TE-TO AD SKOPJE

Combined Cycle Co-Generation Power Plant Project Skopje

Environmental Assessment Report

SECTION A
EXECUTIVE SUMMARY

August 2006

Thermal Energy Plants Department

Table of Contents

Page

1 Introduction 4
1.1 Customer 4
1.2 Location 4
1.3 Local Electricity Market 5
2 Legal and Environmental Frameworks 5
2.1 Legal Background 5
2.2 Environmental Requirements 6
3 Project Description 8
3.1 Project Location and Infrastructure 8
3.2 Existing District Heating Plant 9
3.3 New Combined Cycle Co-Generation Power Plant 11
4 Baseline Conditions 14
5 Environmental Impacts 16
5.1 Impacts During Construction Phase 16
5.2 Impact During Operation Phase 17
6 Analysis of Alternatives 21
7 Environmental Management Plan 23
8 Summarizing Conclusions 25

List of Tables

Table A- 1: Macedonian Power Demand and Supply 5
Table A- 2: Environmental Requirements for the Project 7
Table A- 3: The Main Operating Data of Existing DHP 'ISTOK' of Toplifikacija AD 10
Table A- 4: Main Technical Data of CCPP Skopje 12
Table A- 5: Operation Cases and Heat Cycle Calculations 13
Table A- 6: Main Operational Data of the CCPP Skopje 14
Table A- 7: Main Baseline Data of Site area and City of Skopje 15
Table A- 8: The main Project Impacts and Mitigation Measures during Construction Phase 16
Table A- 9: The Main Project Impacts and Mitigation Measures during Operation Phase 21

List of Figures

Figure A- 1: Location of new CCPP Project respective existing DHP ISTOK....8
Figure A- 2: Heating Season Analysis....11
Figure A- 3: Simplified Process Flow Diagram of CCPP Skopje....11
Figure A- 4: Comparison of Annual Emissions....18
Figure A- 5: Mean annual GLC of SO_2 [µg/m³] for the existing DHP....19
Figure A- 6: Differences of mean annual NO_2-GLC [µg/m³] between existing DHP and new CCPP Skopje....20
Figure A- 7: Specific Emission Data of Alternative Concepts....23
Figure A- 8: Organisation of Environmental Management....24
Figure A- 9: Summary of Environmental Impacts of CCPP Project....26

1 Introduction

1.1 Customer

TE-TO AD, registered in the Republic of Macedonia, is a company which was established in 2005 and is owned by ITERA Energy Holdings London, Toplifikacija AD Skopje and BITAR Holdings Limited.

The company TE-TO AD has the aim to own and operate a combined heat and power plant in Skopje. The company is currently in the progress of developing a 220 MW Combined Cycle Power Plant project in the industrial area of Skopje, Republic of Macedonia. The location of the proposed plant is close to the Toplifikacija AD heating plant 'ISTOK'.

The anticipated capacity of the power plant is approximately 220 MW electrical and up to 160 MW of thermal energy for the local District Heating System of Toplifikacija AD.

TE-TO AD will contract a reputable company, qualified to assume the role of a turnkey Contractor and Service Provider for the Engineering, Procurement and Construction (EPC) and for the Service Maintenance Agreement (SMA) of the entire Combined Cycle Power Plant (CCPP) as specified in a Request for Proposal (RFP) following international regulations.

The Customer will structure the project based on balance sheet financing using his own funds and on proceeds of corporate loans together with an international bank in a 30/70 ratio.

The intended combined cycle power plant of TE-TO AD in Skopje (CCPP Skopje) shall be constructed and operated on the basis of an IPP Project (Independent Power Producer) and shall supply power to the Macedonian electricity market and in case of electricity excess also to the international market. In addition, the major part of the required district heat demand of Skopje city shall be generated and supplied by this power plant.

1.2 Location

The location of the proposed CCPP will be the Republic of Macedonia, which has made significant progress in energy sector reform, most notably through adoption of an Energy Law and establishment of an independent energy regulator. The cooperation agreement with Italy grants the development in conformity to the current existing European Community (EU) laws and regulations.

Notwithstanding this, further progress is required to meet the following objectives for the Macedonian energy sector:

- To provide secure and affordable energy on a sustainable basis;
- To commercialize the energy industry;
- To improve energy efficiency in Macedonia; and

- To improve environmental performance of the Macedonian energy industry.

These objectives derive from the broader goal of the Macedonian government to promote macroeconomic stability and growth whilst protecting poor groups in the population.

1.3 Local Electricity Market

Currently the installed power generation capacity in Macedonia is 1450 MW, comprising approximately 60 percent thermal and 40 percent hydro plant. The forecast of the power demand and supply is presented in Table A- 1 (Based on data provided by ESM).

	1993	1998	2003	2008E	2013E	2019E
Power Demand (GWh)	5690	6626	7222	8074	9780	12600
Power production from existing plants (GWh)	5136	6523	6572	5836	1230	1230
Power imports (GWh)	554	103	950	2238	8550	11370

Table A- 1: Macedonian Power Demand and Supply

The TE-TO AD Company will make a significant contribution to meet the required future energy demand of Skopje / Macedonia

2 Legal and Environmental Frameworks

2.1 Legal Background

The EA report on hand is based on the following legal documents:

- Air Emission Guidelines of European Community: EC 2001/80/EC of October 23, 2001
- Ambient Air Quality Standards of European Community: Council Directive 1999/30/EC of April 22, 1999
- Urban waste water treatment Directive of European Community 91/271/EEC of May 21, 1991
- Since no EC Noise regulation is existent, local and WB standards for noise have been applied: Thermal Power: Guidelines for new plants; in Pollution Prevention and Abatement Handbook, July 1998
- Involuntary Resettlement Directive: OD 4.30 of WB; June 1990

In order to obtain the most environmentally suitable solution, relevant guidelines of the respective field have been compared and the stricter ones have been applied for the project.

Where no EC guidelines are existent, either the respective local guidelines or World Bank guidelines were taken into consideration depending on the strictness.

The following technical documents and information have been used for the preparation of the EA report:

- Feasibility Study Report of the Skopje CCPP as of March 2006
- Bidding Documents for the Skopje CCPP
- Annual Reports of the Skopje DH company Toplifikacija and further operational data of the existing HPP 'East'
- Existing EA report from February 2000 of an antecedent CCPP project which had not been implemented
- Study on an air pollution monitoring system in Macedonia from December 1998
- Ambient air quality measurements (manual as well as from 4 automatic stations) of the years 2004 and 2005.

2.2 Environmental Requirements

Considering the Macedonian and European Standards and Regulations for construction of the power plants, the applicable environmental requirements for the Skopje CCPP Project are summarized in Table A- 2. Where no European standards are available WB standards are used for comparison with the Macedonian. For the judgement of the environmental impacts always the lower value has been applied. The table consists of the requirements on stack emissions, ambient air quality, wastewater discharge, cooling water discharge and noise.

