object that needs to be protected. When determining the position of the system of catchers the method of "fictive sphere" (or "rolling sphere"), because the form of the object being protected is complicated.
The system of catchers is adequate if none of the spots from the space that needs to be protected does not have any contact with the sphere with radius R, that is, the sphere must touch only the ground and/or the system of catchers. In this case, two catchers are planned (E JUS N.B4.902), fixed at the chimney with a ring.

Transformers
Next to the mechanical hall, two tri-phase transformers produced by the company **Schneider Electric Industries SA** with the following basic characteristics:

Capacity	20 000 kVA
Instalation	External
Primary/secondary voltage	35/10 kV
Basic gabarit dimensions	3750/3850/3600
Weight	27 500 kg

Cooling – natural circulation of mineral oil and natural air cooling.

The oil for cooling is located in a steel reservoir, protected by metallization, and the radiators are hot galvanized. The producer of the equipment guarantees that the used material for production of the equipment does not contain PCB.
Measurements for protection of the environment from the transformer substation that refer to the protection of soil and protection of water, are also achieved even from the phase for projecting and building. Transformer's oil, that only in time of incidental conditions can represent a potential contaminator, is accepted in special transformer's oil pit. Transformer's oil pit is positioned under the transformer substations. Transformer's oil pits are dimensioned so that in a case of incident can accept the whole quantity of transformer's oil. Each transformer is positioned on a separate fundament, which is specially designed so that the transformer's oil can be quickly distributed to the transformer's oil pit.

Water supply network
The water supply of the object with sanitary water is planned from the water supply installation within Zelezarnica.
The external water supply network that is brought in soil is positioned on a layer of sand d=15cm, and anticorrosive protected with bitumen and jute and dig in 1.00m, with height of the trench 80cm. The water is being taken to two premises including the room planned for toilet, positioned on the outside of the mechanical hall, under the external steel stairs, and to the room where the reservoir for water and the rest of the necessary equipment are installed.

Canalization
For the whole object a connection with the existing canalization network that is within Zelezarnica is planned.
Fecal canalization. Fecal effluent waters from the object, considering their function and their purpose, are of type human sewage. The solution for the *fecal canalization* is according to the allocation of sanitary consumers. Sewages from the objects are taken away trough a shortest route with a sufficient falling for a secure takeaway and rinsing. All conjunctions are designed with angular pipe connections from 45° where possible. The dimensioning of the network is executed considering the existing regulations in this area.
Atmospheric canalization. Waters from the roof areas are taken away trough horizontal and vertical gutters. Waters from vertical pipes are released to freely fall on the ground.
Industrial canalization. A special connection is designed for the premises in which the water reservoir is installed, as well as the reservoir for oil, and the containers with hydrazine and ammonia for the requirements of the process.
The waste waters, trough a special link are transported to the central collector intended for that purpose within Zelezarnica. It does not mix with the *fecal canalization.*

Protection of air
Companies are obliged by laws and regulations to administer the following measurements:
- Insurance of the technical requirements for protection of air and pollution over the allowed limits when locating, projecting, building and reconstruction of objects that release pollutants into the air.

- Report to the competent sanitary inspection about objects that can pollute the air trough their work.

- Execution of regular control for releasing the pollutants trough own service for measuring or trough qualified institutions.

- Keeping evidence of the results from controlling and submitting these information to the competent organs,

- Correcting the errors of the objects that led to pollution of the environment, on the demand of the competent organs,

- Installing adequate devices for catching and purification of gas, steam and smoke of objects and machinery that pollute the air over the allowed limit.

Maximum allowed concentrations (MAC)

Under MAC it is to understand the concentration of the toxic substances in the working atmosphere (in the air in the surrounding of the working space) which during the everyday eight hour work without any usage of personal protective resources and during a certain number of years does not evoke pathological changes or diseases, that can be discovered trough the existing methods. The values of MAC are very important in choosing and projecting the technological processes and procedures, as well as the matters and materials that will be included in them.

A control of the minimum height of the chimneys has been executed, that will not exceed the maximum allowed concentration (MAC). This height is 6.14m.

According to the calculations it can be concluded that the minimum height of the chimneys should be H=6.14m, where the condition not to exceed the MAC will be satisfied.

The chimneys of the power plant are with height 16 m, and additionally are positioned on a platform, above the steam generators, which is 4m over the ground.

In the basics of the controlling calculations for the decreased quantity of production of pollutants at an alternative production of electricity with fuel mazut (heavy fuel oil) or coal (in comparison with the emission while using natural gas) it is obtained:

		Heavy fuel oil	Coal
Difference in emissions of CO_2	kg CO_2/year	88463929	187747120
Difference in emissions of SO_2	kg SO_2/year	3602880	3072000
Difference in emissions of NOx	kg NOx/year	320723	108200

In accordance with the existing regulations for environmental protection from sources of pollution, a measurement has been organized for measuring the emission of gasses from the chimney of the energy sources.

Conclusion

One of the ways to satisfy all needs of the industrial development, and hence not to bring the environment in an unenviable ecological condition is exactly the selection of natural gas as a basic fuel in the industrial processes and the production of electricity. Its composition and the composition of the products of its combustion, presented in this project, clearly state the ecological advances over the other fossil fuels.

Skopje is a city located in a valley with an unfavorable air circulations, which in the winter period contributes towards increased pollution of the atmosphere. The use of natural gas will in a great proportion assure improvement of the general ecological condition in the city. For this, guarantee is

not only the made analysis and calculation, but the solid determination of the Investor built into the contract for procurement of most up to date equipment, in which it is insisted for the following parameters for the inbuilt equipment:
NO_x < 500 mg/nm^3 (5 % O_2) CO < 650 mg/nm^3 (5% O_2)
All corrective measurements have been undertaken in order to stop pollution of the surrounding even in conditions of accidents in the power plant (outflow of the oil from the transformers, from the oil reservoir, outflow of the hydrazine and ammonia).
Sophisticated systems have been designed for navigation, control and protection of the unwinding of the processes, trough which the possibility for human error to provoke incident and endanger the environment is decreased.