Azerbaijan

FY2019 Ex-Post Evaluation of Japanese ODA Loan

"Shimal Gas Combined Cycle Power Plant Project (Second Unit)"

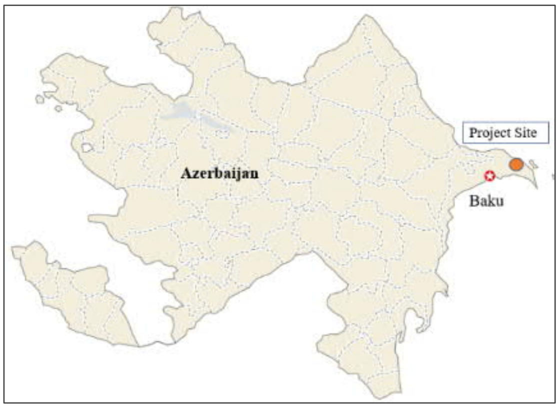
External Evaluator: Hisae Takahashi, Ernst & Young ShinNihon LLC

0. Summary

The project implemented the construction of a gas combined cycle power plant in the Absheron peninsula area of eastern Azerbaijan, aimed at expanding the supply capacity of stable power and improving efficiency. The objective of the project is deemed consistent with the development policy and development needs of Azerbaijan at the time of the project appraisal and ex-post evaluation, as well as with Japan's aid policy. Therefore, the relevance of this project is high. Although the output for power generation was as planned in the implementation of this project, the construction and rehabilitation of transmission lines and substations were implemented as part of a separate project due to the difficulty in keeping them within the project budget as a result of unsuccessful bidding. The project period largely exceeded the plan due to a number of factors that included unsuccessful bidding, a request from the counterpart government for the end of disbursement, suspension of the project related to changes to the assignment of staff in Azerbaijan, and re-procurement of the equipment at a substation. The project cost also largely exceeded the plan due to rises in prices and the extension of the project period. Thus, the efficiency of the project is low. It was confirmed that the expected effectiveness was achieved in terms of power generation, including maximum output, utilization and availability of facilities, as well as transmission including transmission loss ratio. This project is also considered to have contributed to improving power generation efficiency, reserve capacity, as well as reducing the power shortages. Therefore, effectiveness and impacts of the project are high. Although there are some points to be noted in the current maintenance status, there are no particular problems in terms of institutional/organizational, technical, and financial aspects of operation and maintenance. Therefore, sustainability of the project effects is high.

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

1. Project Description



Project location

Shimal gas combined cycle power plant (Second unit)

1.1 Background

At the time of its appraisal, Azerbaijan had a total installed generating capacity of 5,556 MW. However, the actual production capacity had declined to 4,240 MW by 2003 due to aging facilities. This resulted in the actual production capacity falling short of the maximum demand (4,500 MW), with the power supply shortfall being compensated via grid interconnection with Russia. The power environment was also unfavorable with roughly 50 % of the country's population suffering power outages for an average of over 8 hours a day. After becoming independent in 1991, Azerbaijan's power demand declined for a time due to the economic downturn, but began to ramp up again after 1995 and has been rising at an annual rate of around 6.5 % since 2000. Due to this, if new power sources were not pursued, the country would have been forced to use planned outages, etc. to restrict the power supply.

Furthermore, around 80 % of the country's power generation facilities are located in the western part of the country while 60 % of the electricity demand is concentrated in the Absheron peninsula in the eastern part of the country. Because of this, it has been necessary to transmit electricity over a 300 km distance between the east and west sides of the country, while at the same time, heavy oil, which is the fuel used at the western power plant, is being transported from the Absheron peninsula. This has resulted in inefficiency in the country's power supply due to transmission loss and fuel transport costs. This kind of long-distance transmission of electricity is also a factor in the power system's instability.

As described above, the country needs to meet its power demand by developing new power sources in the Absheron peninsula where most power demand is located; reduce transmission losses and fuel transport costs, and; improve the efficiency of its power supply.

1.2 Project Outline

The objective of this project is to achieve the expansion and improvement of the efficiency of stable power supply capacity by constructing a gas combined cycle power plant and related transmission equipment in the Absheron peninsula of eastern Azerbaijan, thereby contributing to the alleviation of power shortage in the country and the sustainable growth of the country's economy.

Loan Approved Amount/ Disbursed Amount	29,280 million yen/28,833 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	May 2005/May 2005
Terms and Conditions	Interest Rate 0.75 % Repayment Period 40 years (Grace Period 10 years) Conditions for Procurement General untied
Borrower/ Executing Agency	The Government of the Republic of Azerbaijan/"Azerenergy" Joint-Stock Company
Project Completion	September 2021 (Completion of the facility construction: September 2019, Defect liability period: October 2019 – September 2021)
Target Area	Suburbs of Baku, a capital city
Main Contractor(s) (Over 1 billion yen)	・Toyo Engineering Corporation (Japan), Azenco Joint Stock Company (Azerbaijan), Mitsubishi Power, Ltd. (Japan)
Main Consultant(s) (Over 100 million yen)	・AF-Enprima Limited (Finland)/Tokyo Electric Power Services Co., Ltd. (Japan) (JV), Tokyo Electric Power Services Co., Ltd. (Japan)
Related Studies (Feasibility Studies, etc.)	・Feasibility Study (2002) (Prepared by the fund of Azerenergy)
Related Projects	[ODA Loan Project] ・Severnaya Gas Combined Cycle Power Plant Project (February 1998) ・Severnaya Gas Combined Cycle Power Plant Project (II) (October 1999) [World Bank] ・"Support of power sector reform" (promoting reduction of subsidies, improvement of tariff collection and rate system, privatization of power distribution companies, improvement of regulatory framework, etc.) [European Bank for Reconstruction and Development] ・Yenikend Hydropower Plant Rehabilitation Project (1994) ・Mingechaur Power Project (1997)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hisae Takahashi, Ernst & Young ShinNihon LLC