Items	Dimension	European Standard	Macedonian Guidelines	Applied Value
Emission				
NO_X (as NO_2)	mg/Nm^3	75	350	75
CO	mg/Nm^3	-	100	100
Ambient Air Quality				
NO_2				
- 0.5 hr max		-	85	85
- 1 hr Average	$\mu g/Nm^3$	200[2)]	-	200
- 24 hrs Average	$\mu g /Nm^3$	-	85	85
- Annual Average	$\mu g /Nm^3$	40	-	40
SO_2				
- 0.5 hr max		-	500	500
- 1 hr Average	$\mu g /Nm^3$	350[3)]	-	350
- 24 hrs Average	$\mu g /Nm^3$	125[5)]	150	125
- Annual Average	$\mu g /Nm^3$	20[1)]	-	20
Particulate				
- 1 hr Average	$\mu g /Nm^3$	-	-	
- 24 hrs Average	$\mu g /Nm^3$	50[4)]	-	50
- Annual Average	$\mu g /Nm^3$	40	-	40
CO				
- 0.5 hr max	mg/Nm^3	-	3	3
- 24 hrs Average	mg/Nm^3	-	1	1
		WB Standard	**Macedonian Guidelines**	
Wastewater standards				
pH	-	6-9	6.8-8.5	6.8-8.5
BOD_5	mg/l	-	4	4
COD	mg/l	-	12	12
TSS	mg/l	50	30	30
Oil and Grease	mg/l	10	-	10
Residual Chlorine	mg/l	0.2	-	0.2
Coliform	MPN/100 ml	-	20'000	20'000
Cooling water discharge temperature	°C	Increase at mixing zone < 3	-	Increase at mixing zone < 3
		WB Standard	**Macedonian Guidelines**	
Noise Industrial Areas				
Day Time	dB(A)	70 (7 - 22h)	70 (6 - 22h)	70
Night Time	dB(A)	70 (22 - 7h)	70 (22 - 6h)	70
Noise Resident. Areas				
Day Time	dB(A)	55 (7 - 22h)	60 (6 - 22h)	55 (7 - 22h)
Night Time	dB(A)	45 (22 - 7h)	50 (22 - 6h)	45 (22 - 7h)

Table A- 2: Environmental Requirements for the Project

1) protection for biological environment
2) not to be exceeded for more than 24 times

3) not to be exceeded for more than 24 times
4) not to be exceeded for more than 35 times
5) not to be exceeded for more than 3 times

3 Project Description

3.1 Project Location and Infrastructure

The CCPP Skopje will be located in the eastern industrial zone of Skopje, the capitol of the republic of Macedonia, directly adjoining to the existing district heat plant “ISTOK” of Toplifikacija.

Close to plant location is the river Vardar, the railway and the connection to the main eastern access road to city of Skopje are very close (see Figure A-1). There is no known restriction for heavy load transport by any low bridge height or limited load.

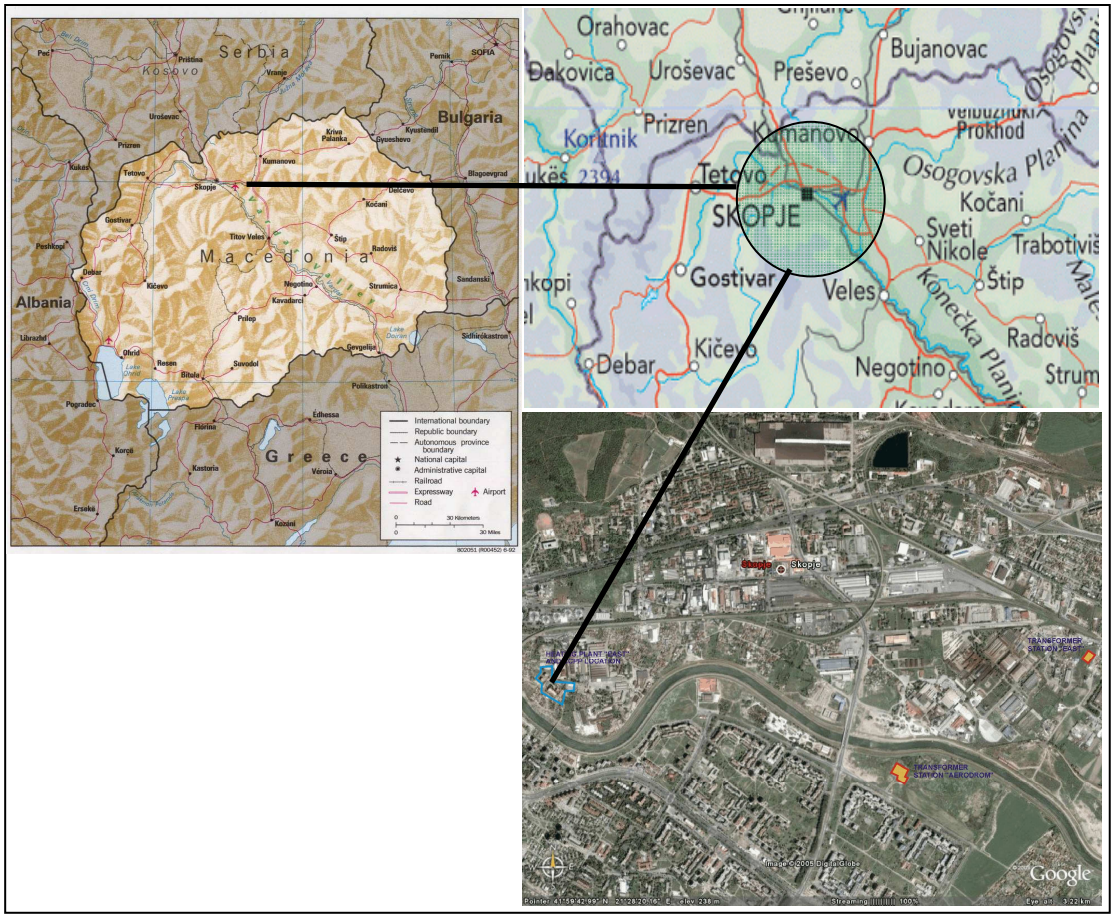


Figure A-1: Location of new CCPP Project respective existing DHP ISTOK

The following connections to required media are available on site (demand for plant future plant operation in brackets):

- Drinking water from city network (2-3 m^3/day)

- Waste water (Sanitary sewage water discharged to municipality sewage network, Service water discharged to river Vardar after proper treatment)

- Fuel and electricity (required during construction phase)

- Raw water wells – one existing well with a capacity of 85m^3/h and two additional wells or intake from river Vardar foreseen to cover all plant needs including fire fighting purposes (max. 240 m^3/h during summer months)

- Natural Gas with a capacity up to 40'000 Nm^3/h and a pressure of 12 bar is available in 2 km distance. In a longer distance of 8 km a 40 bar pipeline would be available (max. 44'000 Nm^3/h in full load operation).

The generated heat will be fed in the existing district heating system. The water from **district heating** will enter the power plant heat exchangers with water temperatures between 45 and 55°C and a flow rate of approx. 5000 m^3/h. A minimum flow of 1700 m^3/h is possible. During the night time between 21:00h and 06:00h, the district heating is switched off, resulting in higher demand in the morning. During the night operation of the CCPP, it is intended to have some heat stored in one of the two existing heavy oil tanks, converted into a 5000 m^3 water tank.

Power Transmission: Since the existing heating plant 'ISTOK' is currently not supplying any electrical power to the grid, a complete new interconnection has to be planned for the considered CCPP Skopje. Based on several investigations performed by the local engineering company TIMEL, the following measures could be possible:

- Interconnection of the plant into the existing 110 kV transmission system: The power evacuation of the CCPP on 110 kV level can be done either by an interconnection to the Transformer Station 'AERODROM' (about 2 km distance), or/and by an interconnection to the Transformer station 'ISTOK' (about 3 km distance).

