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 Amman, Jordan

March, 2006

Shimizu Corporation

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 Ghabawi Landfill Site in Amman, the Hashemite Kingdom of Jordan, and to link this to realization of a CDM project in the future.

Amman, the capital of Jordan, has a population of approximately 1,200,000, which is almost one-quarter the total population of Jordan. It is the political and economic center of the country. Ghabawi Landfill Site, which is owned by the city, is located approximately 25 km east of the city center in the middle of a rocky desert. The project will be implemented in a part of Ghabawi Landfill Site referred to as “Cell 1.” The project target area is approximately 11 ha. Operation was started in 2003 and it is scheduled to carry in waste until 2007.

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 Ghabawi 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, Amman Municipal Government is very keen to see its

realization. Moreover, since Jordan has hardly any experience of technology utilizing renewable energy, the project technology will contribute to the sustainable development of Jordan.

Jordan joined the Kyoto Protocol in 2003. Its DNA is the Ministry of the Environment 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 Ghabawi 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.

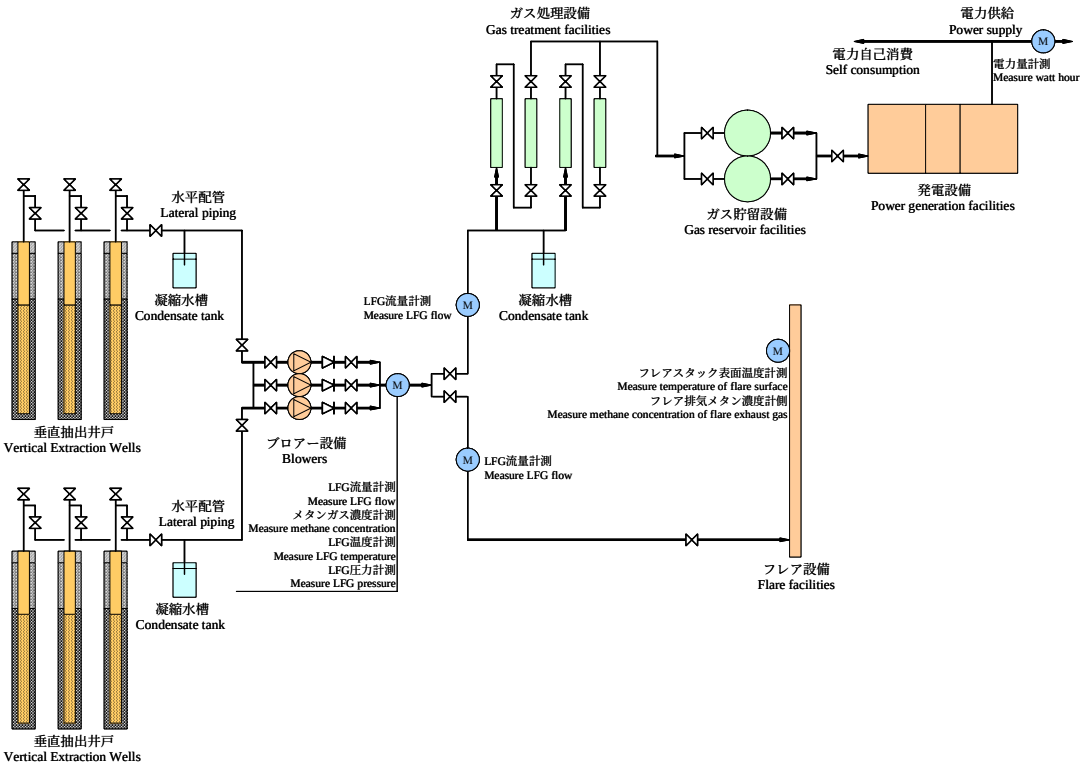

Figure 1 Schematic of the Overall System

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. Incidentally, the collected amount in 2008 is low because it is assumed that the collection system only operates for six months in that year.