2.2 Duration of Evaluation Study

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

Duration of the Study: October 2019 – November, 2021

Duration of the Field Study: May 2021 (Conducted by the Local Assistant)

2.3 Constraints during the Evaluation Study

In this ex-post evaluation, the site survey could not be implemented by the evaluator due to the escalation of the military conflict with Armenia as well as the spread of COVID-19. For this reason, the site survey was implemented by local assistants under the direction of the evaluator, and the evaluator conducted a desktop evaluation based on the results of the information collected, beneficiary survey, and site inspections carried out by the local assistant.

3. Results of the Evaluation (Overall Rating: B[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of Azerbaijan

At the time of the appraisal, the *State Program for the Development of the Fuel and Energy Sector* (2005–2015), Azerbaijan's development policy, called for increasing the actual production capacity to 6,500 MW–7,000 MW by 2015. Moreover, Azerbaijan has been transmitting electricity over some 300 km from its power generation source in the west to Baku, the capital city, which is the largest power consumption area. From the perspective of reducing power transmission losses, it was necessary to construct an efficient and highly responsive power generation facility near Baku. Based on this, the project has been positioned as the highest priority project in the above-mentioned Program.

At the time of the ex-post evaluation, the country's development plan, *Azerbaijan 2020 Outlook for the future* (2012), identified the following priority areas to promote economic growth: to develop the energy, transport infrastructure; to develop regions while taking into account the competitive advantages of each region; and to provide social services through the development of the infrastructure in cities and villages. In the energy sector, the *Strategic Roadmap of Azerbaijan Republic on Utilities (Electrical and Thermal Energy, Water and Gas)* (2016) has been developed. The roadmap also clearly states the intention of increasing the amount of power generated from wind and solar power, and due to current 94% dependence on

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ②: Fair, ①: Low

natural gas for power generation, it sets a strategic goal of increasing the efficiency of power plants, including the introduction of combined cycle[3] power plants in increasing power generation capacity.

3.1.2 Consistency with the Development Needs of Azerbaijan

There had been limited investment in the power sector since Azerbaijan became independent from the Soviet Union in 1991. Accordingly, it was inevitable for facilities operating inefficiently due to the significant deterioration of existed power generation facilities over time at the time of the project appraisal. In 2003, the maximum power demand for electricity was 4,500 MW while the actual production capacity (4,240 MW) fell short of that, thus, it was impossible to meet demand. Furthermore, around 80 % of the country's power generation facilities were located in the western part of the country while 60 % of the electricity demand was concentrated in the Absheron peninsula in the eastern part of the country, causing transmission loss and increased fuel transport costs due to a geographically inefficient power supply structure[4].

At the time of the ex-post evaluation, the supply-demand balance has improved, with the country's maximum power demand at 3,879 MW versus its supply capacity of 6,500 MW and actual production capacity (4,700 MW in summer and 5,200 MW in winter). On the other hand, power plants in operation in Azerbaijan, including the Azerbaijan Power Plant (with a supply capacity of 2,400 MW) which is the largest generation capacity in the country, still face issues such as aging and low generation efficiency. Azerenergy has been implementing the *Rehabilitation Program*[5] for power plants in the country since the fall of 2018, and the program's content indicates that numbers of power plants are in need of rehabilitation and upgrading. Azerenergy has stated the need to consider the closure of aging power plants in the future, thus, it can be said that there is still a high demand for efficient power generation facilities that can ensure a stable power supply. Although a power plant has been constructed under the project in the Absheron peninsula, an eastern part of the country (including the capital Baku) which has the largest power demand, there is still a need to improve power transmission efficiency from the western part of the country, where many of the power plants are located, to the eastern part of the country[6].

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3 A dual power generation system that combines a gas turbine and steam turbine. A facility that uses this method was constructed in this project. This method of power generation can produce more electricity than conventional thermal power generation with the same amount of fuel.

4 Source: Documents provided by JICA

5 Power plant rehabilitation plan, which was formulated by Azerenergy in 2018. Under this plan, from 2018 to 2020, rehabilitation work was carried out on the Azerbaijan Power Plant, the 330 kV substation and 500 kV power plant of the same plant, Janub Power Plant, Sumgait Power Plant, Shimal Power Plant I, Baku Power Plant, Sangachai Power Plant, Shahdagh Power Plant, Astara Power Plant, Khachmaz Power Plant, Shaki Power Plant, Mingachevir Power Plant, Shamkir Power Plant, and the upgrading works was carried out at 330 kV Gobu Substation. Total investment was 513 million manat (about 33,175 million yen). (Source: Questionnaire answers from the executing agency)

6 Source: Questionnaire answers from the executing agency

3.1.3 Consistency with Japan's ODA Policy

Under the *Strategy for Overseas Economic Cooperation Operations* for Azerbaijan, infrastructure development for sustainable growth was positioned as a priority area, with support policies listed as support for socioeconomic development including electric power; support for the introduction of technologies to conserve energy and resources; upgrading of the aging economic and social infrastructure; and the effective use of energy. In addition, based on policy discussions between the governments of Azerbaijan and Japan in 2002, three areas were positioned as ODA priority areas[7]: economic infrastructure development (especially energy, transportation and communications), human resource development and the social sector (especially medical and health care and education). The objective of this project is to achieve a stable power supply and contribute to the country's economic growth, which are deemed to be in line with the ODA priority areas as well as the *Strategy for Overseas Economic Cooperation Operations*.

