Fiscal 2006 Project Consigned by the Ministry of Environment

Fiscal 2006 CDM/JI Project Study

Study into Utilization of Methane Gas at a Landfill Site in Skopje, Macedonia

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Summary

1. Background of the Project

The Study entailed implementation of a feasibility study on a project to conduct power generation and gas combustion using landfill gas (LFG) comprising mainly methane gas generated from Drisla Landfill Site in Skopje, the Former Yugoslav Republic of Macedonia, and to link this to realization of a CDM project in the future.

Skopje, the capital of Macedonia, has a population of approximately 470,000. Drisla Landfill Site, which is owned by the city, is located approximately 10 km south of the city center in a valley on the rim of a mountain range . The project will be implemented in the eastern area of Drisla Landfill Site. Since this landfill site is expected to operate into the future as a receiving site for solid urban waste from Skopje and it is necessary to retain landfill area for use from 2007 onwards, it is necessary to select either the east or west side. The idea of using the west side in the project was examined, however, since the quantity of landfilled waste is lower here, less CERs would be obtained and initial costs would be more expensive, so this was omitted from the project due to lower profitability than on the east side.

In the Study, a plan for introducing gas collection pipes, gas treatment equipment and gas engine power generating equipment, etc. to the project site of Drisla Landfill Site was compiled, and feasibility as a private sector project was assessed from the viewpoints of project effect and profitability, etc. In order to increase the feasibility of realization as a CDM project, the Study was conducted on the assumption that flare stack treatment is combined with a power generating system.

Since the project will contribute to prevention of global warming and improvement of the global environment, Skopje Municipal Government is very keen to see its realization. Moreover, since Macedonia has hardly any experience of technology utilizing renewable energy, the project technology will contribute to the sustainable development of Macedonia.

Macedonia ratified the Kyoto Protocol in 2004. Its DNA is the Ministry of Environment and Nature Planning and the approval procedures and scheme for CDM projects are already in place.

2. Contents of the Project Plan

The project proposes to install landfill gas (LFG) collection pipes at Drisla Landfill Site, and to collect and treat LFG before utilizing it for power generation in a gas engine generator (GEG). The generated power will be sold to the local grid. Meanwhile, LFG that cannot be used in the GEG will be combusted and destroyed via flare stacks.

Since the power generated by this system will enable power stations within the grid to reduce consumption of fossil fuels, the project can be expected to have an effect in terms of energy saving and reduction of greenhouse gas emissions. Moreover, concerning the LFG that cannot be used in the GEG, since methane will be converted to carbon dioxide as a result of combustion and destruction in the flare stack, the greenhouse gas reduction effect will be further boosted.

Figure 1 shows a schematic of the overall project system.

