Republic of Indonesia

FY2016 Ex-Post Evaluation of Japanese ODA Loan Project

"Ulubelu Geothermal Power Plant Project"

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0. Summary

This project constructed geothermal power generation plants in Ulubelu, Tanggamus Regency, Lampung Province with the aim of alleviating the tight power supply-demand balance and improving the stability of power supply of the Southern-Sumatra System[1] in Sumatra Island. The objective of the project which addresses the tight power supply-demand condition by supplying power through renewable energy is well consistent with electric power policy and development needs of Indonesia, as well as with the Japan's ODA policy in the sense that geothermal development – a stable and renewable energy –is promoted. Therefore, the relevance of the project is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Operation and Effect Indicators set at the time of appraisal have largely achieved the target figures. The project is located in Lampung Province where reserve margin is the lowest in Southern-Sumatra System and is playing an important role to reduce power loss and to maintain quality of power supply in this area. In addition, as a result of field interviews, it can be judged that the project has been contributing to the activation of economy and improvement of investment environment in Lampung area. Therefore, the project has largely generated its planned effects; thus, its effectiveness and impact are high. No negative impact on natural environment and land acquisition has taken place. Moreover, creation of local employment by the project and contribution to the community activities of local residents through CSR initiatives were confirmed. No major problem has been observed in the institutional, technical and financial aspects of the operation and maintenance system as well as in the current status. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be highly satisfactory.

[1] It consists of three subsystems: Lampung Subsystem (Lampung Province), South Sumatra Subsystem (South Sumatra Province) and Bengkulu Subsystem (Bengkulu Province).

1. Project Description

Project Location

Ulubelu Geothermal Power Plant

1.1. Background

Development of new power sources was an urgent issue in the face of growing power demand in south area of Sumatra Island in Indonesia. Especially, peak demand in Lampung Province where the project is located was expected to increase at an average rate of 7% per year from about 300 MW in 2003 to about 450 MW in 2009 with the growing population and economy of the area[2]. However, reliability of power supply from the existing generating facilities was low and power supply-demand balance was extremely tight. Although development of power sources had been carried out, increase of demand exceeded the supply from the development and reserve margin was declining. Therefore, it was necessary to increase power supply and to improve its stability in the area. The project aimed to ease the power supply-demand tightness and to secure stability of power supply, by constructing geothermal power generation plants and related facilities in Lampung Province in south area of Sumatra Island.

1.2 Project Outline

The objective of this project is to alleviate the tight power supply-demand balance and to improve the stability of power supply of the Southern-Sumatra System[3] by constructing geothermal power plants (55MW x 2 units) connecting Lampung Subsystem in Southern

[2] Source: information provided by JICA.

[3] "South Sumatra System" referred in the project outline at the time of appraisal covers Lampung Province, South Sumatra Province, Bengkulu Province, Jambi Province, West Sumatra Province and Riau Province. Although Lampung Province where the project is located is covered by South Sumatra System, its range is too wide. For this reason, at the time of ex-post evaluation, discussion was conducted and agreement was made with the executing agency that "Southern-Sumatra System" which covers Lampung Province, South Sumatra Province, and Bengkulu Province would be taken up in the project outline.

Sumatra, thereby contributing to the economic development of the region through improving investment climate etc.

Loan Approved Amount/ Disbursed Amount	20,288 million yen / 16,068 million yen	
Exchange of Notes Date/ Loan Agreement Signing Date	March, 2005 / March, 2005	
Terms and Conditions	Interest Rate	0.75%
	Repayment Period	40 years
	(Grace Period	10 years)
	Conditions for Procurement	General Untied
Borrower / Executing Agency	Republic of Indonesia / State Electricity Company (PT. PLN)	
Project Completion	October, 2013	
Main Contractor (Over 1 billion yen)	Sumitomo Corporation (Japan)	
Main Consultants (Over 100 million yen)	Sinclair Knight Merz (Australia) / PT. Amythas Experts & Associates (Indonesia) / PT. Connusa Energindo (Indonesia) / PT. Tata Guna Patria (Indonesia) / West Japan Engineering Consultants,Inc. (Japan) (JV)	
Feasibility Studies, etc.	F/S (April, 2004)	
Related Projects	Technical Cooperation ・ Study on the Optimal Electric Power Development in Sumatra (2004 – 2005) World Bank ・ Java-Bali Power Sector Restructuring and Strengthening Project (June, 2003 – December, 2013) Asian Development Bank ・ Power Transmission Line Improvement Sector Project (November, 2003 – September, 2013) ・ Renewable Energy Development Sector Project (November, 2003 – June, 2014)	

2. Outline of the Evaluation Study

2.1 External Evaluator

Masumi Shimamura, Mitsubishi UFJ Research and Consulting Co., Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: October, 2016 – January, 2018

Duration of the Field Study: April 2 – April 13, 2017, August 8 – August 11, 2017

3. Results of the Evaluation (Overall Rating: A[4])

3.1 Relevance (Rating: ③[5])

3.1.1 Consistency with the Development Plan of Indonesia

At the time of appraisal of the project, *National Electricity General Plan* (hereinafter referred to as "RUKN[6]") *(April, 2004)* promoted geothermal development – development of a stable and renewable energy was anticipated for future utilization as one of energy resources. According to RUKN, Indonesia is endowed with a great deal of geothermal resource and it was estimated that potential geothermal resource of 10 GW exists in the whole country and 5.4 GW, about half of it, in Sumatra Island at the time of appraisal of the project. The Presidential Decree No. 76 of 2000 advocates the active utilization of geothermal power generation as a way of diversification of energy sources and a means of energy saving. In addition, the Geothermal Law aiming to promote utilization of geothermal power came into force in October, 2003. Accordingly, the project is consistent with the development policy of Indonesia.

At the time of the ex-post evaluation, government policy which encourages the maximum use of new and renewable energy including geothermal energy is also spelled out. Concretely, the Indonesian government sets the target to increase additional power generation capacity of 35 GW within five years between 2015 and 2019 in its *35 GW Program*. Among 35 GW, 3.7 GW, 10% to 15% of total additional power generation capacity is targeted for new and renewable energy including geothermal. Draft RUKN 2015-2034[7] is also in line with the Program. As regards actual volume of power generation, *Electricity Supply Business Plan* (hereinafter referred to as "RUPTL[8]") *2017-2026* of State Electricity Company (hereinafter referred to as "PLN[9]") sets the target that the share of power generation volume by new and renewable energy is to be raised to 22.5 % of the total volume of power generation by 2026 from 11% in 2016. Regarding the component of energy sources, capacity of geothermal power generation is targeted to be increased from 4% in 2016 to 9% in 2026. The implementation of the

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③:High, ②:Fair, ①:Low
[6] Rencana Umum Ketenagalistrikan Nasional
[7] RUKN 2015-2034 has not been approved at the time of ex-post evaluation.
[8] Rencana Usaha Penyediaan Tenaga Listrik
[9] Perusahaan Listrik Negara

project is also consistent with the development policy of Indonesia at the time of ex-post evaluation.