- Interconnection of the plant into the existing 400 kV transmission system: Currently there is no possibility for a direct connection into the 400 kV switchgear in 'Skopje 4' since there is no free field available. However connection possibilities into the 400 kV overhead lines or into a parallel 110 kV overhead line are under investigation.

3.2 Existing District Heating Plant

The HPP "EAST" or "ISTOK" provides, with five boilers, 57.8% of the total heating capacity of DHS.

The boilers are fired in the percentage 70% Mazout and 30% natural gas producing annually about 475'000 MWth for the district heat system of Skopje. For the supply of district heat to the city networks the boilers are annually only about 2'650 to 2'700 hours in operation. Since only heat and no electricity is generated, the plant is fired only in the transition and winter periods (from mid October to mid April). In summer, late spring and early autumn the plant is out of service as the average outside temperatures are higher than 15°C. Also during night time (21:00 to 06:00), the plant is out of operation. The existing district heating system (DHS) is designed for a minimum temperature of -15 °C ambient temperature. The design average ambient temperature in winter is 5.3 °C. The Table A-3 summarizes the main data about the existing district heat production plant HPP "EAST" or "ISTOK" of Toplifikacija AD.

Total installed capacity of 5 hot water boilers	approx. 279 MW_{th}
Total installed capacity of two steam boilers	approx.14.8 MW_{th}
Total annual district heat production	about 475'000 MWh
Total installed capacity of consumer heating stations	about 375 MW_{th}
Consumer's capacity connected to the plant	~ 430 MW_{th}
Total annual operating hours of district heat system	about 2'650-2'700 h/a
Total annual electricity consumption	approx. 12'000 MWh
Annual consumption of water	approx.195'000 m^3
Annual consumption of heavy fuel oil (mazout)	37'000 to 43'000 t
LHV of Mazout	41.05 MJ/kg
Annual consumption of natural gas	13 - 15 $x10^6$ Nm^3
Annual total fuel consumption (heavy oil equivalent):	48 - 56 $x10^3$ t
LHV of natural gas	36.02 MJ/Nm^3

Table A-3: The Main Operating Data of Existing DHP 'ISTOK' of Toplifikacija AD

Only in few times of the heating period, the heating demand of 160 MW is exceeded. Therefore the design of the new CCPP is done according to this value. For those exceptions, the HPP "EAST" will cover the peak demand, which will be a maximum of up to 700 h (see Figure A-2).

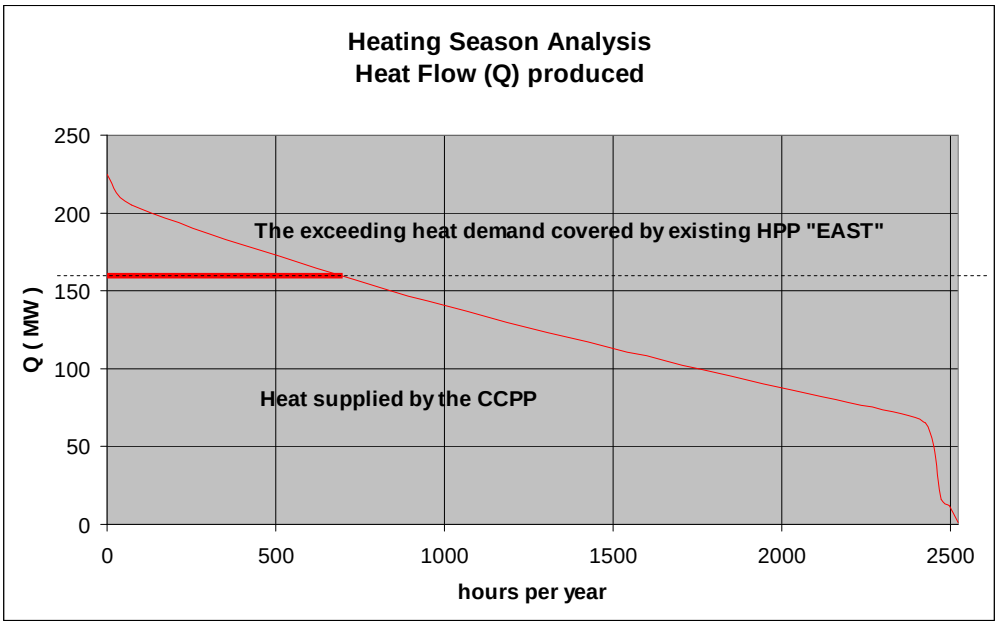


Figure A-2: Heating Season Analysis

3.3 New Combined Cycle Co-Generation Power Plant

The proposed CCPP Skopje Power Project mainly consists of a combined cycle facility with one gas-fired gas turbine, one heat recovery steam generator (HRSG), one steam turbine and the balance of the plant (BOP). The plant shall be supplied, erected and commissioned in the framework of an EPC contract (Turn Key Contract).

A simplified process flow diagram of the CCPP Skopje is shown in Figure A-3

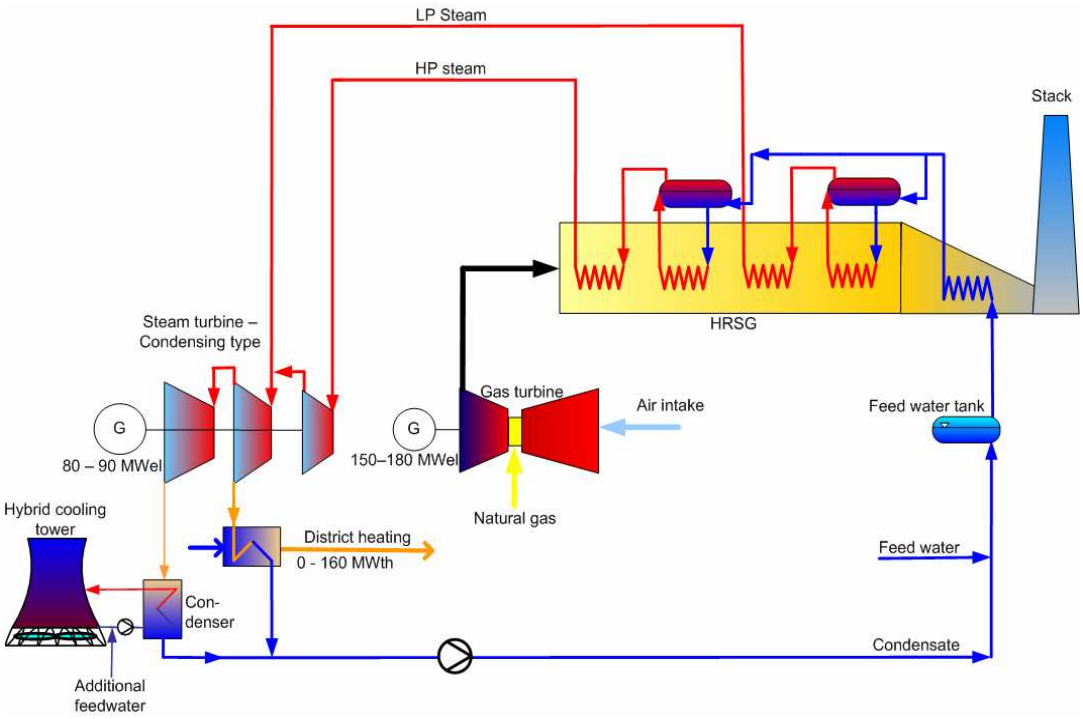


Figure A-3: Simplified Process Flow Diagram of CCPP Skopje

In the following Table A-4, the main technical design data of the CCPP Skopje are summarised.