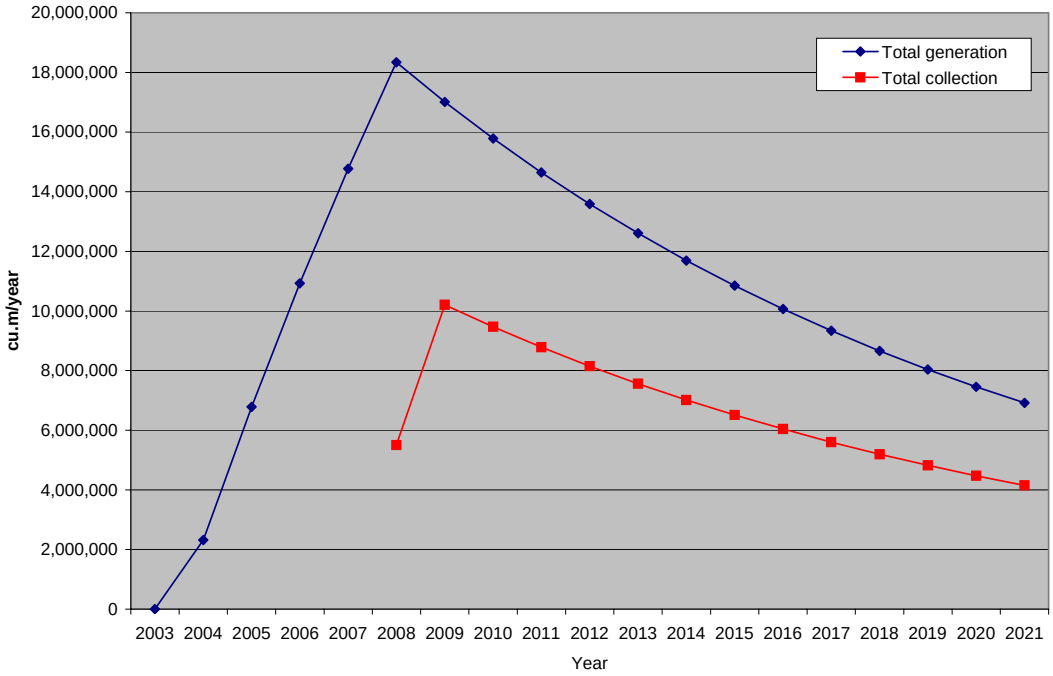

Figure 2 Results of Estimating the Generated and Collected Amounts of Methane Gas

It is expected to install a gas engine generator (GEG) with capacity of 1,800kW. 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.