3.1.2 Consistency with the Development Needs of Indonesia

At the time of appraisal of the project, it was a pressing issue to cope with the tight power supply-demand and to develop stable power supply system in south area of Sumatra Island. With the growing population and economy, the peak power demand in Lampung Province where the project is located was expected to increase to 1.5 times (at an average rate of 7% per year) from about 300 MW in 2003 to about 450 MW in 2009. On the other hand, reliability of power supply from the existing generating facilities was low because of aging of the facilities and operational stoppages due to their maintenance, and power supply-demand balance was extremely tight. Although development of power supply that replaced diesel power generation, which had high generation unit price and low economic efficiency as well as heavy environmental burdens, had been advanced, growth of power demand exceeded supply and reserve margin was falling. Given the situation, it was expected to respond to the tight power supply-demand, to improve stability and reliability of power supply and to enhance efficiency of power generation facilities in the area.

At the time of ex-post evaluation, according to the executing agency, increasing power generation capacity in south area of Sumatra Island continues to be an urgent issue. Especially, Lampung Province is one of the most serious areas facing power shortage. As shown in Table 1, reserve margin in Lampung is negative figures except in 2007, 2008 and 2011, having significantly lower figures than 25%[10], which is considered to be necessary reserve margin for stable power supply, thus alleviation of tight supply-demand balance is a pressing issue. Currently, supply and demand gap in Lampung Subsystem is complemented by power interchange from South Sumatra Subsystem, Bengkulu Subsystem etc. On the other hand, investment on the development of new power sources is planned in Lampung Subsystem and problem on the tight power supply-demand continues to be addressed, as shown in Table 2.

[10] Source: RUKN 2003-2022.

Table 1: Trend of Power Supply-Demand Balance and Reserve Margin in Lampung Subsystem

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
① Maximum Power Demand (MW)	373	394	365	413	467	517	582	613	696	732	891	736
② Power Supply at Peak Demand (MW)	217	414	407	383	433	516	577	549	671	600	719	736
Reserve Margin (%) = (②－①) / ①	-42	5	12	-7	-7	0	-1	-10	-4	-18	-19	0

Source: Results from questionnaire survey of PLN

Note 1) Figures in 2017 cover from January to October, 2017

Table 2: Actual Data on Investment Capacity of Power Generation in Lampung Subsystem

(Cumulative total capacity of each year) (Unit: MW)

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Power Generation Investment by PLN															
Coal Fired	-	200	200	177	177	178	178	177	265	267	300	300	300	300	300
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroelectric	115	117	118	118	118	118	118	118	118	118	118	118	118	118	118
Gas Turbine	16	16	18	18	18	18	18	17	16	16	75	175	360	360	360
Diesel	75	78	71	71	71	123	163	127	112	51	28	25	-	-	-
Geothermal	-	-	-	-	-	-	100	110	110	104	104	104	104	104	104
Others	11	3	-	-	50	80	-	-	50	44	44	44	44	44	44
Power Generation Investment by IPPs [11]															
Coal Fired	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Combined Cycle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydroelectric	-	-	-	-	-	-	-	-	-	-	-	-	56	56	56
Gas Turbine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diesel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Geothermal	-	-	-	-	-	-	-	-	-	-	-	110	110	110	300
Others	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-
Total Power Generation Investment by PLN and IPPs															
Total	217	414	407	384	434	517	577	549	671	600	719	876	1,092	1,092	1,282

Source: Results from questionnaire survey of PLN

Note 1) Figures until 2016 are the actual and figures in and after 2017 are the planned.

3.1.3 Consistency with Japan's ODA Policy

At the time of appraisal of the project, *the Country Assistance Program for Indonesia (November, 2004)* put up "sustainable growth led by the private sector" as one of the priority areas and raised "economic infrastructure development" etc. for improvement of investment environment as assistance strategy. In *the Medium-Term Strategy for*

[11] IPP stands for Independent Power Producer. A wholesale power generation entity which only owns power generation facilities and not transmission system is called IPP collectively.

Overseas Economic Cooperation Operations (April 2002, JICA), the "economic infrastructure development", which was vital for recovery towards sustainable growth through economic reforms was put as priority areas for assistance to Indonesia. In addition, as part of "responding to global issues", which was one of priority areas in the Strategy, providing active assistance to introduce renewable energy was advocated. Furthermore, the assistance strategy for major sectors in the *Country Assistance Strategy for Overseas Economic Cooperation Operations* (September 2004, JICA), raised four issues; stabilizing electric power supply, making power sector more efficient, improving electrification rate, and advancing environmental measures. A policy to "actively provide assistance to develop and enhance power generation facilities as well as power grid expansion etc. in order to secure stable power supply in major economic zones in outer islands (Sumatra Island and Sulawesi Island)" was also laid out.

The project aims to alleviate the tight power supply-demand and improve stability of power supply of the Southern-Sumatra System, to contribute to economic development of south area of Sumatra Island, and to reduce load to a global environment through utilization of renewable energy. Thus the project is consistent with the above strategies.

This project has been highly relevant to the country's development plan and development needs, as well as Japan's ODA policy. Therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The project constructed geothermal power plant facilities of 55MW class x 2 units (total of 110MW class), 150kV transmission line, substation, and distribution lines. Table 3 shows the comparison of planned and actual project outputs. The development and supply of steam which are necessary for generating power were undertaken by PERTAMINA Geothermal Energy (PGE), a subsidiary company of PERTAMINA, a state-owned oil and gas company. The Steam Sales Contract[12] for this project had been signed between PLN, the executing agency, and PGE.

[12] Steam Sales Contract was concluded between the executing agency and PGE in February, 2010 (30-year contract). The initial plan was to conclude the Steam Sales Contract before effectuation of the loan agreement (but conclusion of Steam Sales Contract had not been set as a condition to effectuate the loan agreement). However in actuality, agreement was concluded about 5 years after the signing of the loan agreement. See footnote 15 for reasons for the delay.