	Units	Data
Electricity generation capacity: - Gross - Net	 MWe MWe	 about 220 to 240 about 214 to 234
Operating mode		base load operation with approx. 8'300 h/a operating hours
District heat generation capacity	MWth	max. 160
Net plant efficiency - Condensing mode - District heat extraction mode	 % %	 about 50 to 53 about 70 to 85
Net heat rate	kJ/kWh	about 6'800 to 7'200
Fuel: - Type - LHV - Demand	 - MJ/Nm^3 Nm^3/h	 Natural gas 36 about 42'000 to 47'000
Expected emissions (dry, @ 15% O_2): - NOx emissions - CO emissions	 mg/Nm^3 mg/Nm^3	 about 30 to 50 about 20 to 30
Noise Emissions	dB (A) dB (A)	60 (at the south and west fence) 70 (at the north and east fence)

Table A-4: Main Technical Data of CCPP Skopje

Comment: the final generation capacity of the plant is depending on the plant concept of the selected EPC contractor

The following Table A-5 summarises the results of the heat calculations as well as the estimated annual time shares of the operation cases.

Operation cases & Estimated time share				Heat Calculation Results		
Operation case	aver. T	share	time	gas heat	el. power	th. power
	°C	%	h/a	input (MW)	MWel	MWth
1 summer	25	40	3'320	422	217	0
2 transition (without heating)	15	28	2'291	440	229	0
3 transition *)	10	16	1'340	449	218	100
4 winter *)	2.5	16	1'349	462	231	160
total / weighed average		**100**	**8300**	**438**	**223**	**42**
With above values estimated as annual averages:						
Fuel gas heat input	MWh/a			**3'634'270**		
Electrical power	MWh/a				**1'848'813**	
Thermal power	MWh/a					**349'845**
Fuel utilisation					**60%**	

*) *heating shut down in the night (approx. 1/3 of a day) considered in the electr. power*

Table A-5: Operation Cases and Heat Cycle Calculations

The annual production averages of the CCPP Skopje are approximately 1.85 million MWh electricity and 350'000 MWh heat, corresponding to an overall fuel utilization of 60 %.

The Table A-6 summarises the main operational data of the CCPP Skopje for a maximum plant electrical generation capacity of 240 MW.

	Unit	Data
Plant operational modes: - pure condensing mode - co-generation mode (heat extraction)	 - -	 during April 16 to October 14 during 15 October to April 15
Plant operational hours: - base load operation - condensing mode - co-generation mode	 h/a h/a h/a	 about 8’300 about 5’600 about 2’700
Plant availability	%	90 to 93 (depending on maintenance requirements)
Net electrical power generation: - capacity - annual production	 MW_e GWh	 approx. 230 approx. 1’800
District heat extraction: - extraction capacity - annual heat extraction	 MW_{th} MW_{th}	 160 350’000

	Unit	Data
Natural gas consumption: - per hour - annually	 Nm^3/h Nm^3/a	 approx. 48'000 approx. 400'000'000

Table A-6: Main Operational Data of the CCPP Skopje

4 Baseline Conditions

Skopje is the capital of the Republic of Macedonia which became independent from the republic of Yugoslavia in 1991 (see **Section H, Appendix D1).** The city is located in the north central part of the country, in the Skopje National District. It is embedded in the Skopje valley and is spread on the shores of the river Vardar. The territory of the Skopje valley comprises approximately 460 km². The plant site for CCPP is located in the eastern industrial zone of Skopje, directly adjoining the existing Heat Power Plant (HPP) "East" "(ISTOK" of Toplifikacija). The site is flat and can be found at an elevation of 240 m above sea level.

Most climate and meteorological parameters of the Skopje valley have been analyzed in long term and have been compiled already in an Environmental Analysis of a preceding CHP project (2000). Climate and meteorological baseline data were measured and collected for a 40-year period by Republic Hydro Meteorological Institute and Republican Institute for Health Protection.

Basically, the Skopje geographical area can be classified as moderately continental with big influence of Mediterranean climatic basin. It is characterized by cold winters, with not so expressed transition between winter and summer, with very hot and dry summers.

The main baseline data of the site area and the city of Skopje can be found in Table A-7. For more detailed information please refer to Section D – Baseline Data.

Climate	
Average temperature	Hottest months (July and August): ca. 22.65 °C Coldest month (December and January): ca. 0.7 °C
Average humidity	Summer period: ca. 47 % Transition period: ca. 57 % Winter Period: ca. 72 %
Average rainfall	Summer period: ca. 40 l/m^2 Transition period: ca. 42 l/m^2 Winter Period: ca. 46 l/m^2 partly as snow
Average wind velocity	Summer: ca. 1.5 m/s mainly from West along valley Winter: ca. 1.0 m/s mainly from West along valley
Hydrological characteristics	
Vardar River	Average annual Temperature: 11°C Min. flow rate: ca. 5.2 m^3/s Max. flow rate: ca. 1108 m^3/s

Ground water	Water level below ground level: ca. -2 m to -14 m		
Drinking Water	Derived from non-polluted mountain springs and ground-water wells		
Ambient air quality (avg. values from 4 aut. monitoring stations)	Summer Period non-heating	Transition Period Partly heating	Winter Period Heating
Avg. SO_2 concentration	ca. 10 µg/m^3	ca. 25 µg/m^3	ca. 50 µg/m^3
Avg. NO_2 concentration	ca. 60 µg/m^3	ca.110 µg/m^3	ca. 135 µg/m^3
Avg. CO concentration	ca.1 mg/m^3	ca. 2 mg/m^3	ca. 3 mg/m^3
Avg. PM_{10} concentration	ca. 35 µg/m^3	ca. 65 µg/m^3	ca. 115 µg/m^3
Noise pollution	Industrial Zone	Residential Area	
Average noise level (HPP "EAST" not in operation)	Avg. 61 dB(A) Max. 70 dB(A)	Avg. 59 dB(A) Max. 75 dB(A)	
Average noise level (HPP "EAST" in operation)	Avg. 63 dB(A) Max. 73 dB(A	Avg. 60 dB(A) Max. 76 dB(A)	

Table A-7: Main Baseline Data of Site area and City of Skopje

Summarising all evaluated information on the existing ambient air quality situation the last 2 years in Skopje, the following conclusions can be drawn:

- Generally, the ambient air quality in Skopje is substantially worse in the high winter months than during summer. This applies to all investigated pollutants (PM, CO, NOx, SO_2). This is mainly due to the strong increase in the use of fossil fuels by industry, heating plants and private sector.

- It appears that the emission sources are not common for the different pollutants.

- For the CO and NOx ground level concentrations the urban traffic seems to play a major role besides industrial and other sources like the district heating plant.

- Concerning SO_2, industrial sources and burning fossil fuels in industry, district heating plants and private households seem to play the major role, especially for the strong increase in the heating season.

Comparing the above described ground level concentration data with ambient air quality standards (see Section B), the following statements can be made.