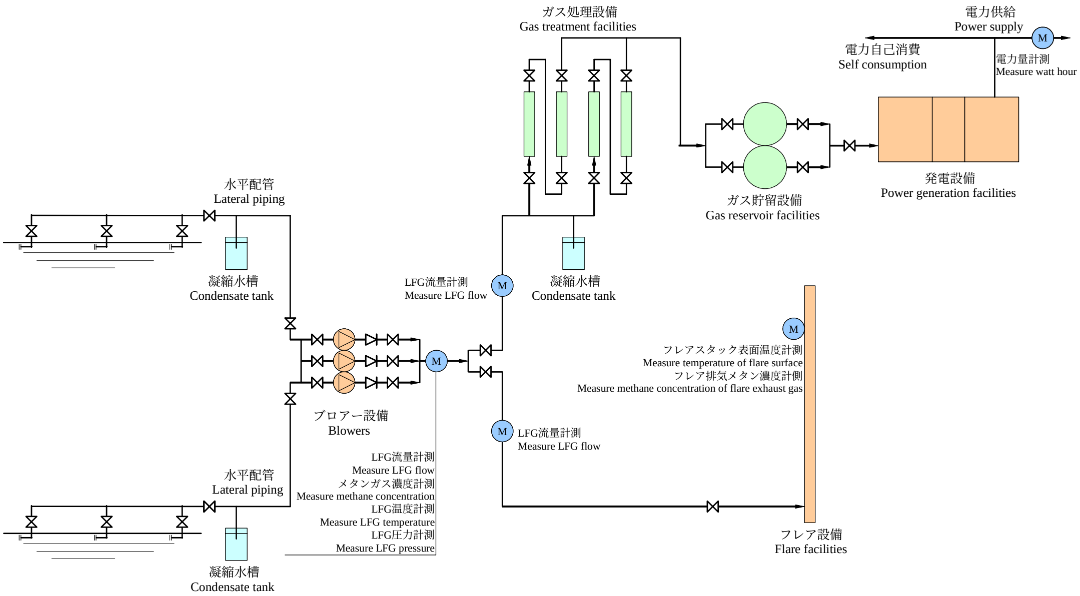

Figure 1 Schematic of the Overall System

As the method for calculating the generated amount of methane gas ($Q_{y,x}$) on the landfill site, the First Order Decay Model (corresponding to Equation 3 in the Guideline) from the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual CHAPTER 6 WASTE) is used in its advanced forms (Equation 4 & Equation 5 in the Guidelines). The 2006 IPCC Guidelines for Inventories have been disclosed, and these have been revised in order to forecast the generated amount of LFG more realistically and accurately. In the project, it is planned to directly measure the amount of greenhouse gas emission reductions based on the collected and used amount of LFG at the time of project implementation. Now, calculations only provide the forecast amount of emission reductions. Moreover, since the conventional calculation method gives more conservative calculation results, the conventional method shall be used. The formula is indicated below.

$$Q_{y,x}=k * R_x * L_0 * e^{-k(y-x)}$$

$Q_{y,x}$	The amount of methane gas (Nm3/y) currently generated (year y) base on the amount of solid waste carried in year x（R_x）
k	The methane generation rate (1/y)
R_x	The amount of solid waste carried in in year x（Mg/y）
y	The current year（y）
L_0	The methane generation potential (Nm^3/Mg, where Mg is the amount of solid waste)

Figure 2 shows the results of trial calculation of the generated and collected amounts of methane gas. Total generation indicates the generated amount of gas from the overall disposal site, while total collection refers to the collected amount of gas in the eastern area, which is the project site. Incidentally, the collected amount in 2008 is low because it is assumed that the collection system only operates for six months in that year.

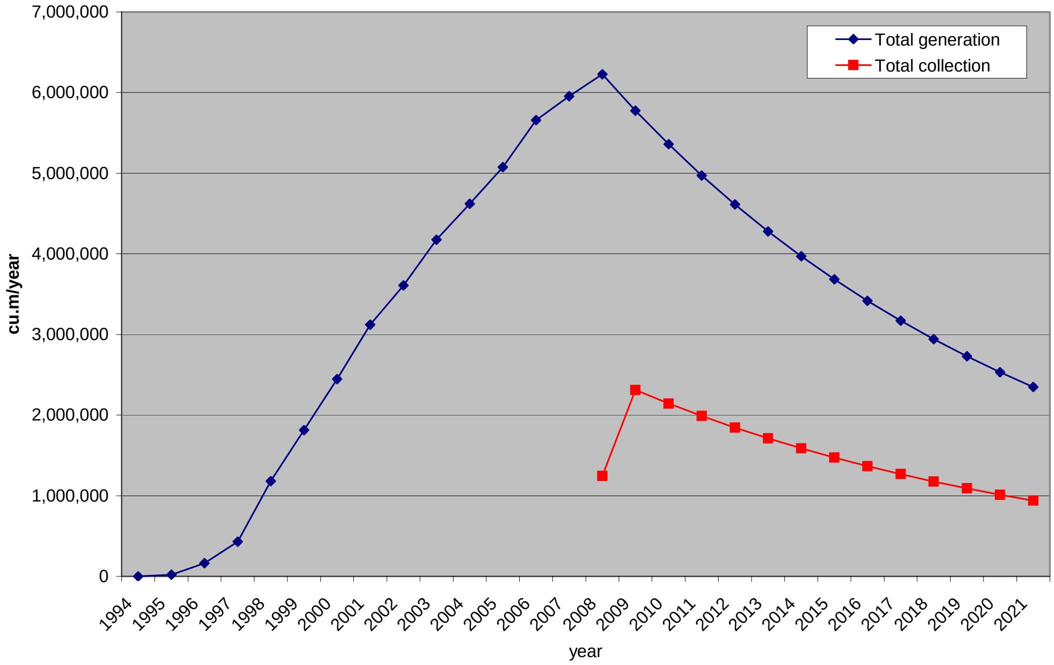

Figure 2 Results of Estimating the Generated and Collected Amounts of Methane Gas

It is expected to install a gas engine generator (GEG) with capacity of 500kW. Part of the electricity generated in the GEG will be used inside the plant for operating blowers, etc., while excess power will be sold to the power grid. Whenever the gas engine is stopped or when there is excess methane gas, all the gas will be destroyed in the flare stack. Figure 3 indicates the forecast amounts of methane gas used in the gas engine and the flare.