In light of the above, this project has been highly relevant to the Azerbaijan's development plan and development needs, as well as Japan's ODA policy. Therefore, its relevance is high.

3.2 Efficiency (Rating:①)

3.2.1 Project Outputs

The planned major outputs of the project consisted of construction of a 400 MW class gas combined cycle power plant, related transmission equipment and consulting services. The major planned and actual outputs are shown in Table 1.

Table 1 Planned and Actual Output

Plan	Actual
・Construction of a gas combined cycle power plant (1 unit 400 MW) and related facilities i) gas turbine, ii) heat recovery steam generator (HRSG), iii) steam turbine, iv) generator system and in-house electric equipment, v) switchyard equipment, vi) instrument and control system, vii) fuel supply system, viii) water supply system, ix) intake and discharge system, x) buildings for gas turbine, xi) other auxiliaries	As planned
・Construction of 220 kV transmission lines (30 km x 2 lines, 46 km x 2 lines, and 31 km x 2 lines) Construction of 1 substation, and upgrading of 2 substations	Out of scope

7 Source: Country Data Book 2005

・Consulting services i) detailed design, preparation of documents for P/Q, tendering and contract, ii) assistance on procurement, iii) construction supervision, iv) performance evaluation after project completion, v) support of operation and maintenance, vi) preparation of Environmental Impact Assessment report, support of environmental monitoring	Mostly as planned

Source: Documents provided by JICA, Project Completion Report (PCR), questionnaire answers from the executing agency

In this project, the construction of power plant facilities was carried out as planned, but the construction and rehabilitation of transmission lines and substations was excluded from the scope of this project. This is because the bidding for the transmission line and substation failed due to the submitted bids being much higher than anticipated and it was therefore judged that it would not be possible to implement within the project budget. According to the executing agency, this change was agreed upon by both Azerbaijan and Japan, and the construction of the transmission line and substation, which was excluded in the project, was conducted with the support of the Asian Development Bank[8] and completed in 2017.

As for consulting services, the necessary support has been mostly provided as planned. With regard to the planned Environmental Impact Assessment (EIA) report preparation and environmental monitoring assistance, the monitoring items and reports could not be confirmed because the necessary documents, including the report, were not kept at the executing agency or power plant. However, an interview conducted with the Shimal Power Plant confirmed that environmental monitoring was conducted during project implementation and that implementation support was provided.

[8] It was completed as a part of "220 kV Hovsam-Shimal TTP-Zobrat-Sanaye Qovshagi Transmission Line Project" which was supported by the Asian Development Bank.

Left photo: Steam turbine (back left) and gas turbine (front) Right photo: HRSG

Left photo: Main transformer Right photo: Control room

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was 55,748 million yen, significantly higher than the originally planned cost of 35,191 million yen (158 % of the original plan).

Table 2 Planned and Actual Project Cost

(Unit: million yen)

	Plan			Actual		
	Japanese portion	Azerbaijan portion	Total	Japanese portion	Azerbaijan portion	Total
Construction work	23,632	3,383	27,014	27,414	26,915	54,329
Power plant portion	19,592	2,934	22,526	27,414	26,915	54,329
Transmission portion	4,040	449	4,488	0	0	0
Consulting services	969	0	969	1,005	0	1,005
Physical contingency	2,507	338	2,846	0	0	0
Price escalation	1,446	0	1,446	0	0	0

Interest during construction	726	0	726	415	0	415
Non eligible item	0	2,190	2,190	0	0	0
Total	29,280	5,911	35,191	28,833	26,915	55,748

Source: Document provided by JICA, PCR, questionnaire answers from the executing agency
Note 1: Figures do not match in total because of the rounding.
Note 2: Exchange rate As of appraisal: 1 manat ＝ 0.22 yen, Actual: 1 manat = 105.2 yen (Average rate by International Financial Statistics of IMF during the project implementing period) In January 2006, the new manat, which was formerly equivalent to 5,000 manats, was introduced. Later, the devaluation of the manat occurred in 2015 and then the fall in the exchange rate due to the transition to a floating exchange rate in December of the same year. Accordingly, the exchange rate at the time of the appraisal and the ex-post evaluation differed significantly.

However, since the power transmission and transformation portions were excluded from the project scope, a comparison of the project cost at the time of the project appraisal (35, 191 million yen - 4,488 million yen = 30,703 million yen) versus the actual cost (55,748 million yen) indicates that the total project cost is 182% of the plan. Of this amount, the ODA loan amount was 11 4% of the planned cost (28,833 million yen/(29,280 million yen – 4,040 million yen)), while the Azerbaijan government’s share was 492 % of the planned cost (26,915 million yen/(5,911 million yen – 449 million yen)). The main reasons why the project cost exceeded the plan were higher costs, including that of construction materials, due to higher oil prices, higher global plant prices, fluctuation of the exchange rate and extension of the project period[9]. Project cost, including the consultant re-extension contract, which was incurred after the completion of the loan disbursement in August 2014, was borne by the Azerbaijan side and significantly exceeded the planned amount.

3.2.2.2 Project Period

The project period[10] was planned to be 75 months as opposed to an actual 197 months, from September 2005 to September 2021, which was significantly longer than planned (263% of the plan).