Table 3: Comparison of Planned and Actual Project Outputs

Plan	Actual
Civil Works, Procurement of Equipments etc.	
・ Construction of geothermal power plant facilities (55MW x 2 units)	・ As planned
・ Construction of 150kV transmission line	・ As planned
・ Expansion of substation etc.	・ As planned
・ Construction of distribution lines	・ As planned (Note 1)
Consulting Services	
・ Review of existing resource development study (related to steam)	・ As planned
・ Detailed design, assistance in tendering, construction supervision	・ As planned
・ Assistance in O&M, transfer of knowledge and technology, and human resource development	・ As planned
・ Assistance in environmental management	・ As planned

Source: Results from questionnaire survey of PLN

Note 1) Although this is one component of the project, it was removed from the coverage of Japanese ODA loan and was developed utilizing PLN's own funds.

There was no change with respect to project outputs for civil works and procurement of equipments etc. However, according to PLN, construction of distribution lines was removed from the coverage of Japanese ODA loan and was developed utilizing PLN's own funds. This was because PLN had to cope with the urgent power supply needs of its distribution area in Tanggamus Regency. Thus, PLN has utilized its own funds from the FY 2006 and 2012 budget to develop distribution lines.

Consulting services were carried out as planned. As regards man-month (MM) of consulting services, while the initial plan was 526MM, it turned out to be 529.8MM in actuality – increased by 3.8MM. This was due to the delay in tendering process of contractors (the delay in tendering process includes the delay associated with PGE's delay of the plan – completion of tender documents and the start time of bidding were behind the schedule as described below). It was deemed necessary for consultants to be on board including prolonged project period, which resulted in increase of their MM.

Turbine and Generator

Cooling Tower

Main Steam Isolation Valve

Switch Yard

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was initially planned to be 23,875 million yen (out of which 20,288 million yen was to be covered by Japanese ODA loan). In actuality, the total project cost was 19,095 million yen[13] (out of which 16,068 million yen was covered by Japanese ODA loan), which is lower than planned (80% of the planned amount).

The reason why the total project cost was lower than planned was due to the cost reduction as a result of competitive bidding for which bid price was below the estimate and the effect of depreciation of local currency, Indonesia Rupiah against yen during the project period[14].

[13] The figure includes the cost related with construction of distribution lines which the executing agency carried out utilizing its own funds.

[14] At the time of appraisal, it was estimated as 1 Indonesian Rupiah (IDR) = 0.012 JPY. However, the actual rate was a weak Rupiah trend as 1 IDR = 0.0102 JPY (average rate by IMF between 2005 and 2014)

3.2.2.2 Project Period

The overall project period was planned as 84 months, from March, 2005 (signing of Loan Agreement) to February, 2012 (completion of warranty period) as opposed to 104 months in actuality, from March, 2005 (conclusion of Loan Agreement) to October, 2013 (completion of warranty period), which is longer than planned (124% of the initial plan). Loan period was extended due to project delay. It was extended in December, 2012 and the final disbursement was on June, 2014.

Table 4 summarizes the comparison of planned and actual project period.

Table 4: Comparison of Planned and Actual Project Period

Item	Plan (At Project Appraisal)	Actual (At Ex-post Evaluation)
Selection of consultants	Apr. 2005 – Mar. 2006 (12 months)	Apr. 2005 – Nov. 2006 (20 months)
Consulting services	Mar. 2006 – Feb. 2012 (72 months)	Dec. 2006 – Oct. 2013 (83 months)
Detailed design and procurement	Apr. 2006 – Mar. 2008 (24 months)	Dec. 2006 – Feb. 2010 (39 months)
Construction of generation facilities(Unit 1)	Apr. 2008 – Aug. 2010 (29 months)	Feb. 2010 – Sept. 2012 (32 months)
Start of generation (Unit 1)	Aug. 2010	Jul. 2012
Construction of generation facilities(Unit 2)	Oct. 2008 – Feb. 2011 (29 months)	Feb. 2010 – Oct. 2012 (33 months)
Start of generation (Unit 2)	Feb. 2011	Sept. 2012
Warranty period	Mar. 2011 – Feb. 2012 (12 months)	Sept. 2012 – Oct. 2013 (14 months)

Source: Information provided by JICA, and results from questionnaire survey of PLN

Main reasons for project delay were as follows: (1) selection of consultants was delayed (contract negotiation between PLN and consultants took time; thus, contract signing and start of consulting services was delayed), and (2) tendering process for contractors was delayed (prequalification by PLN was behind the schedule and as a result of delay of the plan by PGE [15], a steam supplier, completion of tender documents and the start time of bidding were delayed – PLN could not receive geothermal resource data, which was necessary for the preparation of tender documents, from PGE on time). Period for consulting services was extended significantly as a result.

[15] According to the information obtained from the executing agency, the plan was delayed because PGE took a long time to drill the wells to secure steam volume necessary for ensuring power outputs of the power plants (because it took some time to drill the wells of sufficient steam volume). This led to a delay in concluding the Steam Sales Contract between the executing agency and PGE.

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

The financial internal rate of return (FIRR) calculated at the time of project appraisal was 8.0%, on the assumption that sales from power generated from the project to be considered as benefit, expenses for construction cost and operation and maintenance cost to be regarded as cost, and project life assumed to be 25 years. The FIRR recalculated at the time of ex-post evaluation based on the same assumptions as the appraisal turned out to be 6.0%. The main reason for the lower result in comparison with the figure at the time of appraisal can be attributed to the consideration of decrease of power sales due to reduced steam volume in future prediction. Recalculation of the economic internal rate of return (EIRR) is not carried out at the time of ex-post evaluation since it was not calculated at the time of appraisal.

Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair.

BOX 1: Difficulties which the Contractors Faced and Countermeasures Undertaken in the Course of Project Implementation

The degree of difficulty was high and ”race against time” was required to implement the project due to following reasons: the project site is located in the mountains, thus it was necessary to level the land fist by shaving the hillside slope so as to make construction works possible; the scope of the project was not just to construct power plants but to develop a new transmission line of about 26km to the existing transmission line as well as related new substations; and the contractors had to absorb the delay of construction of steam condensing system portion (*) in the project although this portion was outside the scope of this project (PGE was the responsible organization)[16]. The contractors facilitated project implementation by appropriately carrying out project management and securing a smooth interface for operations between each scope. Concretely, close communication and collaboration system between each operation unit was taken and unity of mixed teams consisting of multiple organizations (contractors, manufactures, Japanese and foreign consultants etc.) was strengthened through thorough discussion for the following tasks including; leveling the land of power plant construction site (hillside slope), timely

[16] This portion was a different project outside the scope of this power plant construction. Although PLN was responsible for coordination, its construction work was delaying. Unless the steam condensing system was developed, generation of electricity was not possible even the power plants were completed. Given the situation, the contractors aimed to absorb the delay of the steam condensing system development and to keep the delivery date so as to generate electricity within the construction period of the power plants.

procurement of equipments and materials, transportation of equipments and materials with due consideration to local residents, foundation work for installation of steel towers in the mountains, plant installation and so on. In addition, initiatives were carried out by the contractors to facilitate PLN's review and approval process – in collaboration with consultants, the contractors reflected the details into the drawings and thoroughly explained them to PLN which could not be covered in the contract document between PLN and the contractors. In this way, construction period was shortened for about 2 months by optimizing the overall project management including construction system, procurement, cost management etc. Thus; smooth start of power generation was realized by absorbing the delay of construction of steam condensing system by PGE, which was outside the project scope.