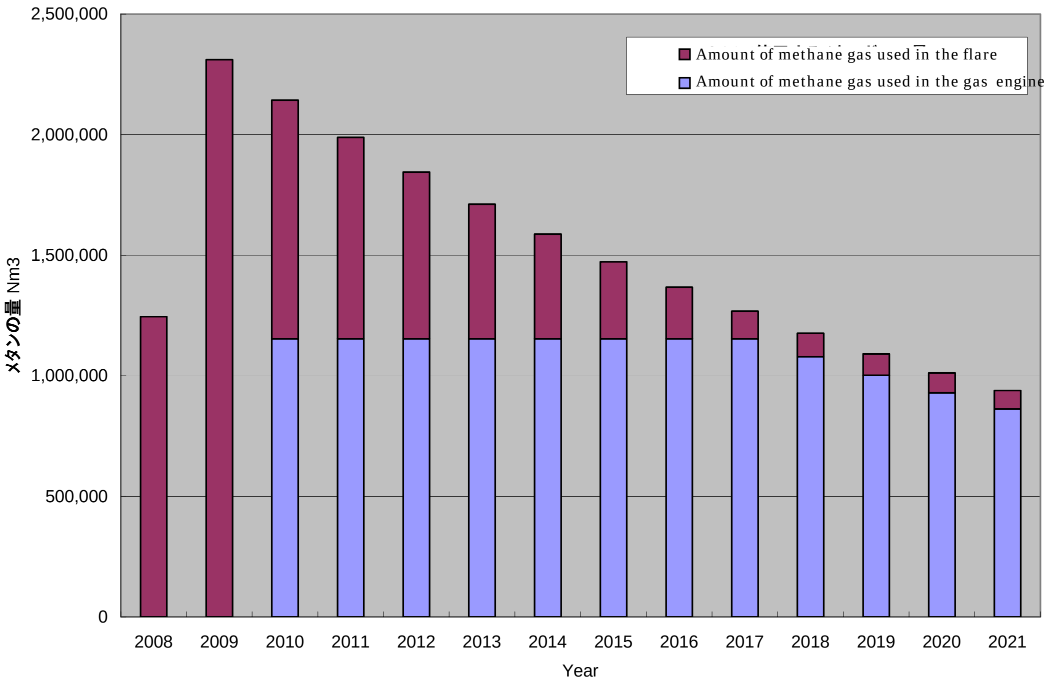

Figure 3 Purposes of Use of Recovered Methane Gas

3. Project Implementation Plan

The participants on the Japan side will conduct the initial project investment (ordering of construction works), while Skopje Municipal Government will be responsible for all other aspects of project operation (monitoring, operation and maintenance of instruments, accounting work, CER management, subcontracting, personnel affairs, reporting, etc.).

Although the project is rather small in scale, when considered from the viewpoint of CO2 credit acquisition, it may be better to adopt the pay-on-delivery approach for averting project risk. However, in order to resolve the shortage of funds in the initial stage, it will be necessary to initially pay an amount equivalent to the amount of carbon credits. Doing so will be extremely beneficial for the project funding plan. Moreover, in order to realize the project at an early point, it is better to implement it based on direct investment for the total necessary funds (without specifying the method of fund raising in particular).

Project profitability is greatly affected by the economic value of CERs. If CERs have no economic value, project profitability is low even before funds are raised and realization becomes near impossible. On the other hand, if it is assumed that CERs do have economic value, assuming that the project period is 14 years and price of CER is

US$15/t-CO2, the IRR (after tax) will be 6.28%, indicating that sufficient profits can be secured. Examination of profitability was also conducted assuming the case where the project os conducted on the west side of the landfill site, however, because the quantity of landfilled waste is lower here, it was found that profitability deteriorates due to there being less CERs and higher initial costs.

