Japanese ODA Loan

Ex-Ante Evaluation (for Japanese ODA Loan)

1. Name of the project

Country: The Republic of Kenya

Project: Olkaria V Geothermal Power Development Project

Loan Agreement: March 9, 2016

Loan Amount: 45,690 million yen

Borrower: The Government of the Republic of Kenya

2. Background and Necessity of the Project

(1) Current State and Issues of the Power Sector in Kenya

The installed power generation capacity of Kenya is 2,195MW, of which hydropower is responsible for approximately 37% (821MW), fossil fuel-fired thermal power for approximately 33% (729MW), geothermal power for approximately 27% (598MW), and other renewable energy for approximately 3% (72MW) (as of 2015). The Greater Olkaria Geothermal Area produces around 90% (540MW) of the total geothermal electricity, of which Kenya Electricity Generating Company Limited (KenGen) accounts for about 80% (430MW) and independent power producers (IPPs) for about 20% (110MW) (as of 2015). Although the peak power demand is 1,512MW as of 2015, the electricity supply is unstable as approximately 37% of the electricity comes from hydropower, which is susceptible to frequent droughts. Moreover, the import of fossil fuels for thermal power plants has become one of the causes for the current account deficit of Kenya.

In order to meet the future growing power demand and promote the stable supply of electricity, it is urgent for Kenya to develop new power plants. In particular, geothermal development has become an increasing priority, not only because it is a reliable energy source unaffected by weather but also because Kenya is located in the East African Great Rift Valley, which has a huge geothermal potential.

(2) Development Policies for the Power Sector in Kenya and the Priority of the Project

The Least Cost Power Development Plan 2011-2031 (LCPDP), a long-term plan formulated by the Government of Kenya in 2013, estimates that the peak power demand will soar from 1,512MW to 7,254-12,423MW during the 15 years between 2015 and 2030, driven by the economic growth and the population expansion (increasing at an annual growth rate of 2.64%). On the other hand, the installed power generation capacity is 2,195MW as of 2015. Moreover, the power supply is unreliable as around 37% of the electricity is produced by hydropower, which is susceptible to droughts and other weather influences. These factors have posed a need to expand the capacity of reliable base-load power plants. In this context, the Government of Kenya has adopted the LCPDP, which aims to increase the installed geothermal power capacity to 5,530MW by 2030 (from 598MW in 2015) by taking

an advantage of the country's huge geothermal potential. Moreover, in 2014, the Government of Kenya formulated two electricity development plans consisting of ongoing and feasible power plant projects: the Medium Term Plan (MTP) for 2014 to 2018 and the Ten-Year Power Sector Expansion Plan 2014-2024. Both plans give the highest priority to geothermal energy development as it can expand base-load power generation capacity using domestically produced renewable energy. The Olkaria V geothermal power plant, which is to be developed through this Project, is also included in the above three plans as a project committed to by the Government of Kenya.

(3) Japan and JICA's Policy and Operations in the Power Sector

Japan's Country Assistance Policy for the Republic of Kenya (2012) identifies the Development of Economic Infrastructure as a priority area, under which Program on Power Generation and Transmission Improvement has been launched to provide support for the construction of power plants and transmission lines within the country as well as the development of international transmission networks for the purpose of promoting the stable supply of electricity for economic growth. Meanwhile, the Fifth Tokyo International Conference on African Development (TICAD V) adopted the Yokohama Action Plan 2013-2017, which aims to promote investment in renewable energy including geothermal power under the Pillar IV: Promoting Sustainable and Resilient Growth. Thus, the Action Plan provides a basis for the implementation of this Project.

JICA has continued to support the expansion of power generation capacity in Kenya. The ODA Loan Projects for this purpose includes the Mombasa Diesel Generating Power Plant Project (operations commenced in December 1999), the Sondu／Miriu Hydropower Project I & II (operations commenced in February 2008), and the Sondu-Miriu Hydropower Project Sang'oro Power Plant (operations commenced in July 2012). Moreover, JICA is currently implementing the Olkaria-Lessos-Kisumu Transmission Lines Project (L/A signed in December 2010) and the Olkaria I Unit 4 and 5 Geothermal Power Project (operations commenced in February 2015).

JICA is also implementing Technical Cooperation Projects for the geothermal power sector: the Project for Capacity Strengthening for Geothermal Development (from September 2013 to September 2017), which aims to assist Geothermal Development Company Ltd. (GDC) with their capacity building to reduce the technical risk of failing to locate geothermal energy sources and ensure sufficient steam supply; and the Project for Reviewing GDC's Geothermal Development Strategy (from February 2014 to March 2016), which aims to update the geothermal development plan in Kenya. Furthermore, JICA has extended technical support to other power sectors. The Project for Establishment of Rural Electrification Model

Using Renewable Energy (from August 2011 to January 2017) is being carried out to establish a rural electrification model using renewable energy sources and promote the electrification of public facilities and other social amenities in non-electrified areas. Going forward, JICA is planning to further strengthen its support for stable power supply in Kenya and neighboring countries, focusing on the construction of new power plants, especially those using renewable energy sources, and the development of national and international power transmission networks.