- For all investigated components the exceeding of ambient air quality standards has been assessed or can not be excluded.

- SO_2 is well below the standards during summer, in the high winter months during heating season a sporadic exceeding can not be excluded.

- The other components show a more critical behaviour as they exceed the standards in winter and partly in summer.

5 Environmental Impacts

The Project, including the construction and operation of the thermal cogeneration power plant of 220-240 MWel will play a very important role in the development of the Macedonian Energy Sector. It will promote the policy of industrialization and modernization of Macedonia in the coming decades and make a big contribution to the overall socio-economic development. In this section of the EA Report, the impact of the Combined Cycle Co-Generation Power Plant Project on the environment will be investigated. All relevant types of emissions and influences are considered in the study, particularly those that may have an impact on the physical and biological resources in the vicinity of the project, as well as those that could affect humans and their quality of life.

Beside significant beneficial impacts, and despite the use of a modern, clean technology and the use of natural gas as exclusive fuel, the project may have minor negative effects on the environment. But the design, approach and implementation are intended to minimise such negative effects as much as possible.

5.1 Impacts during Construction Phase

The Table A- 8 summarises the main impacts of the CCPP Skopje during the construction phase of the plant. In addition, the table contains a short assessment of each individual impact and the applied mitigation measures. As an overall assessment, it can be stated that there are no serious impacts during the construction period.

No.	Impact	Possible Effects	Assessment / Mitigation Measures
1	Land clearing of local people	Resettlement and compensation of people	Resettlement of some houses constructed by squatters on an area of about 3900 m^2close to the proposed CCPP. Resettlement to be performed according to WB OD 4.30.
2	Land used	Space requirement	A total of approx. 2 ha of land is required (no requirement of green field; Site located in an industrial area
3	Traffic / transportation	Increase in traffic volume	Temporarily affects. Transport of main plants and equipment by water way. Keep the traffic slow for safety and noise reasons.
4	Construction labour and activities	Increase in air pollution, noise and waste quantity	Temporarily affects. Avoiding of dust pollution by periodic watering of site during civil works. Avoiding of noisy activities during the night. Wastewater and solid waste disposal according to the local regulations.
5	Socio-economic	Employment aspects	Positive effects on temporary employment for local workers.

Table A- 8: The main Project Impacts and Mitigation Measures during Construction Phase

5.2 Impact during Operation Phase

The operational impacts can be considered as follows:

- CO_2 emission (contribution to greenhouse effect)
- Flue gas emissions into the atmosphere (e. g. NOx, CO)
- Ambient air quality
- Cooling water supply and discharge
- Noise within and outside the plant boundary
- Waste water discharge
- Solid waste disposal.

Concerning flue gas emissions and ambient air quality, it has to be considered that the operation of the new CCPP will almost completely replace the operation of the existing district heating plant (DHP). In the future, the DHP will be put in operation only for very limited time in case of extreme high peak heat demand. Insofar, the actual impact of the new CCPP is represented by the difference between the future situation (CCPP) and the existing situation (DHP).

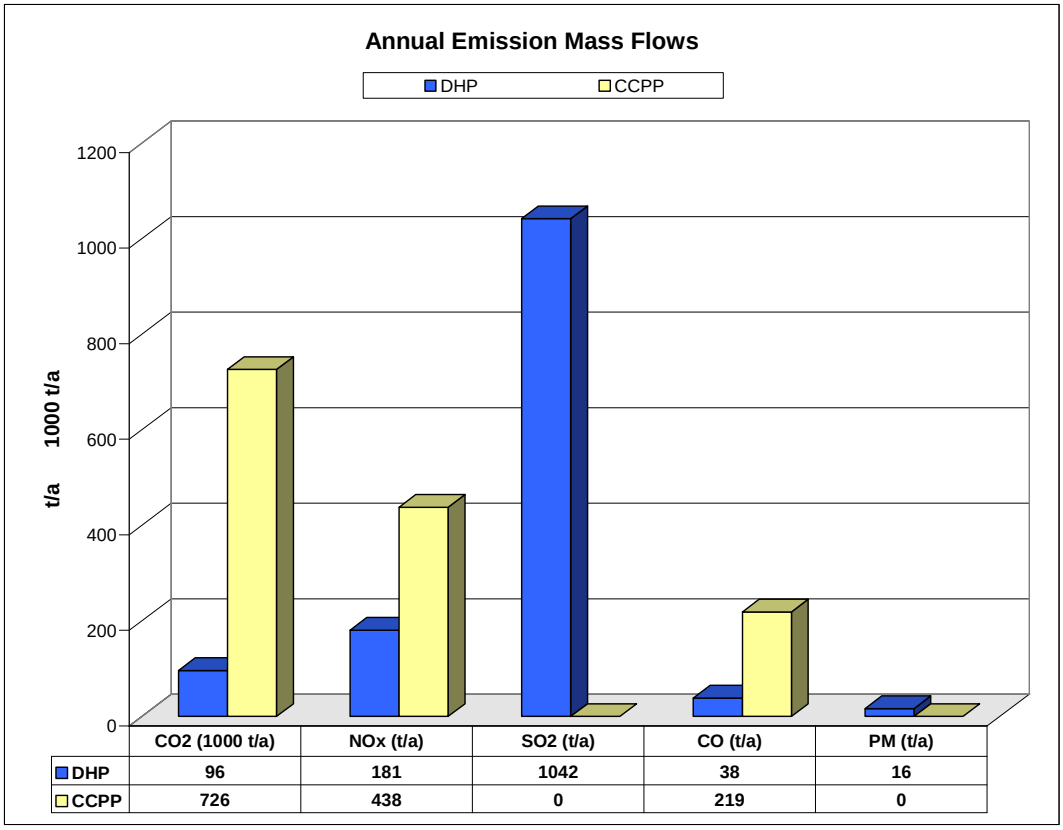
The greenhouse gas emission will be minimized due to the CCPP concept with high efficiency, i. e. low specific CO_2 emission.

No special secondary mitigation measures to control air emissions are required during the operation of Skopje CCPP. The mitigation measures to minimise air pollution are found in the technology and design of the power plant, such as:

- Combined cycle concept with high efficiency
- Natural gas as exclusive fuel
- Dry low NOX system (gas as fuel)

The hourly NOx and CO emission mass flows of existing DHP and new CCPP are of a comparable order of magnitude, but the SO_2 and particulate emissions will drop down to zero with the new CCPP in operation.

Figure A-4 shows the comparison of the annual emission mass flows. Due to the CCPP operation over the whole year compared to the short heating period of the DHP the annual emissions of CO_2, NOx and CO are higher for the combined cycle plant whereas SO_2 and PM are higher for the district heating plant (and are zero for CCPP).



	CO2 (1000 t/a)	NOx (t/a)	SO2 (t/a)	CO (t/a)	PM (t/a)
DHP	96	181	1042	38	16
CCPP	726	438	0	219	0

Figure A-4: Comparison of Annual Emissions

But in this context it has to be considered that the existing DHP only produces heat during heating seasons. The new CCPP however will produce as main product electricity (and additional heat during heating seasons). As a consequence, the electricity which will be produced by the new CCPP leads to corresponding emission savings elsewhere.