Table 1 shows the project implementation schedule. It is planned to advance procedures to register with the CDM Executive Board during the first half of fiscal 2007. Then it is scheduled to install the SPC and conduct detailed design in the second half of 2007, to start the construction works from January 2008, and to start the project from July 2008. The Project implementation period is scheduled for 14 years.

Table 1 Project Implementation Schedule

Work Item	2006	2007	2008	2009	2010	2011		2021
FS implementation								
PDD preparation		March						
DOE decision and validation		May - June						
Approval by both governments		July						
UN approval		Sept						
SPC establishment and start of detailed design		Sept						
Start of construction works			Jan					
Start of credit period			July		Credit period: 14 years			

4. Baseline Setting

"ACM0001/Version 5 Consolidated baseline methodology for landfill gas project activities" and "ACM0001/Version 5 Consolidated monitoring methodology for landfill gas project activities" have been selected for application to the project.

Meanwhile, the project is as described below.

① Currently, LFG collection is not carried out on the landfill site in Skopje and all LFG is released into the atmosphere. (Baseline)

② The project proposes to collect LFG on the existing landfill disposal site and to flare the captured gas.

③ The captured gas will be used to produce energy (electricity), and emission reductions will be claimed for displacing energy generation from other sources.

Therefore, since the project falls under applicability of (a) and (c) under ACM0001, this methodology can be applied.

Also, according to ACM0001, the Tool for Demonstration of Additionality is used to demonstrate the fact that the project is additional to the baseline, which is set as maintenance of the status quo.

Moreover, in ACM0001, since emission reductions in the case of project implementation are directly measured in the monitoring plan, there is no measurement of baseline emissions and project emissions. Accordingly, based on ACM0001, emission reductions are directly measured.

Table 2 shows the results of calculating the greenhouse gas emission reductions in the project.

Aggregate reductions over the credit period (2008~2021) are calculated as 334,862 t-CO_2.

Table 2 Results of Calculating Emissions and Emission Reductions

Year	Project Emissions	Baseline Emissions	Leakage	Emission Reductions
	t-CO_2e	t-CO_2e	t-CO_2e	t-CO_2e
2008	77,018	93,725	0	16,707
2009	55,804	86,952	0	31,149
2010	50,046	83,725	0	33,679
2011	46,315	77,896	0	31,581
2012	42,854	72,488	0	29,634
2013	39,620	67,013	0	27,393
2014	36,641	62,358	0	25,717
2015	33,880	58,078	0	24,199
2016	31,318	54,110	0	22,793
2017	28,927	50,165	0	21,237
2018	26,834	46,595	0	19,761
2019	24,904	43,228	0	18,324
2020	23,112	40,074	0	16,962
2021	21,451	37,178	0	15,728
Total	538,725	873,586	0	334,862

5. Monitoring Plan, etc.

Monitoring items in the project have been decided based on ACM0001. As for efficiency of the flare equipment, 0.9, which is the default value of closed flare equipment indicated in the methodology, is used.

Figure 4 shows the monitoring plan in schematic form.

※ ID numbers correspond to the monitoring items.

The sold amount of electric energy measured in this monitoring plan (ID9) is the amount obtained after subtracting electricity used in the system from the amount of electric energy generated in the GEG.