(4) Other Donors' Activity

In the Greater Olkaria Geothermal Area, where this Project is located, the World Bank, the European Investment Bank (EIB), the Development Bank of Germany (Kreditanstalt für Wiederaufbau; KfW), and the French Development Agency (Agence Française de Développement; AFD) are providing support to the Olkaria IV geothermal power plant[1].

(5) Necessity of the Project

According to the LCPDP, the peak power demand is estimated to surge from 1,120MW to 7,254-12,423MW during the two decades between 2010 and 2030 in Kenya, driven by the economic growth and the population expansion (increasing at an annual growth rate of 2.64%). On the other hand, the installed power generation capacity was 2,195MW in 2015. Thus, Kenya is facing an increasingly serious shortage of electricity. This has posed an urgent need to ensure stable power supply to support economic activities and make economic growth sustainable. This Project is in line with the development issues and policies of the Government of Kenya as well as the assistance policies of the Government of Japan and JICA. Not only is this Project expected to expand electricity supply to meet the growing demand, but the renewable energy power plant developed through this Project can also reduce CO_2 emissions and other air pollutants, compared to a thermal power plant of the same capacity. Therefore, it is highly necessary for JICA to implement this Project.

3. Project Description

(1) Project Objective

The project is to assist in increasing and stabilizing the power supply in the country by constructing a geothermal power plant with an output of 140 megawatts at the Greater Olkaria Geothermal Area in Nakuru County, located in central Kenya, thereby contributing to a better investment environment and economic development

[1] It is a power plant with a capacity of 140MW (consisting of two units, each with a capacity of 70MW). The plant was handed over from the contractor to KenGen in September 2014.

of the country.

(2) Project Site/Target Area

The Greater Olkaria Geothermal Area in Nakuru County (approximately 120 km northwest from Nairobi)

(3) Project Components

1) Construction of a geothermal power plant (two units with an output of 70 MW each)
2) Construction of a set of steamfields
3) Construction of switching station, power transmission lines (approximately five kilometers in length) and related facilities

(4) Project Cost

75,824 million yen (Loan Amount: 45,690 million yen)

(5) Project Implementation Schedule

March 2016 to December 2019 (46 months in total); the project is completed with the completion of guarantee period (at the end of December 2019).

(6) Project Implementation Structure

1) Borrower: The Government of the Republic of Kenya
2) Executing Agency: Kenya Electricity Generating Company Limited (KenGen)
3) Operation and Maintenance System: KenGen's Department of Geothermal Operations will be responsible for operations and maintenance. KenGen takes charge of the operations and maintenance of 10 geothermal power plant units (with a total capacity of 430MW) in the Greater Olkaria Geothermal Area, including Olkaria I Units 4 and 5 developed through the preceding project. Moreover, KenGen maintains a healthy financial position as its electricity sales generate sufficient revenues to cover the operation and maintenance costs. Therefore, KenGen is assumed to be capable of operating and maintaining the facilities of this Project.

(7) Environmental and Social Considerations/Poverty Reduction/Social Development

1) Environmental and Social Considerations
   (i) Category: A
   (ii) Reason for Categorization: This project falls into the geothermal power sector category under the JICA Guidelines for Environmental and Social Considerations (April 2010).
   (iii) Environmental Permit: The Environmental and Social Impact Assessment (ESIA) report for this Project was approved by the National Environment Management Authority of Kenya (NEMA) in September 2014.
   (iv) Anti-Pollution Measures: Although hydrogen sulfide (H_2S) will be emitted during construction and after the commencement of operations, the air quality is likely to meet the standards of the WHO Air Quality Guidelines, which the Government of Kenya applies to this Project. The noise levels during

construction and after the commencement of operations can also be kept below the standards of the noise pollution guidelines of Kenya by taking mitigation measures such as installing noise barriers. The general and industrial waste generated during construction and after the commencement of operations can be properly disposed of by contracting with a waste management company licensed by the National Environment Management Authority (NEMA) as specified by law.

(v) Natural Environment: Although the project site adjoins in the north to the Hell's Gate National Park under the management of the Kenya Wildlife Service (KWS), this Project is likely to have minimal adverse impact on the natural environment and landscape in and around the National Park since the Project is designed in accordance with the ecosystem management plan of the National Park to install pipelines in a way that takes the ecosystem into consideration, equip transmission lines with devices to prevent bird strikes, and take measures to recover vegetation.