(*) This portion is the installation of condensing steam pipe that carries steam taken from excavated wells to the power plants.

3.3 Effectiveness[17] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

Table 5 summarizes the operation and effect indicators set at the time of appraisal of the project and their actual figures between 2013 and 2017 (from January to June). (Since the end of warranty period, which is the definition of project completion, was in October 2013; the target year is 2015 – 2 years after completion.)

[17] Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 5: Operation and Effect Indicators

Indicators	Target	Actual			
	2014	2014	2015	2016	January – June 2017
	2 Years After Completion	1 Year After Completion	2 Years After Completion	3 Years After Completion	
Operation Indicators					
Maximum Output (MW)	110	110	105	93	94
Plant Load Factor (%) Note 1)	85	93.27	93.18	81.13	82.9
Availability Factor (%) Note 2)	85	99.96	97.94	97.28	99.83
Auxiliary Power Ratio (%) Note 3)	Below 3%	3.4	3.5	3.7	3.7
Forced outage hours by Human Errors (hours)	0	0	0	0	0
Forced outage times by Human Errors (times)	0	0	0	0	0
Forced outage hours by Machine Errors (hours)	0	3.51	18.89	53.55	7.6
Forced outage times by Machine Errors (times) Note 4)	0	3 (1)	4 (3)	8 (6)	2 (1)
Planned outage hours by periodic inspection (hours)	720 hours per one inspection	0	323.3	370.3	0
Planned outage times by periodic inspection (times)	8 times in 30 years of operation	0	1	1	0
Effect Indicators					
Net Electric Energy Production (GWh/year) Note 5)	794	858.7	825.6	735.2	372.6

Source: Information provided by JICA, and results from questionnaire survey of PLN

Note 1) Plant Load Factor (%) = Annual energy production / (Rated output x Annual hours) x 100

Note 2) Availability Factor (%) = (Annual operation hour / Annual hours) x 100 (average of two power generation facilities). Annual operation hours include stand by hours.

Note 3) Auxiliary Power Ratio (%) = (Annual Power consumption in the power plant / power generating at sending-end) x 100

Note 4) Figures in parentheses are forced outage times by machine errors occurred within Ulubelu Geothermal Power Plant of the whole forced outage times by machine errors.

Note 5) Net Electric Energy Production (GWh) = Annual energy production – Power consumption in the power plant. The figure in 2017 is low since the data is for a half year (January to June).

In regard to indicators related to power generation capacity etc. in 2015, which is the target year of the operation and effect indicators, the figures have largely reached the target value. According to PLN, the power plants were operating smoothly after completion of the project, however, after the minor inspection conducted in early 2016, steam volume supplied by PGE decreased (out of 11 production wells supplying steam to the power plants, steam supply volume of 3 wells has decreased). As a consequence, figures of maximum output, plant load factor, availability factor, and net electric energy production have decreased. However, all these indicators exceeded 80% of the target value (maximum output: 85% of the target value, plant load factor: 95%, availability factor: 114%, and net electric energy production: 93%). In addition, PGE is focusing on recovering steam volume, and the maximum output in January to June 2017 is 94MW, slightly more than the volume in 2016.

According to PLN, the reason why the auxiliary power ratio exceeds the target value is because power supply to office buildings within Ulubelu Geothermal Power Plant as well as power supply to outdoor lights of access road and security facilities are included in the figures. PLN explained that if such power supply was excluded, the figures would be below 3%[18]. There is no forced outage due to human errors. According to PLN, machine errors are the total number of outages within Ulubelu Geothermal Power Plant and outages outside Ulubelu Geothermal Power Plant. The former are troubles related to electric system such as breakdown of circuit breaker and auxiliary transformers as well as troubles related to valves used for steam lines etc. PLN explained that both troubles can be handled by regular maintenance activities by Ulubelu Geothermal Power Plant. The latter are electricity faults caused by voltage instability of Lampung Subsystem and errors due to voltage collapse[19], which are cause by factors outside the control of Ulubelu Geothermal Power Plant.

As regards planned outage by periodic inspection, it was set as 8 times within 30 years of operation at the time of appraisal, which is equivalent to once in 3.75 years in simple calculation. On the other hand, when looking at the actual figures, as of 3 years after project completion, power plants have already stopped 2 times in total, once in 2015 and 2016, respectively. Therefore, as a result of confirming the definition of periodic inspection to PLN, PLN explained that while the actual figures are outages due to minor inspections, the target figure set at the time of appraisal may have assumed major inspections, and outages due to minor inspections may not have been included.

[18] According to PLN, the auxiliary power ratio set at the time of appraisal may have excluded these power supply.
[19] A phenomenon in which voltage rapidly drops in the entire system since frequency in electric power system cannot be maintained within a proper range due to collapse of power supply-demand balance.

The reason why only outages due to major inspection was assumed at the time of appraisal is unknown, however, according to PLN, it is necessary to shut down the generators etc. in minor inspection too, thus, minor inspections in 2015 and 2016 are reflected in the actual figures[20]. Therefore, there is no problem although the actual figures of outage times have been recorded more than expected.

3.3.2 Qualitative Effects (Other Effects)

According to PLN, the power plants play an important role to reducing power loss and maintaining power quality (voltage) in the Southern-Sumatra System and Lampung Subsystem since the power plants are located in Lampung Province, a high power demand area, and have been contributing to decrease power interchange from other areas. Currently, Lampung Subsystem adjusts its supply and demand gap through power interchange from other subsystems, which consist Southern-Sumatra System (South Sumatra Subsystem and Bengkulu Subsystem) (see Table 6). PLN pointed out that such power interchange across the areas would become inhibiting factors for stable and efficient power supply[21]and that it is important to supply power within the same area as much as possible so as to secure stability and appropriate power quality in the entire power system. In this regard, it is extremely significant that the power plants are located in Lampung Province which has high power demand.

It should be noted that power interchange from other subsystem to Lampung Subsystem is increasing according to Table 6. This is because the supply is running short of demand (see Table 1). However, when considering that power interchange could have happened for the volume of additional power supply from the project, it can be said that the project is contributing to the decrease of power interchange (if the project was not implemented, further power interchange would have been necessary).