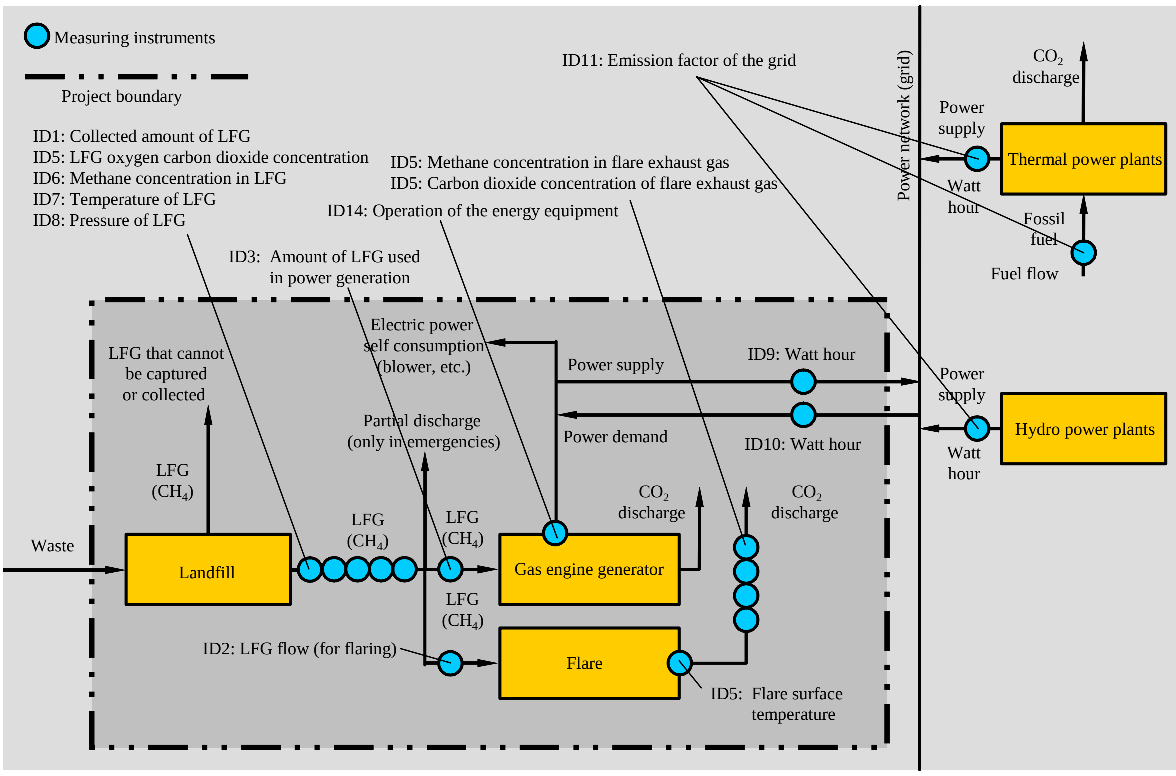

Figure 4 Monitoring Plan Schematic

6. Profitability

Project profitability is assessed according to the investment payback period (PBP) and the internal rate of return (IRR). The initial cost is approximately 3,833,000 US$ (3,073,000 US$ at the start of construction, plus 760,000 US$ after two years), the running cost is approximately 19,200 US$ per year for operation and 34,655 US$ per year for maintenance (from the third year onwards). In addition, a verification cost of 20,000 US$ per year is forecast.
As for taxation, corporate profit tax is 15% of ordinary profit.
Plant and equipment depreciation was calculated assuming a depreciation rate of 90%.
The power tariff was set at 5.0 US$cent/kWh based on the existing data. This is the price at which the power generator sells electric power to the power distribution company.
The exchange rate used in the calculations was, 1US$ = 116.00 yen.
Finally, concerning the project implementation schedule, assuming the project facilities commence operation from the second half of 2008, it is assumed the project credit period will be 14 years from 2008 to 2021.

Concerning the investment payback period, the number of years from the start of the project (start of construction) to the time when aggregate project balance enters the black was calculated for the case where CERs have no economic value and the four cases where the economic value of CERs is 5 US$/t-$CO_2$, 10 US$/t-CO_2, 15 US$/t-$CO_2$ and 20 US$/t-$CO_2$ respectively.

Table 3 Investment Payback Period in Each Case

Economic Value of CERs		Investment Payback Period
Case where CERs have no economic value	0 US$/t$CO_2$	Irrecoverable (Irrecoverable)
Cases where CERs have economic value	5 US$/t$CO_2$	Irrecoverable (Irrecoverable)
	10 US$/t$CO_2$	13 years (14 years)
	15 US$/t$CO_2$	9 years (9 years)
	20 US$/t$CO_2$	7 years (7 years)

※ Figures in parentheses indicate pretax values.

As for the internal rate of return (IRR), as is shown in Table 4, comparative examination was carried out for five different cases, i.e. the case where CERs have no economic value and the four cases where the economic value of CERs is 5 US$/t-$CO_2$, 10 US$/t-CO_2, 15 US$/t-$CO_2$ and 20 US$/t-$CO_2$ respectively. Since this assessment of project profitability based on IRR is sought as an indicator for determining the propriety of investment, the project IRR not taking into account interest and loan repayments was used.