Table 3 Project Period of the Project

	Plan (as of the appraisal)	Actual
Signing of L/A	May 2005	May 2005
Selection of consultant	April – November 2005	May 2005 – April 2006
Bidding and contract	December 2005 – March 2007	Concurrence to the bidding result December 2010
Construction (of power plant, transmission lines and substations)	April 2007 – June 2009	September 2011 – September 2019
Defect liability period	July 2009 – June 2011	October 2019 – September 2021
Project period	75 months	197 months

Source: Document provided by JICA, PCR, questionnaire answers from the executing agency

9 Interview surveys with the executing agency and the commissioned consultant
10 The project period is defined as the period from the month in which the L/A is signed to the month in which the defect liability period ends.

The main reasons for the delays are as follows.

(1) Unsuccessful bidding

The project has been greatly delayed due to two unsuccessful rounds of bidding. The first failure was due to the lack of bidders meeting the minimum technical score specified in the Request for Proposal. Therefore, some items of the technical evaluation were modified and a second bid was readied. In the second bid, although the minimum score was cleared, the bid price was much higher than the expected price, ending in an unsuccessful bid. After a third round of bidding, it was decided to divide into civil works and equipment procurement.

(2) Project suspension due to request for end of loan disbursement

In May 2008, after two unsuccessful biddings, the executing agency suddenly requested to end the loan disbursement. Although clear information on the details and background of the request could not be obtained, the project was suspended until the counterpart requested the resumption of the loan in June 2009 and both parties agreed to resume the project again in August 2009, after various efforts from the parties concerned. This suspension became one of the factors that delayed the project.

(3) Delays in construction due to the mobilization of associate manpower to another national priority project and currency devaluation

The project experienced significant delays due to construction progress being affected by the Azerbaijan side contractor who were assigned to another national project on a priority basis, as well as the budget allowance becoming unfeasible due to depreciation of the country's currency which was caused by the significant drop in oil prices from 2015.

(4) Delays due to re-procurement of the equipment during a commissioning

During a commissioning test conducted in 2018, due to problems occurred with a part of the equipment at a substation, it was necessary to re-procure the main transformer itself, its attachments, and peripheral equipment. Accordingly, the start of commissioning testing as well as construction completion were delayed.

As described above, there were a variety of factors causing the project's delay; however, the request for the suspension of the loan by the government and preferential assignment of the contractor's workers to a national project were matters beyond the control of the executing agency and project stakeholders. In implementing the prolonged project, the commissioned consultant engaged in the project signed a direct contract with the executing agency in a form that did not utilize ODA loans. After the disbursement of the ODA loan was completed in 2014, the consultant continued to provide support with the Azerbaijan side's budget until the completion of construction in 2019.

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

Table 4 shows the internal rate of return (IRR) of the project calculated at the times of the appraisal and the ex-post evaluation along with calculation assumptions. The IRR at the time of the ex-post evaluation was recalculated using the same assumptions as the ones used for the appraisal. At the time of the appraisal, only the Financial Internal Rate of Return (FIRR) was calculated for this project, and it could not be confirmed why the Economic Internal Rate of Return (EIRR) was not calculated. Therefore, in the ex-post evaluation, the FIRR was recalculated based on the calculation conditions at the time of the appraisal and compared the results.

Table 4 Internal Rate of Return and Calculation Assumption

	Financial Internal Rate of Return (FIRR)
Internal rate of return	As of appraisal: 8.8 %　As of ex-post evaluation: 1.1 %
Cost	Project cost, operation and maintenance cost
Benefit	Revenue from sale of energy
Project life	30 years

Source: Recalculation is based on JICA documents and data provided by the executing agency at the time of the ex-post evaluation.
Note: The FIRR calculated at the time of the appraisal was 9.2 %, but given that the project life starting point was set to the year that the project was expected to be completed, it was recalculated in accordance with the ex-post evaluation reference and by setting the starting point to the year that the L/A was signed.

The FIRR at the time of ex-post evaluation was 1.1 %, which fell below 8.8 % at the time of project appraisal. Although the benefits (electricity sales revenue) were higher than expected at the time of the assessment due to higher electricity sales charges and a high utilization rate of the facility, the significant delay of the project period (263 % versus to the plan) delayed the facility's operation for about 10 years, was considered to have significantly impacted the project.

In light of the above, both the project cost and project period significantly exceeded the plan. Therefore, efficiency of the project is low.

3.3 Effectiveness and Impacts[11] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

Table 5 summarizes the actual data for each of the operation and effect indicators after the completion year of the project facilities construction.

[11] Sub-rating for Effectiveness is to be put with consideration of Impacts.

Table 5 Operation and Effect Indicators of the Project

		Target	Actual		
		2021	2019 Note 1	2020	2021 Note 2
		2 Years after completion	Construction works completion year	1 year after construction works Completion	Project Completion
Generation	Maximum output (MW)	400	377	380	380
	Plant load factor (%)	Over 70	87.4	85.2	88.2
	Plant availability (%)	Over 90	93.8	95.6	99.8
	Auxiliary power rate (%)	Below 3	2.2	2.1	2.1
	Gross thermal efficiency (%)	Over 50	57.1	56.7	57.2
	Length of outage time by human errors (hr)	0	0	0	0
	Length of outage time by mechanical errors (hr)	0	136	341	5
	Length of outage time by planned/ periodical inspection (hr)	Below 775	0	42	0 Note 3
	Number of outages by human errors	0	0	0	0
	Number of outages by mechanical errors	0	8	7	3
	Number of outages by planned/ periodical inspection	1	0	1	0
	Amount of net generated output (GWh)	2,379	2,363	2,511	2,601
Transmission	Availability factor (%)	Within 100	82.0	85.1	90.2
	Transmission loss (%)	Below 5	0.38	0.38	0.35

Source: Documents provided by JICA, questionnaire answers from the executing agency
Note 1: Actual results for October-December 2019
Note 2: Actual results for January to April 2021
Note 3: Although not included in the table data, there were 224 hours of planned outages in May 2021.