Table 6: Data on Power Interchange from Other Subsystems to Lampung Subsystem

	2011	2012	2013	2014	2015	2016	2017
Power Interchange at the Peak Load (MW)	210	240	260	272	340	350	181
Power Interchange during Ordinary Times (MW)	180	234	252	260	310	320	350

Source: Results from questionnaire survey of PLN

Note 1) Figures in 2017 cover from January to October, 2017

[20] As described below (sustainability), major inspections are planned to be conducted every 4 years and minor inspections every 2 years.

[21] The executing agency explained the following as its logic: “When the place for power generation is far from power consuming area (when power transmission distance is long) ➔ electric resistance increases ➔ power loss increases ➔ power voltage reduces.”

3.4 Impacts

3.4.1 Intended Impacts

3.4.1.1 Improvement of Investment Environment

Table 7 shows the trend of electricity sales in Lampung area. Electricity sales to business and industrial sectors have been increasing. It can be considered that the project is contributing to the activation of economic activities and improvement of investment environment in Lampung area when also taking into consideration the results of interviews with local residents and companies (see below).

Table 7: Trend of Electricity Sales in Lampung Area

(Unit: GWh)

	Actual						Projection		
	2011	2012	2013	2014	2015	2016	2017	2018	2019
Residential	1,457	1,731	1,877	2,069	2,205	2,368	2,568	2,786	3,037
Business	306	383	427	399	401	438	482	534	600
Social	167	188	206	214	239	253	270	291	315
Industrial	395	491	671	709	726	775	840	924	1,042
Total	2,325	2,793	3,182	3,392	3,571	3,835	4,160	4,534	4,993
Growth Rate (%)	14	20	14	7	5	7	8	9	10

Source: Results from questionnaire survey of PLN

Note 1) Partial inconsistency of figures exists due to rounding error.

Note 2) Growth rate is a growth rate of electricity sales from the previous year.

Note 3) Figures in and after 2016 include some electricity sales by IPPs (share of IPPs are relatively small), however, it cannot be separated out from the electricity sales by PLN.

The results of interviews with local residents and companies have shown that the impacts regarding industrial development and job creation etc. have been generated after project completion. According to the interviews, local companies have expanded their operation due to stable power supply and herewith increased the number of employees from local residents as well as their salaries, enterprises newly entering in Lampung Province have increased, and employment of local residents during power plant construction and after the operation has been created.

3.4.1.2 Alleviation of Global Environmental Burdens through Utilization of Renewable Energy

At the time of appraisal, possibility to regard the project as a target of emissions

reduction project (CDM[22] project) was explored, however, it did not result in a CDM project. According to PLN, this was because preparations for CDM application of the project were not ready within PLN (establishment of system and staffing could not take place sufficiently). The effect of CO_2 emission reduction by the project cannot be identified exactly since the available data is not sufficient. At the time of appraisal, contribution to the alleviation of global environmental burdens was expected as project effect. Therefore, it was desirable to confirm the system for data collection and calculation of reduction of greenhouse gas emissions.

3.4.2 Other Positive and Negative Impacts

3.4.2.1 Impacts on the Natural Environment

The project falls under A category of JBIC Guidelines for Confirmation of Environmental and Social Considerations (Environmental Guidelines) (April, 2002) because it is a development project of large-scale power plants. The Environmental Impact Assessment Report (hereinafter referred to as "AMDAL"), the Environmental Management Plan (hereinafter referred to as "RKL"), and the Environmental Monitoring Plan (hereinafter referred to as "RPL") of the project have been approved by the Environmental Assessment Committee of Tanggamus Regency in September, 2004 for power generation and in October, 2004 for transmission line.

PLN has conducted environmental monitoring[23] during and after completion of the project on a quarterly basis based on AMDAL, RKL and RPL, and no particular negative environmental impact has been reported at the time of ex-post evaluation. In addition, since project implementation up to now, no negative impact on natural environment such as air pollution, odor, and noise has been pointed out from the interview with the local residents carried out during the field study. PLN's monitoring results of the critical environmental indicators for geothermal power generation are shown in Table 8 (measured in December, 2016). Concentration of air pollutant – Sulfur Hydrogen (H_2S), and water quality in the reinjection wells – Arsenic (As) and Mercury (Hg) were significantly lower than the standards.

[22] CDM is a mechanism for which investment countries (developed countries) are allowed to implement projects that reduce greenhouse gas emissions in host countries (developing countries) and to apply its additional reduction volume of greenhouse emissions, compared to the case where there is no such project, as part of the reductions of greenhouse emissions by the investment countries. For CDM application, the implementing agency on the host country side needs to develop systems and human resources etc. in order to determine the emissions.

[23] Environmental monitoring was carried out on the items of: gas emission from the power plant, ambient air, water quality, industrial waste water, sanitary waste water treated through a septic tank, waste sludge disposal, noise and so on.

Table 8: Results of Environmental Monitoring

Indicator	Standard	Results of Monitoring
Air Quality: Sulfur Hydrogen (H_2S)	35 mg/Nm_3 Note 1)	7 mg/Nm_3
Water Quality: Arsenic (As)	1 mg/L Note 2)	0.005 mg/L
Water Quality: Mercury (Hg)	0.002 mg/L Note 2)	0.001 mg/L

Source: Results from questionnaire survey of PLN

Note 1) Regulation of State Minister of Environment Concerning Emission Standard for Geothermal Power Generation Activities (No.21, 2008)

Note 2) Government Regulation on Water Pollution Control and Water Quality Management (Government Regulation No. 82 of 2001)

As a result of interviews with PLN and local residents, although part of the transmission line passes through the protected forests, PLN minimized protected forest passage in detailed design and pruning of trees under the route was also limited to the height exceeding 8.5m as planned, and effect of installation of towers in the protected forests is also limited (as shown in Table 9, the actual land acquisition area (12.9ha) also decreased from the planned area (21.2ha)). Therefore, it is judged that there is no effect on the water/soil conservation function by logging the protected forest in this area.

3.4.2.2 Land Acquisition and Resettlement

Table 9 shows the comparison of planned and actual resettlement and land acquisition. Area for land acquisition was reduced from the planned area after concrete transmission route was decided during the detailed design stage. Relocation did not take place. According to interviews[24] conducted during the field study with PLN and local residents regarding resettlement and land acquisition during project implementation, the compensation process for land owners (farmers) who have given up part of their farm land for the project was carried out in accordance with the Indonesian Regulations (Presidential Decree No.36-2005 and No.65-2006 (revised regulation)) and no particular problem was pointed out. There was no objection regarding compensation amount from the farmers, either.