(vi) Social Environment: Although this Project will not involve land acquisition or involuntary resettlement, another project [2] to construct the Olkaria IV geothermal power plant entailed land acquisition and involuntary resettlement of 52 households in the area of this Project. These processes were completed in September 2014, and alternative houses, schools and other public facilities, and infrastructure for water and electricity supply were constructed in the resettlement site. The procedures for the land acquisition and resettlement in the area of this Project were carried out in accordance with the laws and regulations of Kenya and the resettlement action plan formulated under the Olkaria IV Project. It has been confirmed that there are no significant differences between these procedures and the JICA Guidelines for Environmental and Social Considerations. Moreover, no special objection was raised against this Project at the stakeholder meeting held when the ESIA was adopted.

(vii) Other/Monitoring: The lives and livelihoods of people affected by the Olkaria IV Project are to be monitored by KenGen before and during construction. The air quality, noise level, and waste management will be monitored by KenGen and the contractor during construction and by KenGen after the commencement of operations. The animals and plants in the adjoining national park will be monitored by KenGen and the KWS during construction and after the commencement of operations.

2) Promotion of Poverty Reduction: None in particular.

[2] It is a project funded by the World Bank. The construction was completed in December 2014. In light of the hydrogen sulfide and noise generated by the project, a total of 5,910 acres of land was acquired, and 150 households were resettled from four villages in the Greater Olkaria Geothermal Area. One of the four villages was located within the area of this Project.

3) Promotion of Social Development

- Gender Perspective: Out of the project scope.
- Measures to Prevent Infectious Diseases Including AIDS: None in particular.
- Participatory Development: None in particular.
- Consideration for Handicapped, etc.: None in particular.

(8) Collaboration with Other Donors:

Fifteen percent of the costs of drilling geothermal production and injection wells required for this Project will be borne by KenGen, and the remaining 85% will be financed by the Export-Import Bank of China. KenGen is also responsible for coordinating the construction of the production and injection wells with this Project.

4. Targeted Outcomes

(1) Quantitative Effects

Indicators/items		Monitoring entity	Method and frequency
Maximum output (MW)		KenGen	Maximum output is surveyed in two years after the project completion
Plant load factor (%)		KenGen	Plant load factor is surveyed in two years after the project completion
Availability factor (%)		KenGen	Availability factor is surveyed in two years after the project completion
Auxiliary power ratio (%)		KenGen	Auxiliary power ratio is surveyed in two years after the project completion
Outage hours by cause (hours/year)	Human error	KenGen	Plant load factor and availability factor are surveyed in two years after the project completion
	Machine failure	KenGen	
	Planned outage	KenGen	

(2) Qualitative Effects

- Improvement of people's lives, development of regional economies, improvement of the investment climate, reduction of environmental loads by

increasing and stabilizing electricity supply

- Reduction of CO_2 emissions and other air pollutants by using renewable energy

(3) Internal Rate of Return

Based on the conditions below, the economic internal rate of return (EIRR) of the project is 10.53% and the financial internal rate of return (FIRR) is 6.23%.

【EIRR】

- Cost: Project cost, operation and management cost
- Benefit: Cost difference between this Project and the construction of a coal-fired thermal power plant of the same capacity; and operation and maintenance cost reduction
- Project life: 25 years of benefit after the commencement of operation

【FIRR】

- Cost: Project cost, operation and management cost
- Benefit: Revenue from the electricity sales
- Project life: 25 years of benefit after the commencement of operation

5. External Risk Factors and Control

None in particular

6. Lessons Learned from Past Projects

(1) Findings of Similar Projects

The results of ex-post evaluation of similar projects (e.g. Tiwi Geothermal Power Plant Complex Rehabilitation Project and Northern Negros Geothermal Project, both implemented in the Republic of the Philippines) indicated that some geothermal development projects had not achieved the expected outcomes because they could not produce sufficient steam to generate the expected amount of electricity. This was attributed to the inadequate analysis of geothermal reservoirs and the inappropriate maintenance after the commencement of power plant operations.

(2) Lessons Learned to the Project

This Project is also exposed to the risk of failing to produce sufficient steam. Therefore, in light of the above lesson learned, the preliminary study reviewed the results of the Feasibility Study for Development of KenGen's Geothermal Concession Area in Olkaria Beyond 430MW (September 2012; conducted by KenGen) to examine the feasibility and sustainability of the development plan from the viewpoint of whether sufficient steam can be obtained or not. In this Project, the steam production and injection capacity is likely to be sufficient to generate 140MW

of power for the next three decades.

7. Plans for Future Evaluation

(1) Indicators for Future Evaluation: Maximum output (MW), Plant load factor (%), Availability factor (%), Auxiliary power ratio (%), Outage hours by cause (hours/year), EIRR and FIRR.

(2) Timing: Two years after the project completion.