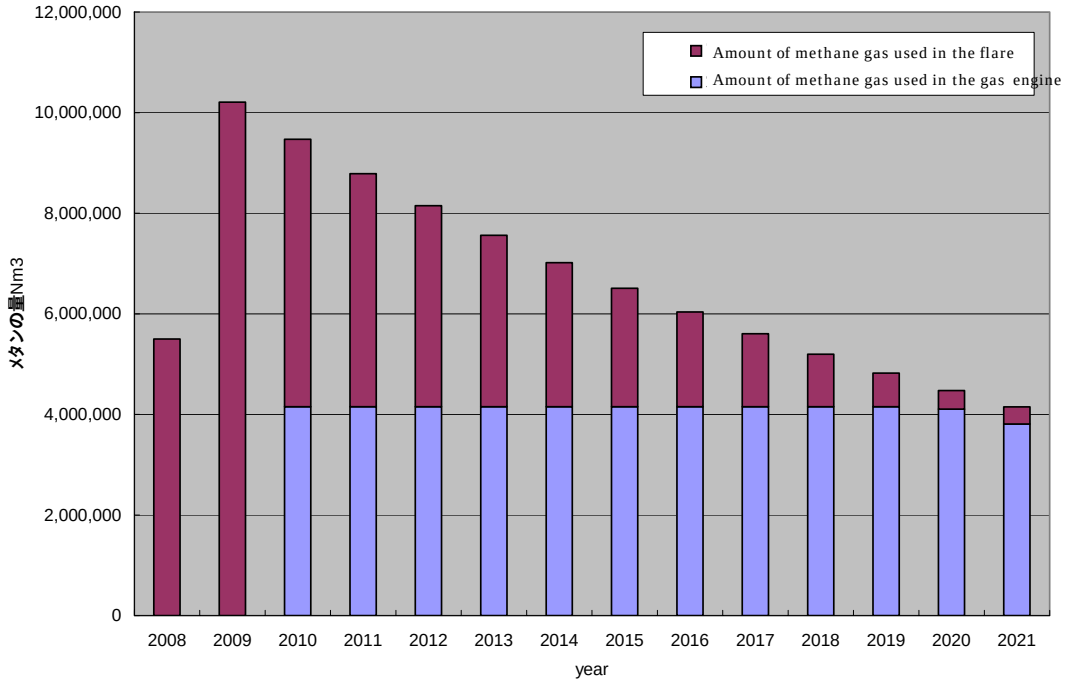

Figure 3 Purposes of Use of Recovered Methane Gas

3. Project Implementation Plan

The participants on the Japan side will conduct the initial project investment (ordering of construction works), while Amman 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.).

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$8/t-CO2, the IRR (after tax) will be 11.15%, indicating that sufficient profits can be

secured. Advertisement for Japanese participants other than Shimizu Corporation will take place from now, but it is thought that numerous corporations will be willing to invest in such a project.

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 Amman 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 1,460,439 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	201,521	276,057	0	74,535
2009	117,811	256,110	0	138,299
2010	103,045	247,633	0	144,589
2011	95,147	230,465	0	135,318
2012	87,820	214,537	0	126,717
2013	81,023	199,760	0	118,737
2014	74,717	186,051	0	111,334
2015	68,866	173,332	0	104,466
2016	63,438	161,532	0	98,094
2017	58,403	150,585	0	92,183
2018	53,731	140,429	0	86,698
2019	49,397	131,007	0	81,610
2020	45,448	122,149	0	76,701
2021	42,164	113,323	0	71,159
Total	1,142,530	2,602,969	0	1,460,439

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.