The overall emission saving potential has been estimated when comparing the operation of the new CCPP (electricity and heat production) with the operation of the existing DHP (only heat production) and a lignite-fired or oil-fired power plant (only electricity production) elsewhere. Based on a lignite/oil ratio of 70%/30% in the Macedonian power production, saving potentials of approx. 1.2 mio t/a CO_2, 2700 t/a NOx and 3800 t/a SO_2 are estimated.

Dispersion calculations for existing DHP and new CCPP have been performed to estimate the impact of the new CCPP on ambient air quality. One of the results is that a first maximum of ground level concentrations (GLC) occurs in the east, and a second maximum in WNW direction (see example SO_2 of DHP in Figure A-5; DHP/CCPP in the center).

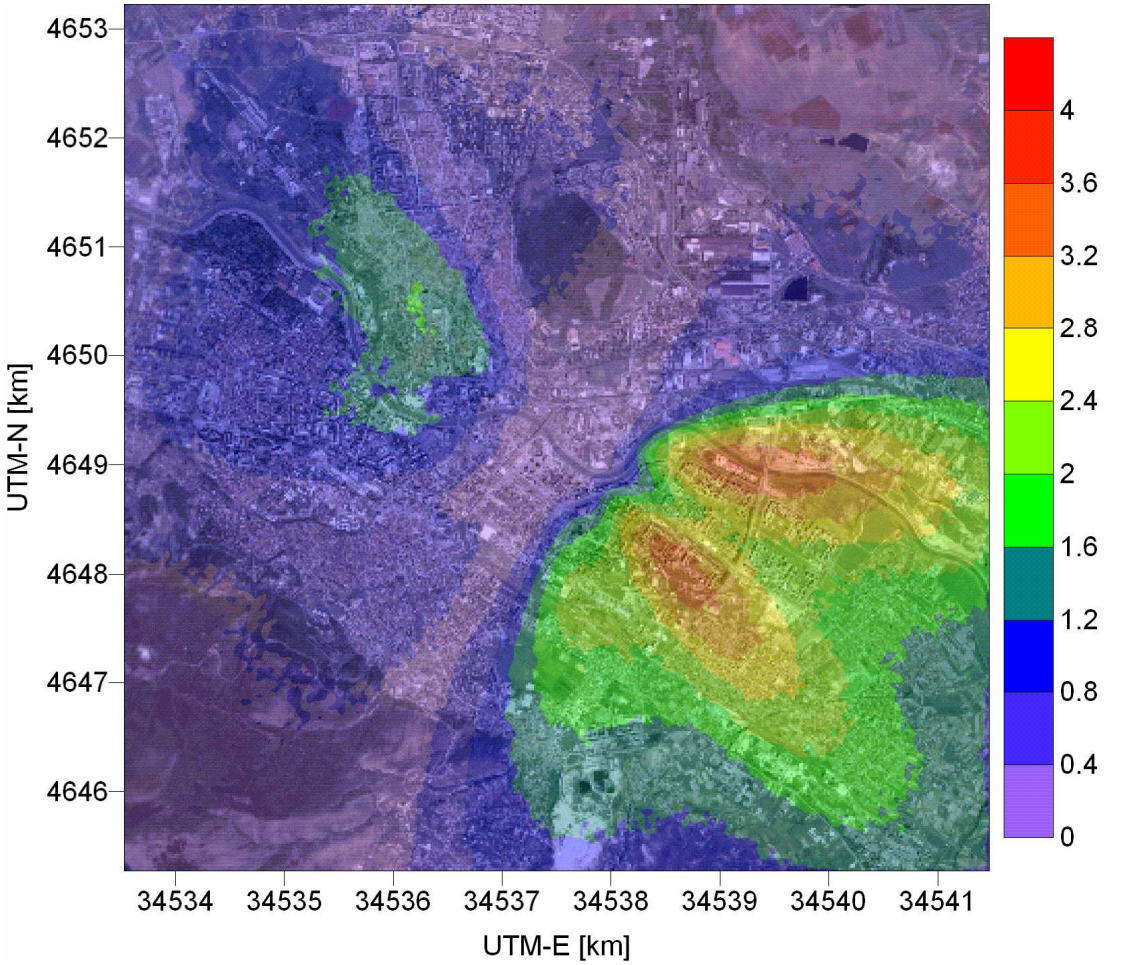


Figure A-5: Mean annual GLC of SO_2 [µg/m³] for the existing DHP

Despite the increased annual CO and NO_x emission flows (due to much higher operation time of CCPP compared to DHP) no substantial deterioration of average ambient air quality must be expected within the investigation area with the new CCPP. The estimated ground level concentration values for NO_2 and CO have the same order of magnitude though the annual emission mass flows for the CCPP are much higher. Reasons for that are the better stack exhaust conditions on the one hand and the fact, that the meteorological conditions during summer (CCPP operation over year) are much favourable for the dispersion on the other hand. The latter results in a low amount to the GLC's during summer compared to wintertime (DHP operation concentrated on winter). The Figure A- 6 illustrates the results for NOx as example.