[24] As described later, interviews were conducted with 12 local residents living in 6 villages in the range of approximately 30km from the power plants. They were mainly rice farmers (including village chief) and 2 of them were working in the power plants. Interviewees were selected from those introduced by the village chief or persons of great influence from each village to whom PLN called out. They turned out to be all men.

Table 9: Comparison of Planned and Actual Resettlement and Land Acquisition

Plan		Actual	
Land	Resettlement Household	Land	Resettlement Household
21.2ha	0	12.9ha	0

Source: Results from questionnaire survey of PLN

3.4.2.3 Other Impacts

According to interviews with PLN and local residents, there was no electricity or limited power supply in the six villages[25] located in the range of approximately 30km from the power plants before the project (power supply time was limited to several hours in a day). In contrast, these villages were electrified and stable power supply was realized as a result of construction of distribution lines by the project. By this, villagers could use agricultural machineries such as rice huller, which resulted in improvement of work efficiency and increase of harvest. In addition, they can now transport harvested rice using the access road developed by the project by vehicles (before the project, they carried harvested rice passing through unpaved mountain roads on foot).

In addition, as part of the CSR programs, Ulubelu Geothermal Power Plant has been providing support for self-reliance of local residents in the surrounding areas including the six villages mentioned above. The programs include generation of biofertilizer through breeding of goat, promotion of maternal and child health care (vaccination), dissemination of child education for energy/power conservation and so on. Through these initiatives, Ulubelu Geothermal Power Plant is contributing to strengthening unity among residents and activation of interaction among residents.

This project has largely achieved its objectives. Therefore effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspects of Operation and Maintenance

The operation and maintenance of the power plants after project completion is undertaken by Ulubelu Geothermal Power Plant under the supervision of PLN Bandar Lampung Sector (hereinafter referred to as “Regional Office”). Daily communication

[25] Six villages are: Muara Dua Village, Pagar Alam Village, Karang Rejo Village, Gunung Tiga Village, Data RajanVillage, and Ngarip Village.

between the Regional Office and Ulubelu Geothermal Power Plant are taken place and they have a close cooperation system. The Regional Office belongs to the Southern Sumatra Power Generation located in Palembang City. These organizations maintain good relationship and regular coordination meetings are carried out every quarter. In case discussion agenda arise, special meetings are convened, and exchanges of information and opinions are conducted as needed.

Ulubelu Geothermal Power Plant allocates division managers who take responsibility for operation (A-D)[26], maintenance and administration under the head of the plant. About 40 staffs work at the whole power plants. Of which more than 90% are engineers in charge of operation and maintenance (in addition to about 40 staffs, about 30 helpers[27] who have been employed from the local residents are providing support). According to power plant staffs, number of engineers necessary for operation and maintenance has been secured.

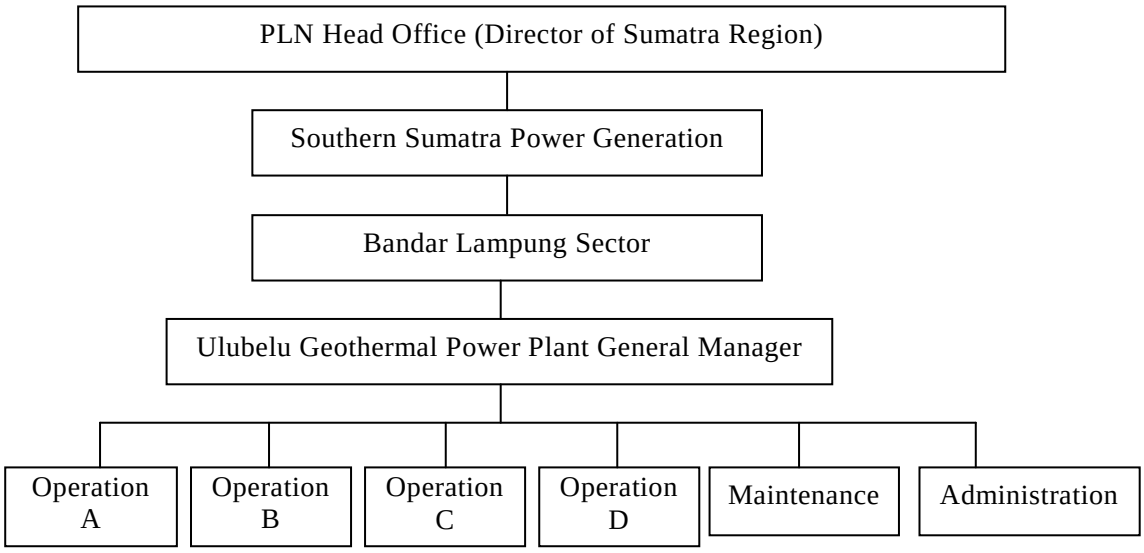

Figure 1: Organizational Structure of Operation and Maintenance of Ulubelu Geothermal Power Plant

Source: Prepared by the evaluator based on the information provided by PLN

Ulubelu Geothermal Power Plant has acquired ISO 90001 (quality management system), ISO 14001 (environmental management system), SMK3 (labor safety and sanitation management system), Security Management System, and operation and maintenance of the power plants has been taken place in conformity with these management systems. In addition, Ulubelu Geothermal Power Plant has introduced

[26] Operation Division adopts A to D four shift system a day.
[27] Helpers are mainly in charge of miscellaneous tasks as assistants of engineers.

Energy Management System, Supply Chain System on spare parts, Asset Management System, and Risk Management System, which are standardized within PLN, and has been carrying out operation and maintenance work.

Therefore, no particular problem has been identified regarding the institutional structures of operation and maintenance of Ulubelu Geothermal Power Plant.

3.5.2 Technical Aspects of Operation and Maintenance

As regards technical aspects of operation and maintenance, technical staffs who have acquired qualification as electricity engineers, authorized by the Indonesian Society of Power Generation Professionals (HAKIT) and the Indonesian Electrical Power Engineers Association (IATKI) as well as those who have gained sufficient experiences on operation and maintenance of power plants are deployed. In addition, during project implementation, consultants have provided training and technical transfer regarding operation and maintenance[28]. Furthermore, contractors have provided on-site operation and maintenance training to 33 PLN staffs during project implementation[29]. Engineers in charge of operation and maintenance have been receiving on the job training. They are also obliged to attend trainings on their own areas of responsibility and trainings according to the level of their own qualification at the PLN Learning Centers[30] once or more than once every year. In this way, appropriate human resource management system has been built in PLN. Ulubelu Geothermal Power Plant in coordination with the PLN Learning Centers is planning to establish training center on geothermal generation (on-site training as well as desk training) officially from 2018[31].