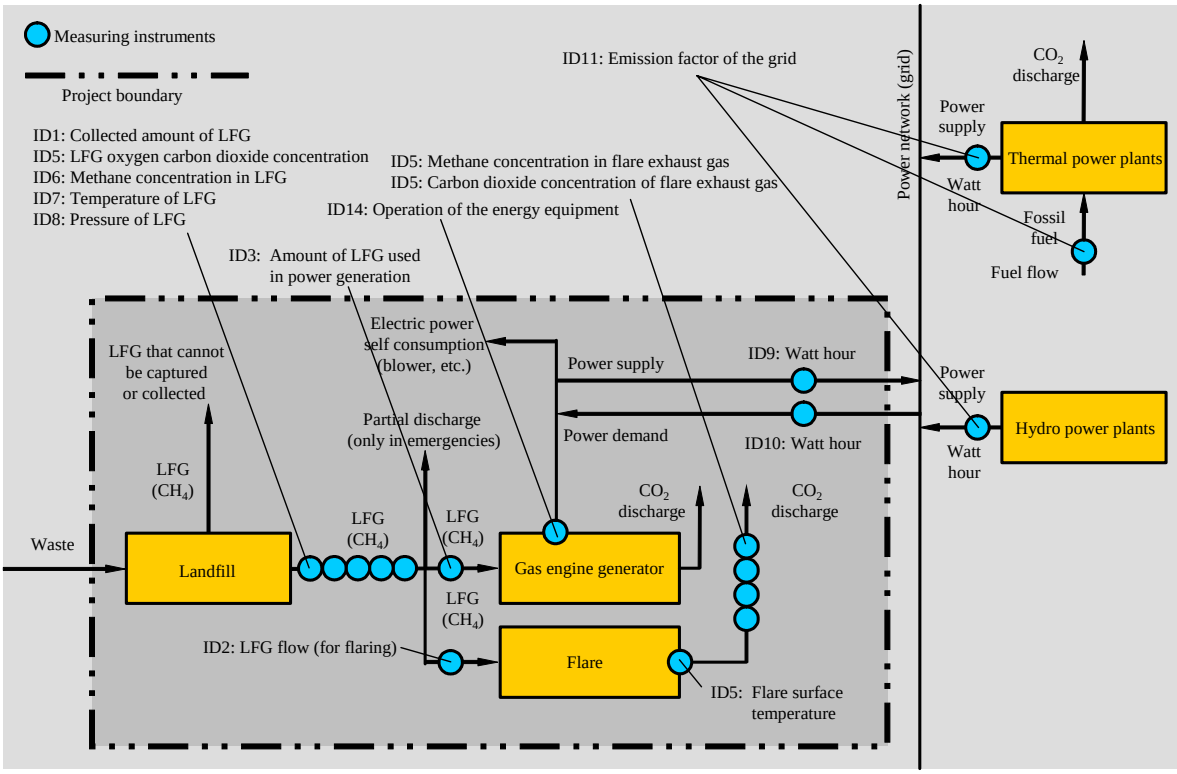

Figure 4 Monitoring Plan Schematic

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 7,226,000 US$ (5,117,000 JD), and the running cost is approximately 297,000 US$ (210,000 JD) per year.

As for taxation, corporate profit tax is taken into account. According to Jordanian law, this is set at 25% of ordinary profit.

Plant and equipment depreciation was calculated assuming a depreciation rate of 90%.

Since the system will be connected to the grid operated by JEPCO (Jordan Electric Power Co.), the power tariff was set at the JEPCO purchase price of 4.370 US$cent/kWh (0.0309 JD/kWh).

The exchange rate used in the calculations was, 1US$ = 0.78 JD, 1US$ = 122.55 yen.
Finally, concerning the project implementation schedule, assuming the project facilities commence operation from July 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 2 US$/t-$CO_2$, 4 US$/t-CO_2, 8 US$/t-$CO_2$ and 12 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)
Cases where CERs have economic value	2 US$/t$CO_2$	(Irrecoverable)
	4 US$/t$CO_2$	(Irrecoverable)
	8 US$/t$CO_2$	9 years
	12 US$/t$CO_2$	6 years

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 2 US$/t-$CO_2$, 4 US$/t-CO_2, 8 US$/t-$CO_2$ and 12 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, however, since an IRR (after tax) of 11.15% can be expected when the economic value of CERs is 8 US$/t-CO2, the project is an attractive proposition for 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
Cases where CERs have economic value	2 US$/t$CO_2$	0.09
	4 US$/t$CO_2$	4.31
	8 US$/t$CO_2$	11.15
	12 US$/t$CO_2$	17.11

As was mentioned earlier, the initial cost of the project is approximately 7,226,000 US$. On the other hand, the total reduction in greenhouse gas emissions over the project credit period (2008-2021) is 1,460,439 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）	1,460,439
Cost（1000 US$）	7,226
CO_2 Reduction Cost（US$/t$CO_2$）	Approx.4.9

7. Conclusion and Future Work

The F/S conducted examination of the project to collect LFG from the landfill disposal site in Amman 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 CO2 emissions at power stations.

The Government of Jordan 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.

Amman 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 1,800 kW (1.8 MW) will be installed and acquisition of carbon credits will be aimed for from 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 8 US$/t-CO2 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 N2O 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.

Through this study, it was possible to examine a landfill gas recovery project in the Middle East for the first time. As a result, characteristics of landfill methods and conditions of LFG generation in arid areas could be gauged. Also, it was possible to understand trends and advertise policies of the Government of Japan in the Middle East, where projects have so far been absent. Nearby countries have already expressed an interest in the activity. The Middle East has so far adopted a positive attitude towards reducing emissions of greenhouse gases, and some countries are starting to show an interest from the viewpoint of attracting overseas investment. It will be necessary to immediately actualize the project in order to solidify Japan's record in the region, and moreover, to continue developing projects and linking these to realizing the objectives of Japan.
Shimizu Corporation intends to work towards the prompt implementation of the project while keeping an eye on future political and economic trends in Jordan.