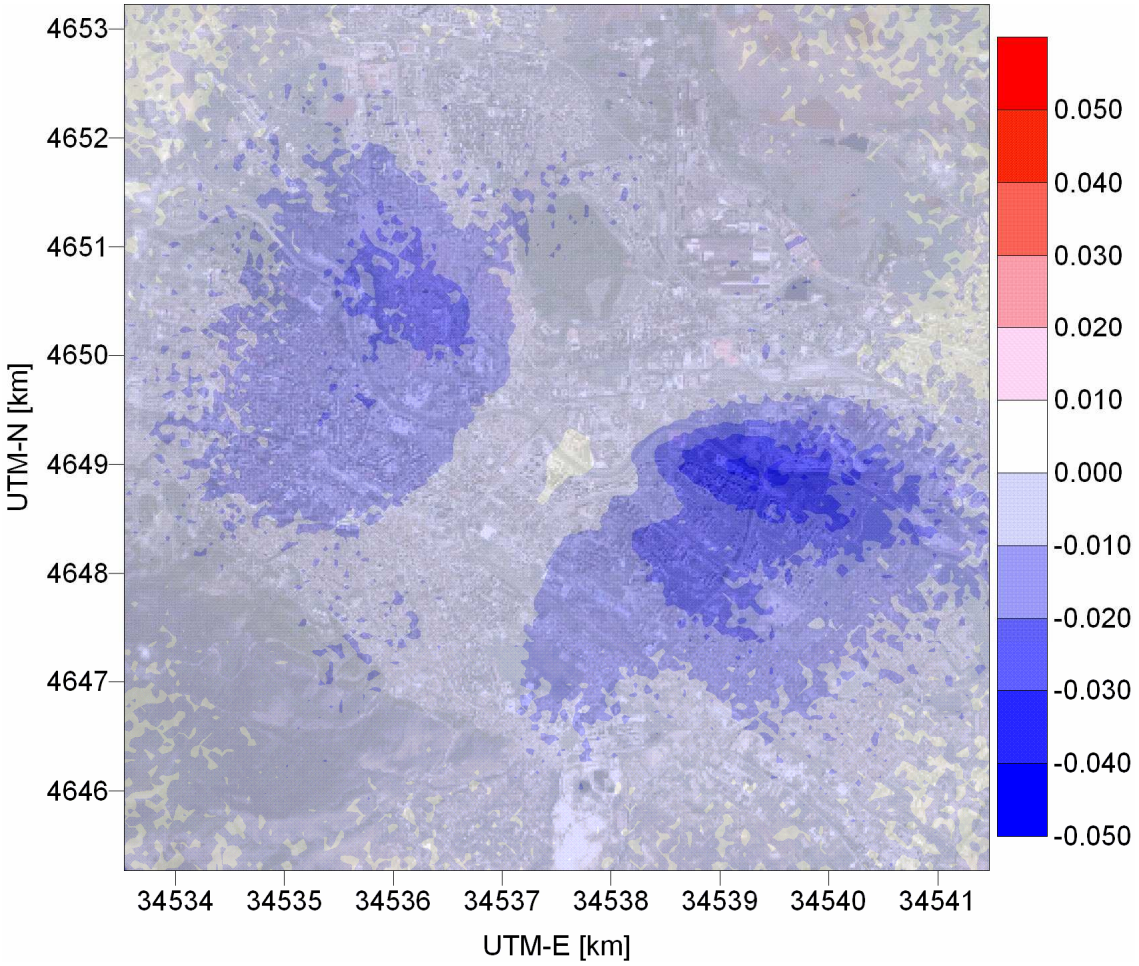


Figure A- 6: Differences of mean annual NO_2-GLC [µg/m³] between existing DHP and new CCPP Skopje

Also the other impacts caused by the new plant (e. g. noise, water, wastewater) are limited. In the Table A-9 all main environmental impacts during operation phase of CCPP Skopje, as well as their assessment and mitigation measures are briefly summarized.

No.	Impact	Possible Effects	Assessment / Mitigation Measures
1	Climate	Greenhouse effect	Minimising of specific CO_2 emissions by high plant efficiency and natural gas as fuel (392 kg/MWh_{el}).
2	Emissions	NO_x, CO and other pollutants	Limitation of NO_x emission by applying modern combustion technology (DLN). No SO_2 and dust emissions (gas as exclusive fuel)
3	Ambient air quality	Increasing of pollutant ground level concentration	Despite higher annual NOx and CO emission loads (due to longer operation time), the impact on ambient air will barely deteriorate

No.	Impact	Possible Effects	Assessment / Mitigation Measures
4	Noise	Plant surrounding	Applying noise protection measures in order to meet the required standard
5	Fresh water demand	Water availability	Fresh water demand will be supplied by wells drilled specially for the plant
6	Cooling water demand	Water availability	Limited demand because of combined cycle technology. About 70 % of power will be generated by gas turbines which do not need cooling water. Maximum demand for Skopje CCPP is about 90 m^3/h which will be supplied by the drilled wells
7	Wastewater discharge	River pollution	Applying of wastewater treatment in order to meet the required standards
8	Cooling water discharge	Temperature increase of river water. Effects on fish species	Limitation of cooling water temperature increase. Using of suitable discharge system for appropriate temperature distribution in Vardar River. Temperature increase at the edge of the mixing zone max. 0.6 °C. This temperature increase in a closed area will not affect the fish species.
9	Solid waste disposal	Pollution of rivers and near area	The solid waste will be disposed by an authorised local disposal company according to local regulations.
10	Socio-economic	Country and future development	The impact of the project on the local and Macedonian socio-economic development can be assessed as high

Table A-9: The Main Project Impacts and Mitigation Measures during Operation Phase

6 Analysis of Alternatives

Concerning the situation without the CCPP project and on alternative sites it can be concluded:

- The situation without the new CCPP Skopje cannot be considered as better from the environmental point of view.

- Also an alternative site for the new CCPP as heat and power plant is out of question and could not be identified.

Two alternative technologies for power generation from fossil fuels have been discussed and compared with the Skopje CCPP concept, particularly in connection to the environmental impact aspects:

- Generation of 223 MW by a fuel oil-fired conventional power plant (considering typical fuel oil)

- Generation of 223 MW by a lignite-fired conventional power plant (considering lignite as coal which is main fuel for Macedonian power generation).

The potential environmental impacts of these alternative technologies are higher than for the new CCPP plant concept, because of:

- Higher CO_2 emission

- Higher NOx emission

- Higher SO_2 emission

- Higher cooling water demand

- Additional consumables

- Additional residues to be treated and to be disposed

- Higher burden to transport ways due to transport of high amounts of fuel.

Considering all gained results, it can be assessed that the plant concept of Skopje CCPP is the most suitable technology selection for generation of 223 MW power in Skopje. This plant concept is based on modern combined cycle technology with high thermal efficiency and relatively low environmental impact. At the same time the CCPP as power and heat generation plant will replace the heat generation in the existing DHP and thus ensure further environmental improvement with respect to SO_2 and particulate emissions in winter.

The Figure A- 7 illustrates the specific emissions of the considered alternatives, clearly indicating CCPP as best solution from the environmental point of view.

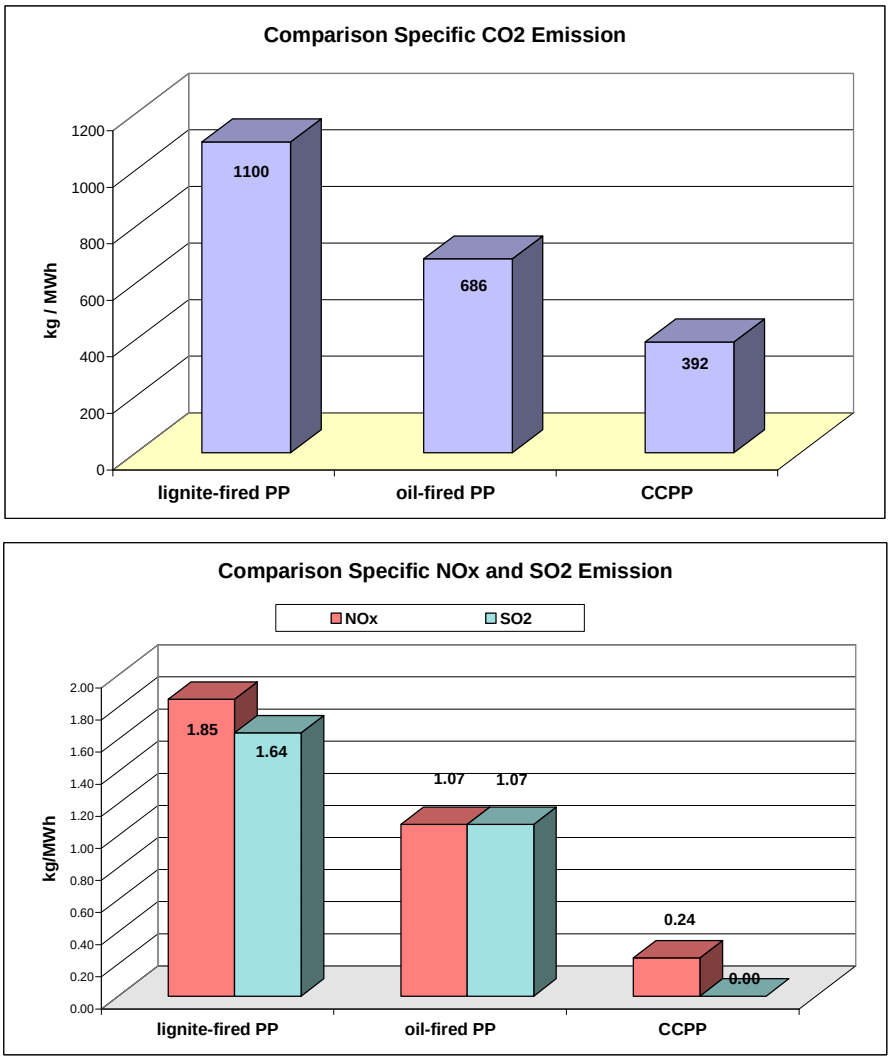


Figure A- 7: Specific Emission Data of Alternative Concepts

7 Environmental Management Plan

In order to properly assess environmental impacts of the CCPP Skopje as well as evaluate the effectiveness of mitigation measures applied for the abatement of environmental pollution, a program of monitoring and oversight of the project shall be implemented. This program comprises mitigation measures during construction and operation phases as well as appropriate monitoring activities during the operation of the CCPP Skopje.