According to the data for the period from October 2019 to April 2021[12], since the second Shimal Power Plant unit began operating, maximum output[13], plant load factor, plant availability, auxiliary power rate, gross thermal efficiency, length and number of outages due to human error, amount of net generated output, transmission availability factor and transmission loss rate have

[12] Since the construction of second unit of Shimal Power Plant was completed in September 2019, the data obtained from the executing agency covered from October 2019 to the latest data available at the time of the survey (April 2021).
[13] Actual maximum output continues to be around 380 MW versus the maximum output of 400 MW, but this is due to the fact that the gas and steam turbines do not reach the standard level in summer due to the higher seawater temperature, and a 20 MW reserve is maintained during winter in accordance with dispatcher instructions. (Source: Interview with Shimal Power Plant)

mostly achieved target as of April 2021. This verifies that the project has achieved its intended effects. On the other hand, the length of outage time by mechanical errors and number of outages by mechanical errors have not achieved the target due to a certain length and number of outages caused by mechanical error. The main causes of mechanical error were compressor failure (as of November 2019), damage to electrical couplings[14] (as of May 2020), and transformer failure (as of November 2020) and so on. In this project, the target for these indicators were set at 0 hours/year and 0 times/year, respectively. According to Shimal Power Plant engineers and the commissioned consultant, it is expected that many parts will have initial defects during the first few years of operation, and some kinds of breakdown will occur[15]. Therefore, it would have been unrealistic to achieve the target value of zero for total hours and frequency of outages due to mechanical failure.

In addition, the target for the length of outage time by planned/periodical inspections, which was set at a maximum of 775 hours per year, was only 42 hours in 2020. This indicates that the planned routine inspections were not carried out. According to Shimal Power Plant, this was due to the fact that the timing of routine inspections at the second Shimal Power Plant unit were temporarily postponed due to the need to carry out inspection and repair work at other power plants that were deemed to be directly affected by the problems in Azerbaijan's energy grid in 2020. This postponed work was carried out in May 2021, resulting in 224 hours of outage time due to planned outages.

3.3.1.2 Qualitative Effects (Other Effects)

One of the expected qualitative effects of the project was a reduction of primary energy consumption as a result of constructing a gas combined cycle power plant capable of generating power with high efficiency. Comparing fuel oil consumption per MW at the second Shimal Power Plant unit against the Azerbaijan Thermal Power Plants that have been operating until now shows that the Shimal plant consumed around 67 % of the amount of fuel consumed at the Azerbaijan plant[16]. According to the actual power generation and fuel consumption of both power plants from January to August 2020, the second Shimal Power Plant unit was able to reduce by 181,040,096 Nm^3[17]. This has also resulted in a fuel cost savings of approximately 18 million manat (roughly 1,127 million yen)[18]. Therefore, it can be judged that the improvement

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[14] This refers to the parts used to connect metal pipes, etc.

[15] For example, Unit I of Shimal Power Plant, which was built using a past ODA loan, reportedly had around 1, 200 hours of downtime due to mechanical failures in the year after it began operation, around 600 hours 2 years later, and around 400 hours 3 years later, thus the situation, where the operation has been getting stabilized over time, is reported. In many past ex-post evaluations of other power plant construction projects, target values were set based on the expectation that a certain number of hours/times of outages would occur due to mechanical failures during their first few years of operation.

[16] Fuel consumption per MW for the second Shimal Power Plant unit is roughly 185.6 Nm^3, while it is roughly 277.3 Nm^3 at Azerbaijan Power Plant.

[17] Nm^3 (normal rube) is a unit for expressing the volume of gas.

[18] Source: Documents provided by the executing agency

of the second Shimal Power Plant unit has contributed to improving power generation efficiency.

3.3.2 Impacts

3.3.2.1 Intended Impacts

Expected impacts of this project were a reduction of power shortages and sustainable economic growth. Azerbaijan has increased the installed capacity of its power plants from 5,556 MW in 2003 to 6,500 MW in 2019, and the construction of the second Shimal Power Plant unit has also contributed to this increase. According to the executing agency, the reserve supply capacity, which was 290 MW before the second Shimal Power Plant unit began operation, has now increased to 640 MW. Based on this, the plant is judged to have contributed to improving the power shortage situation. Figure 1 shows the economic growth rate and amount of electricity generated since 2005. It shows that the power generation growth rate has lagged behind the economic growth rate, and the reserve supply capacity is deemed to have expanded due to enhancing generation capacity during that time.