Manufacturers of generating facilities and turbines etc. have prepared manuals for operation and maintenance and they have been revised by Ulubelu Geothermal Power Plant as needed. The manuals are utilized for daily operation and maintenance work as well as periodic inspections.

Therefore, no particular problem has been identified regarding the technical aspects of operation and maintenance.

[28] 8 PLN staffs have received training regarding management of operation and maintenance technology for 10 days in Japan (May, 2011). In addition, 16 PLN staffs divided into two groups have received operation and maintenance training for 10 days each in Japan (October, 2011, November-December, 2011).
[29] Trainings were carried out in June-July, September, December 2011, January, July-August, September, 2012, October 2012-October 2013.
[30] PLN's training institutes are established in three places nationwide (Jakarta, Palembang and Surabaya).
[31] The power plant has so far received about 80 trainees and provided on-site training for 2 weeks to 1 month by experienced engineers.

Control Room

Transmission Line

3.5.3 Financial Aspects of Operation and Maintenance

The necessary operation and maintenance costs are estimated by Ulubelu Geothermal Power Plant, and the budget request will be made to the Regional Office directly supervising the power plants and then submitted to PLN Headquarter, via Southern Sumatra Power Generation which has jurisdiction over the Regional Office. After getting approval from PLN Headquarter, budget will be allocated to the power plants via Southern Sumatra Power Generation and the Regional Office.

Table 10 shows comparison of budget, actual allocation and actual expenditure of operation and maintenance cost of the power plants. The power plants' maintenance cost has been properly secured, and is also well operated and maintained on site.

Table 10: Operation and Maintenance Cost of Ulubelu Geothermal Power Plant

(Unit: million IDR)

	2014	2015	2016	2017
Budget (Requested Amount)	N.A.	615,689	657,756	497,203
Actual Allocation	N.A.	615,689	657,756	497,203
Actual Expenditure	490,290	615,809	507,669	81,907

Source: Results from questionnaire survey of PLN

Note 1) Actual expenditure in 2016 decreased because stem purchase cost from PGE dropped by approximately 15% compared with the previous year.

Note 2) Budget for 2017 decreased because the budget was prepared based on the steam purchase cost of the previous year. Actual expenditure of that year is up to February (expenditure for two months).

As regards financial situation of the entire PLN, recent income statement and balance sheet are shown in Table 11 and 12, respectively.

Table 11: Income Statement of PLN Note 1)

(Unit: billion IDR)

	2012	2013	2014	2015	2016
Total Revenues	232,656	257,405	292,721	273,900	283,263
Sale of Electricity	126,722	153,486	186,634	209,845	214,140
Government's Electricity Subsidy	103,331	101,208	99,303	56,553	60,442
Other Revenues	2,604	2,711	6,783	7,502	8,682
Total Operating Expenses	203,115	220,911	246,910	225,574	254,450
Fuel and Lubricants	136,535	147,634	170,488	138,408	109,492
Maintenance	17,567	19,839	20,207	21,861	21,227
Personnel	14,401	15,555	15,749	20,321	22,660
Other Operating Expenses Note 2)	34,612	37,883	40,466	44,983	101,071
Income Before Financial and Other Items	29,541	36,493	45,811	48,325	28,814
Net Financial and Other Items Note 3)	-28,509	-75,715	-35,387	-64,239	-12,837
Tax Benefit	2,174	9,654	-4,159	21,940	-5,428
Income (Loss) for the Year	3,206	-29,567	6,264	6,027	10,549

Source: PLN Annual Report

Note 1) Partial inconsistency of figures exists due to rounding error

Note 2) Power Purchase, Depreciation of Fixed Assets etc.

Note 3) Tax Revenue and Cost, Foreign Exchange Profit and Loss etc.

Table 12: Balance Sheet of PLN Note 1)

(Unit: billion IDR)

	2012	2013	2014	2015	2016
Total Assets	549,376	590,219	603,659	1,314,371	1,274,576
Total Noncurrent Assets Note 2)	472,066	505,382	518,235	1,235,026	1,173,609
Total Current Assets	77,310	84,837	85,424	79,345	100,967
Total Equity and Liabilities	549,376	590,219	603,659	1,314,371	1,274,576
Total Equity	159,270	150,331	164,671	804,791	880,798
Total Noncurrent Liabilities	315,503	350,582	351,430	389,441	272,155
Total Current Liabilities	74,603	89,306	87,558	120,139	121,623

Source: PLN Annual Report

Note 1) Partial inconsistency of figures exists due to rounding error

Note 2) Total noncurrent assets drastically increased in 2015 because reevaluation of assets (review) was carried out.

When reviewing the income statement, while electricity sales of PLN have been increasing smoothly every year, the organization is supported by a big amount of government's electricity subsidy [32]. Government's electricity subsidy substantially decreased in 2015 and 2016 because adjustment of electricity tariff was made in May, 2014 and January, 2015 [33].

Main factors behind the high-cost structure are identified as the high financial burden for fuel and lubricants necessary for power generation, low electricity tariff, and so on. PLN aims to reduce government's electricity subsidies, raise the electricity tariff, increase self-financing ratio (issuance of corporate bonds), and introduce private funds aggressively (construction of power generation facilities etc. by combining PLN's self-financing and private funds), in order to improve its financial and management conditions. While the electricity pricing is a decision matter of Indonesian government, which is out of control of PLN, the government has been expanding the customer categories introducing the floating tariff system as a direction of reform. As regards balance sheet, current ratios are slightly low, but no particular problem is expected due to the certainty of tariff collection and government's electricity subsidy. On the other hand, the high-cost structure of PLN etc. will not affect the project because, as mentioned above, operation and maintenance cost for the power plants has been appropriately financed and the power plants have been well operated and maintained.

Therefore, no particular problem has been identified regarding the financial aspects of operation and maintenance.

3.5.4 Current Status of Operation and Maintenance

The power plant facilities constructed by the project have been maintained well and operated smoothly. The geothermal power plants have developed a maintenance plan (52 week maintenance plan) which sets down type of maintenance, budget, inspection schedule etc. and conducts maintenance activities appropriately based on this plan. Concretely, major inspection (every 4 years), minor inspection (every 2 years) [34], periodic maintenance (every week), daily maintenance, corrective maintenance, and

[32] The government subsidy to PLN is stipulated in the Article 66 of the Law on State Enterprises of 2001 on Public Service Obligation. (Financial compensation for state-owned enterprises.)