The project IRR is negative in the case where CERs have no economic value and where the economic value of CERs is 5 US$/t-$CO_2$, however, since an IRR (after tax) of 6.28% can be expected when the economic value of CERs is 15 US$/t-CO2, the project is feasible as a business venture. When the country risk is taken into account, it may be difficult to secure funds through project finance, however, in that case i9t is scheduled to secure the full amount through direct investment.

Table 4 Internal Rate of Return (IRR) in Each Case

Economic Value of CERs		IRR
Case where CERs have no economic value	0 US$/t$CO_2$	Minus (Minus)
Cases where CERs have economic value	5 US$/t$CO_2$	Minus (Minus)
	10 US$/t$CO_2$	0.44 (0.88)
	15 US$/t$CO_2$	6.28 (6.66)
	20 US$/t$CO_2$	11.13 (11.81)

※ Figures in parentheses indicate pretax values.

As was mentioned earlier, the initial cost of the project is 3,833,000 US$. On the other hand, the total reduction in greenhouse gas emissions over the project credit period (2008-2021) is 334,862 t-CO_2.

The cost of reducing greenhouse gas emissions was calculated by dividing CO_2 emissions over the credit period (2008~2021) by the initial cost (converted to US$). Table 5 shows the results.

Table 5 CO_2 Reduction Cost

Item	Amount
GHG Emission Reduction (t- CO_2)	334,862
Cost (1000 US$)	3,833,000
CO_2 Reduction Cost (US$/t$CO_2$)	Approx. 11.4

7. Conclusion and Future Work

The F/S conducted examination of the project to collect LFG from the landfill disposal site in Skopje and use this to generate electricity in a gas engine, in order to reduce atmospheric emissions of methane and, using the generated power to replace electricity from grid power stations, to reduce CO_2 emissions at power stations.

The Government of Macedonia has already completed the CDM project approval scheme including the CDM project approval procedure, and there is a strong possibility that the project will be approved in the host country.

Skopje City Municipality, the project counterpart, welcomes implementation of this CDM project from the viewpoints of environmental improvement and acceptance of overseas investment, etc., and it gave immense cooperation in the course of the FS.

In the project plan, from the viewpoint of securing profitability, etc., it is envisaged that a gas engine generator of 500 kW (0.5 MW) will be installed and acquisition of carbon credits will be aimed for from the second half of 2008. As a result, it was concluded that the project can be sufficiently profitable so long as it is approved by the government as a CDM undertaking and the market price of carbon credits is 15 US$/t-$CO_2$ or higher.

However, the project also contains elements of risk such as uncertainty over the amount of incoming solid waste, the amount of generated LFG and setting of the project period, etc., and these risks will need to be carefully addressed when it comes to advancing the project.

The consolidated methodology can be applied to projects for the collection and utilization of methane gas from landfill sites, and since there are no elements beyond the control of the project participants such as the review and approval of new methodology, this is extremely advantageous from the viewpoint of certainly and quickly realizing the project in readiness for the initial commitment period from 2008.

Meanwhile, when it comes to forming LFG projects, unlike chlorofluorocarbon destruction and N_2O destruction projects, it is essential to conduct detailed examination in the survey stage because numerous factors such as the following have an impact:

- Weather conditions in the host country;
- Shape of the landfill site;
- Composition of solid waste depending on lifestyles; and
- Waste collection system

Based on detailed investigation of such elements, it is possible to gauge the effect and profitability of the project.

Moreover, interpretations of LFG projects differ according to the host country, and it is sometimes difficult to coordinate the opinions of central government agencies and local governments (counterparts) regarding project realization. As competition to acquire projects heats up between countries, this coordination of views is the most important theme in the project development stage. In this case, the host country is enthusiastic about realizing the project under Japanese support and it holds the FS in high regard.

In this study, as was mentioned in the project outline, since it is not possible to capture gas through ordinary vertical wells due to the topographical features of the site, i.e. poor groundwater level, this has an impact on the project profitability. This will be useful knowledge when it comes to screening the project based on topographical features. It is hoped to further examine this point with the Skopje Municipal Government and further enhance feasibility of the project in future.
Shimizu Corporation intends to work towards the prompt implementation of the project while keeping an eye on future political and economic trends in Macedonia.