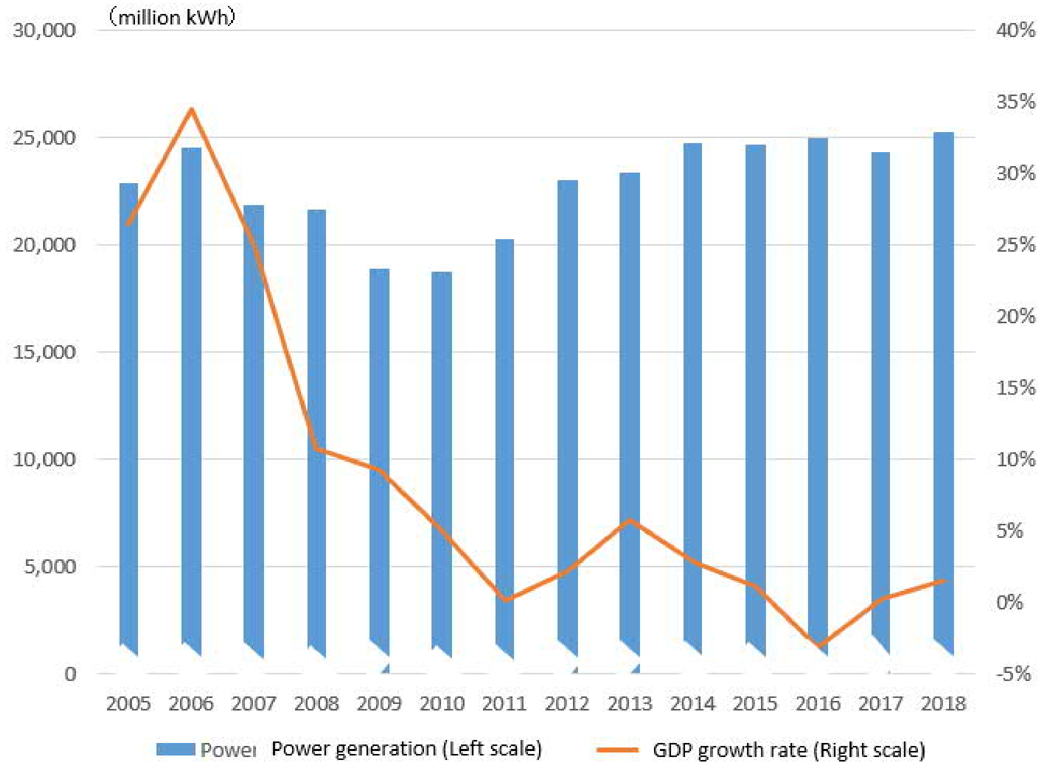

Figure 1 Changes in GDP Growth Rate and Power Generation from 2005 to 2018

Source: Statistics published by the National Statistics Committee

The macro impact of this project is difficult to judge as the power generation facilities constructed under the project just started operating in September 2019. As mentioned above, however, the implementation of the project is considered to have played a role in securing reserve supply capacity and realizing a stable supply of electricity.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the natural environment

In accordance with *JBIC Guidelines for Confirmation of Environmental and Social Considerations* (April 2002), the project falls into Environmental Category A, as this project is categorised as a large-scale thermal power generation sector. In Azerbaijan as well, an EIA and its approval must be implemented in two stages. In this case, the first stage was approved in 2005 and second stage in March 2007 by the Ministry of Ecology and Natural Resources. Upon checking with the executing agency, it was not possible to confirm the items stipulated in the EIA in writing and monitoring items as they did not keep the documents. However, it was confirmed through interviews at the Shimal Power Plant that the stipulated items were monitored during construction and there were no negative impacts. The executing agency has also established an environmental protection policy that conforms to ISO 14001, the international standard for environmental management systems, and has taken daily measurements of the quality and temperature of the cooling water before and after its cooling, and the quality of the exhaust gas (content of carbon monoxide, nitrogen oxides, carbon dioxide, etc.), and Ecology Department within the executing agency has conducted monitoring to ensure these falls within the standards. Up to the point of ex-post evaluation, it has been confirmed that no negative impacts have occurred.

(2) Resettlement and land acquisition

Since the second unit of Simal Power Plant was constructed at the site of an existing power plant, no land acquisition or resettlement occurred when implementing this project.

In light of the above, this project has mostly achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating:③)

3.4.1 Institutional/Organizational Aspects of Operation and Maintenance

The operation and maintenance of the second unit of Shimal Power Plant, constructed within the project, is under the jurisdiction of Azerenergy. Azerenergy is responsible for the construction, maintenance, operation, and management of power generation, transmission, and substation facilities in Azerbaijan, and also handles the supply of power to distribution companies[19].

[19] Other than head office functions, the power plant and transmission and substation maintenance departments have been formally spun off.

The Boiler-Turbine Department of Shimal Power Plant is in charge of carrying out operation and maintenance activities (see Figure 2). As of 2021, the plant has 191 employees, of which 37 are engaged in the operation and maintenance of the second unit.

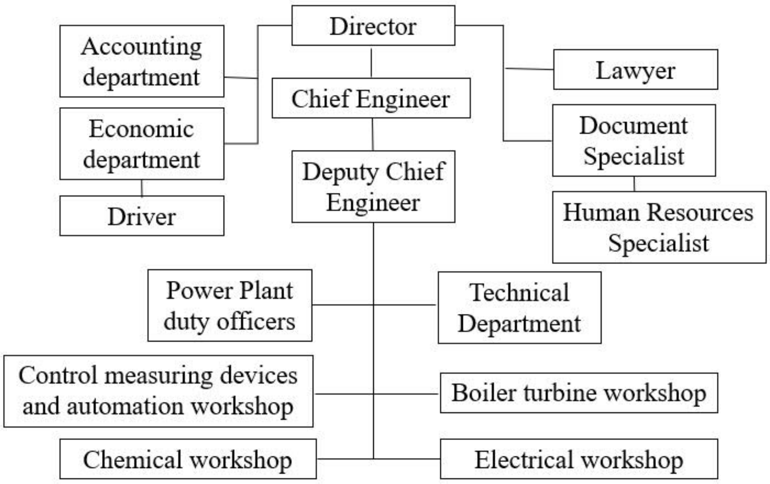

Figure 2 Organization Chart of Shimal Power Plant

Source: Documents provided by the executing agency

For both the first and second units, 10-year long-term service agreements have been entered into with the gas turbine manufacturer. The contracted manufacturer dispatches experts to carry out maintenance alongside power plant staff. Although anything besides the gas turbines are not covered by the long-term service agreement, support or assistance can be requested by entering into a separate contract with the manufacturer in the event of a problem. Due to the fact that there are few technicians that specialize in gas turbines and these contracts also include the procurement of spare parts, it is common for power plants with gas turbines to enter into such long-term service agreement[20] in Azerbaijan.