[33] Concretely, out of the entire 17 customer categories of electricity tariff, total of 10 categories including large customers for industrial use (4 categories in May 1, 2014 and 6 categories in January 1, 2015) were excluded from the target for the government's electricity subsidy and transferred to the floating tariff system from the previous fixed tariff system. Electricity tariff of these 10 categories are adjusted every month based on: (1) inflation rate issued by the central statistics office, (2) exchange rate of rupiah against dollars announced by the central bank, and (3) crude oil price in Indonesia. The fixed tariff is maintained as before to households with little power consumption (the poor).

[34] Minor inspection was conducted at the beginning of 2016. The first major inspection is planned on 2017. (Unit 1: planned on September, 2017 and Unit 2: planned on October, 2017).

preventive maintenance activities are carried out.

About the issue of decrease in steam volume which PGE supplies, PGE has: (1) repaired the three production wells which encountered decrease in steam volume after minor inspection in 2016[35] (implemented), (2) drilled one new production well in 2016 (implemented), and (3) planned to drill two more additional production wells in September, 2017 (scheduled) in order to restore steam volume as mentioned above. Information has been closely shared between PGE and PLN regarding PGE's countermeasures and the situation of production wells since problems occurred in the first place. (As regards (1), steam volume has not been restored to the original volume even after the repair. Regarding (2), observation of the situation is necessary until steam volume stabilizes (until the end of 2017).)

As regards spare parts, Ulubelu Geothermal Power Plant has introduced supply chain management system and inventory management system which have been standardized within PLN. Under the system, spare parts necessary for maintenance have been refilled and stored in the warehouse of Ulubelu Geothermal Power Plant on a timely basis. Spare parts have been categorized into three, based on their importance (A: spare parts with very high importance. In case spare parts under this category have not been procured in a timely manner, blackouts may occur, B: lack of spare parts under this category may create temporary problems, C: spare parts under this category are consumable items which would not create troubles to the point of affecting power outputs) and different procurement/storage management is carried out for each category. Especially, category A spare parts are indispensable for operating the power plants and usually take time for procurement. Thus, a system has been adopted to prepare in a structured way for more than one year ahead of time in order to procure them in a timely manner.

Therefore, no particular problem has been identified regarding the current status of operation and maintenance.

No major problems have been observed in the institutional, technical, financial aspects and current status of the operation and maintenance system. Therefore sustainability of the project effects is high.

[35] According to PLN, problem seemed to have occurred in the process of drawing steam and hot water from the geothermal reservoir using the production well.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project constructed geothermal power generation plants in Ulubelu, Tanggamus Regency, Lampung Province with the aim of alleviating the tight power supply-demand balance and improving the stability of power supply of the Southern-Sumatra System in Sumatra Island. The objective of the project which addresses the tight power supply-demand condition by supplying power through renewable energy is well consistent with electric power policy and development needs of Indonesia, as well as with the Japan's ODA policy in the sense that geothermal development – a stable and renewable energy –is promoted. Therefore, the relevance of the project is high. Although the project cost was within the plan, the project period exceeded the plan. Therefore, efficiency of the project is fair. Operation and Effect Indicators set at the time of appraisal have largely achieved the target figures. The project is located in Lampung Province where reserve margin is the lowest in Southern-Sumatra System and is playing an important role to reduce power loss and to maintain quality of power supply in this area. In addition, as a result of field interviews, it can be judged that the project has been contributing to the activation of economy and improvement of investment environment in Lampung area. Therefore, the project has largely generated its planned effects; thus, its effectiveness and impact are high. No negative impact on natural environment and land acquisition has taken place. Moreover, creation of local employment by the project and contribution to the community activities of local residents through CSR initiatives were confirmed. No major problem has been observed in the institutional, technical and financial aspects of the operation and maintenance system as well as in the current status. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

The importance of continuous survey on quantity and quality (pressure, temperature and components [36]) of steam as well as well-planned and prompt measures to prepare for future changes in geothermal power plants

In Indonesia, different organizations conduct geothermal power generation development – PGE undertakes heat source survey, development and steam supply in its geothermal field and PLN carries out development, and operation and maintenance of geothermal power plants, as in this project. Since geothermal energy is an element of nature, even if quantity and quality of steam was secured as planned based on the preliminary survey at the beginning of power generation, they may change over time with the operation of power plants. In this regard, when different organizations undertake geothermal power generation development like the case in Indonesia, it is important for the executing agency to monitor periodically that the steam supply organization continues the survey on quantity and quality of steam and promotes systematic heat source development even after starting operation of the power plants based on the Steam Sales Contract. Also, if there are indications of future changes in quantity and quality of steam, it is critical for the executing agency, in close collaboration with the steam supply organization, to identify the cause as soon as possible, and to carry out countermeasures such as additional drilling of production wells while gathering detailed information on the conditions of heat source etc. In particular, when additional drilling is going to be carried out, well-planned and prompt measures through collaboration between both organizations is the key since prior approvals from pertinent authorities including the Ministry of Environment are necessary. It is also important that JICA regularly grasps the situation and promptly urges the steam supply organization to take appropriate measures through the executing agency when there is a problem or sign of problem concerning quantity and quality of steam even after project completion, from the viewpoint of securing project sustainability.

End

[36] There was a problem of the amount of steam in this project, but regarding the problem of steam quality, refer to the ex-post evaluation report on Japanese ODA loan project in Indonesia, “Lahendong Geothermal Power Plant Project”, which was implemented almost in the same period as this project. https://www2.jica.go.jp/en/evaluation/pdf/2015_IP-517_4.pdf

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	1) Civil Works, Procurement of Equipments etc. ・ Construction of geothermal power plant facilities (55MW x 2 units) ・ Construction of 150kV transmission line ・ Expansion of substation etc. ・ Construction of distribution lines 2) Consulting Services ・ Review of existing resource development study (related to steam) ・ Detailed design, assistance in tendering, construction supervision ・ Assistance in O&M, transfer of knowledge and technology, and human resource development ・ Assistance in environmental management	1) Civil Works, Procurement of Equipments etc. ・ As planned ・ As planned ・ As planned ・ As planned 2) Consulting Services ・ As planned ・ As planned ・ As planned ・ As planned
2. Project Period	March, 2005 – February, 2012 (84 months)	March, 2005 – October, 2013 (104 months)
3. Project Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 15,747 million yen 8,128 million yen (677,375 million IDR) 23,875 million yen 20,288 million yen 1IDR=0.012 yen (As of September, 2004)	 12,233 million yen 6,862 million yen (672,711 million IDR) 19,095 million yen 16,068 million yen 1IDR=0.0102 yen (Average between 2005 and 2014)
4. Final Disbursement	June, 2014	

End