The concept and design of the combined cycle co-generation power plant Skopje are characterised by high efficiency and using exclusively natural gas as fuel, accounting for relative low environmental impacts.

Figure A-8 shows a recommendation for the organisation of the environmental management and monitoring of the CCPP Skopje project.

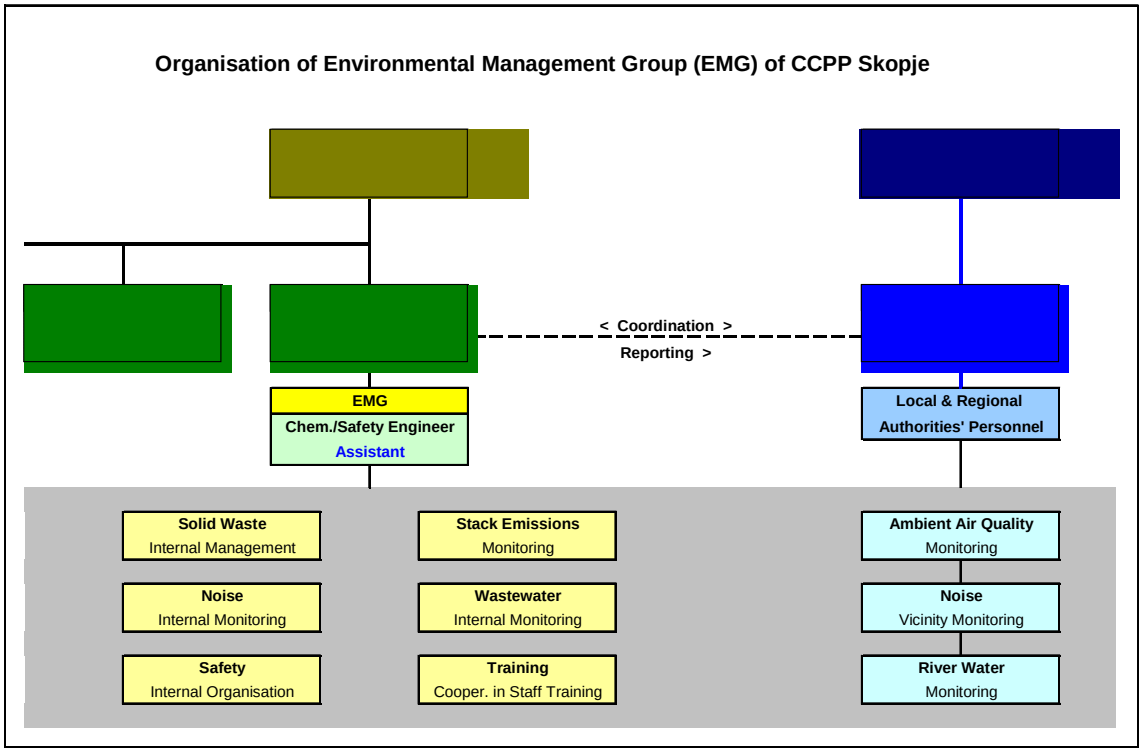


Figure A-8: Organisation of Environmental Management

The Management Board of the CCPP Skopje will be responsible for the internal environmental management and monitoring of the plant. For this purpose, the board shall nominate and appoint an Environmental Engineer as head of an **Environmental Management Group (EMG)**. He will report directly to the General Manager of the CCPP Plant Company. The environmental engineer as Head of the EMG shall be assisted by a chemical engineer or safety engineer as Assistant and Deputy Head of EMG.

The EMG shall be responsible for the execution of environmental related issues such as:

- Stack emission monitoring
- Internal waste management
- Wastewater monitoring
- Internal noise monitoring
- Labour safety
- Organisation and cooperation in staff training activities.

Other activities like the monitoring of the ambient air quality (using the existing 4 automatic stations) will remain within the responsibility of the regional and local authorities. The head of the environmental management group is also responsible for coordination of environmental measurements and monitoring with local and regional authorities and for the requested reporting to the authorities.

The organisation of the environmental management group of CCPP Skopje shall be set in place early in order to commence work during the construction phase.

8 Summarizing Conclusions

Considering all investigation results, the CCPP Skopje project can be assessed as follows:

- The project will play an important part to meet the growth in electricity demand in Skopje and Macedonia.
- Besides strengthening the power supply, it is expected that the project will stimulate industrial development
- The project will replace heat production of an old plant with mazout as main fuel with a modern, natural gas-fired combined cycle co-generation plant.
- Due to design, selected technology (combined cycle) and fuel (natural gas) the environmental impacts of the plant will be minimized to an acceptable level.
- The overall environmental impact of the plant can be assessed as slight and for implementation of such an important project, the impacts can be stated as acceptable.
- The project fulfils the relevant local and European Standards and Regulations. In particular, the pollutant emissions of the plant will be well below Macedonian and even WB and EU Standards.
- The project will create employment for many workers during the construction and operation phase, and numerous indirect jobs in the supporting local services and supply industry
- The benefits and positive impact of the project on the local and Macedonian socio-economical development can be assessed as relatively high.

In the Figure A-9, the environmental impacts of the combined cycle co-generation power plant Skopje are summarized, applying a scale from "negligible" to "strong".

Most of the impacts can be assessed as slight. The above impacts have been assessed for the new CCPP project (which practically will replace operation of the existing DHP).

If it is furthermore taken into consideration that the new plant will replace electricity production of lignite-fired or oil-fired power units elsewhere, thus the overall impacts would even be lower.

Summarized Environmental Impacts

Impact	favourable	negligible	slight	medium	strong	Remark
Impacts during Construction						**only temporary**
Land clearing						few illegally settled people to be resettled
Land used						no additional land needed; existing site
Air pollution						mainly dust
Water pollution						sanitary water
Noise						construction equipment & machines
Impacts during Operation						
CO2, climate						CCPP (CHP) concept with high efficiency and natural gas as exclusive fuel. So, comparable low specific emission. Local annual increase, but savings elsewhere.
NOx emission						< standard
CO emission						< standard
SO2 emission						no (savings at DHP)
Dust emission						no (savings at DHP)
Other emisssions into atmosphere						no (savings at DHP)
Impact on ambient air (GLC)						
Solid residues						correct disposal, acc. local standards
Wastewater						correct disposal, acc. local standards
Impact on water (thermal)						< standard
Impact on fish						no contribution to bad water quality of Varder River
Impact on flora & fauna						
Noise						

Figure A-9: Summary of Environmental Impacts of CCPP Project