As mentioned above, the operation and maintenance system for the second unit of Simal Power Plant is clear, and there is no shortage of personnel in charge of maintenance work, so it can be said that there is no particular concern.

3.4.2 Technical Aspects of Operation and Maintenance

With regard to operation and maintenance of the facility, training was provided by the contractor at the time of the generator's installation and start-up. Even after the conclusion of this project, Azerenergy's training centre continues to provide training to support maintaining and improving of the technical skills of staff engaged in the maintenance of the Shimal Power Plant (see Table 6 for a training summary).

[20] Source: Hearing survey with Shimal Power Plant

Table 6 Shimal Power Plant Employee Knowledge and Professional Development Training Courses for 2019 - 2021

Course title	Number of courses	Number of participants
Operational transformations in power plants	4	29
Operation of heat technical equipment	3	42
Chemical treatment of water and chemical water regime	2	15
Operation of control measuring devices and automation devices	2	14
Total	11	100

Source: Questionnaire answers from the executing agency

Although there is a shortage of gas turbine specialists, as mentioned above, specialists are dispatched under a long-term service agreement, and Shimal Power Plant staff work alongside them to perform maintenance. The fact that second unit of Shimal Power Plant has continued to operate at its rated output since its start-up indicates that there are no concerns in terms of technical aspect.

3.4.3 Financial Aspects of Operation and Maintenance

At the time of the project appraisal, Azerenergy had been running a deficit since 2001 because its rates did not meet the cost level and were kept low under government policy. Since that time, in 2016 the retail electricity rate, which had been 0.06 manat per kWh (about 3.6 yen) since 2007, was increased to 0.07 manat per kWh up to 250 kWh/month and 0.11 manat per kWh above 250 kWh/month. This has resulted in increasing Azerenergy's electricity sales revenue and the company has been consistently profitable since then. On the other hand, the company's final profit and losses continues to be in the red due mainly to foreign exchange losses, equipment damage and other losses, as well as cost depreciation on aging facilities and equipment built in the 1980s. That being said, although the exact amount could not be obtained from the executing agency, it has been confirmed through interviews with the executing agency and Shimal Power Plant that the budget required to operate and maintain second unit of Shimal Power Plant has been secured. In addition, Government has also provided financial support to Azerenergy, including government grants and loan guaranties and it is planned that the government policy regarding the provision support will continue in the foreseeable future[21].

Therefore, while it is necessary to continue to monitor Azerenergy's final profit and losses which continue to be in the red, it would be fair to say that there are no serious financial concerns since operating profit has remained in the black as result of the electricity rate hike, and the fact that the budget necessary to appropriately operate and maintain the activities of the second unit of Shimal Power Plant has been allocated.

[21] Source: *Azerenergy, Consolidate Financial Statements for the Year Ended 31 December 2018.*

Table 7 Profit or Loss of Azerenergy

(Unit: thousand manat)

	2015	2016	2017	2018
Revenue				
Sales of energy	725,879	807,170	1,010,337	1,045,470
Other sales	7,883	2,991	2,999	2,556
Expenses				
Fuel	-392,466	-371,019	-647,584	-518,534
Depreciation and amortization	-159,268	-152,895	-183,136	-178,973
Staff costs	-54,164	-41,623	-42,066	-49,581
Repair and maintenance	-23,982	-22,259	-72,757	-39,611
Ohers	231,050	-78,308	68,642	-181,164
Operating profit	334,932	144,057	136,435	80,163
Non operating expense・special loss	-1,313,281	-281,760	-658,937	-139,331
Profit/loss before income tax	-978,349	-137,703	-522,502	-59,168
Net profit	-870,530	-108,928	-602,873	-307,335

Source: Prepared by the evaluator based on the consolidate financial statement published in the web site of Azerenergy

3.4.4 Status of Operation and Maintenance

The operation and maintenance status of the facilities developed in this project is judged to be generally good. With regard to the gas turbine, maintenance and inspections are being performed in accordance with the long-term service agreement, and they are running smoothly. On the other hand, as discussed in the section on effectiveness, since the start of operation in September 2019, there have been roughly 42 hours of outage time due to planned outages, which indicates that the planned periodic inspections have not been carried out. According to interviews conducted with the Shimal Power Plant, there have been delays due to the maintenance work required to deal with mechanical failures since the start of operation as well as the national grid accident that occurred, but 60 days of planned inspections have been scheduled for the first unit and 21 days for the second unit in 2021. Other problems reported were that the drum level of the heat recovery steam generator sometimes becomes unstable, for which the cause is now being investigated; also, the pressure regulating valve of the steam turbine sometimes does not open during start-up. To resolve these, measures are being taken to start the turbine with the pressure set to zero to ensure reliable operation. Nevertheless, these problems have not affected power generating functionality itself. The condition of the other facilities (electrical system, monitoring and control system, fuel supply system, water supply system, gas turbine building, and other auxiliary equipment) has been confirmed to be in good condition through site visits by the local assistants and interviews with Shimal Power Plant.

There have also been no problems in procuring consumables and wearing parts due to the long-term service agreement. However, it was reported that manuals were only available in English with no Azerbaijani language translation provided. The executing agency pointed out that manuals that contain many technical terms are difficult to understand quickly when in

English and translating them is time-consuming so it would be preferable if they were provided in Azerbaijani.

As for the intake that feeds cooling water into the power plant, at the time of the project appraisal, since seaweed and sand were clogging the intake of the first unit of Shimal Power Plant, the installation of an intake for both units was planned and implemented. Although some sand and other materials are still clogging the intake due to the construction method[22] being modified, this has been addressed by dredging, and no further problems had arisen up to the time of the ex-post evaluation.

Photo: Pond-type water intake

As mentioned above, the operation and maintenance status of facilities and equipment maintained in this project is generally good, and because future maintenance is expected to be carried out as planned, it can be said that there are no concerns.

In light of the above, no major problems have been observed in the institutional/organizational, technical, financial aspects and current status of the operation and maintenance system. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project implemented the construction of a gas combined cycle power plant in the Absheron peninsula area of eastern Azerbaijan, aimed at expanding the supply capacity of stable power and improving efficiency. The objective of the project is deemed consistent with the development policy and development needs of Azerbaijan at the time of the project appraisal and ex-post evaluation, as well as with Japan’s aid policy. Therefore, the relevance of this project is high. Although the output for power generation was as planned in the implementation of this project, the construction and rehabilitation of transmission lines and substations were implemented as part of a separate project due to the difficulty in keeping them within the project budget as a result of unsuccessful bidding. The project period largely exceeded the plan due to a number of factors that included unsuccessful bidding, a request from the counterpart government for the end of disbursement, suspension of the project related to changes to the assignment of staff in Azerbaijan, and re-procurement of the equipment at a substation. The project cost also largely exceeded the plan due to rises in prices and the extension of the project period. Thus, the efficiency of the project is low. It was

[22] The water intake method was changed from a deep typed intake, in which water is captured from a point 450 m offshore and 8 meters deep to prevent algae and sand from becoming blended into the intake water, to a pond-type intake method.

confirmed that the expected effectiveness was achieved in terms of power generation, including maximum output, utilization and availability of facilities, as well as transmission including transmission loss ratio. This project is also considered to have contributed to improving power generation efficiency, reserve capacity, as well as reducing the power shortages. Therefore, effectiveness and impacts of the project are high. Although there are some points to be noted in the current maintenance status, there are no particular problems in terms of institutional/organizational, technical, and financial aspects of operation and maintenance. Therefore, sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

・It was confirmed that, up to April 2021, there was a total of 0 hours of planned outage time after the facility went into operation, and that planned inspections and maintenance had not been carried out. This was due to the fact that after the second Shimal Power Plant unit went into operation, it became necessary to deal with the problems that occurred in the national grid, resulting in planned inspections at second unit being postponed. Taking into account that postponed work was carried out in May 2021 and the second Shimal Power Plant unit has only been in operation for a short time since beginning service, no operational issues have occurred up to the time of the ex-post evaluation. However, in order to prevent future breakdowns of facilities and equipment, it will be necessary for Azerenergy and Shimal Power Plant to establish a system that ensures that the necessary time for routine inspections and maintenance can be secured and carried out based on its medium- and long-term plan.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

<u>Setting realistic operation and effect indicators</u>

In this project, the length of outage time and the number of outage by machine error was set as an operation and effective indicator, and the targets were set at 0 hours/year and 0 times/year, respectively. However, it would be difficult to expect that no damages will occur including the initial defects during the first few years of operation, and some kinds of breakdown will occur. Therefore, in many cases, setting the target as zero is difficult to achieve realistically. Thus, when setting operation and effect indicators at the time of project planning, it is desirable to set realistic target after understanding the characteristics of the facilities and equipment maintained by the project, while also referring to the indicators and targets of similar projects in the past.

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project outputs	1. One unit of gas combined cycle power plant and related facilities (i) gas turbine, ii) heat recovery steam generator, iii) steam turbine, iv) generator system and in-house electric equipment, v) switchyard equipment, vi) instrument and control system, vii) fuel supply system, viii) water supply system, ix) intake and discharge system, x) buildings for gas turbine, xi) other auxiliaries)	1. As planned
	2. Construction of 220 kV transmission lines (30 km x 2 lines, 46 km x 2 lines, and 31 km x 2 lines) Construction of 1 substation, and upgrading of 2 substations	2. Out of scope
	3. Consulting services i) detailed design, preparation of documents for P/Q, tendering and contract, ii) follow up on procurement, iii) construction supervision, iv) performance evaluation after project completion, v) support of operation and maintenance, vi) preparation of EIA report, support of environmental monitoring	3. Mostly as planned
2. Project period	March 2005 – June 2011 (75 months)	March 2005 –September 2021 (197 months)
3. Project cost Amount paid in foreign currency Amount paid in local currency Total ODA loan portion Exchange rate Note 1	 29,280 million yen 5,911 million yen (205,550 million manat) 35,191 million yen 29,280 million yen 1 manat = 0.02 yen (As of December 2004)	 28,833 million yen 26,915 million yen (255 million manat) 55,748 million yen 28,833 million yen 1 manat = 105.2 yen (Average between May 2005 and September 2019)
4. Final disbursement	August 2014	As planned

Note 1: In January 2006, the new manat, which was formerly 5,000 manats, was introduced. Later, the devaluation of the manat in 2015 was occurred and the fall in the exchange rate due to the transition to a floating exchange rate in December of the same year. Accordingly, the exchange rate at the time of the appraisal and the ex-post evaluation changed significantly.