

Armenia

Ex-Post Evaluation of Japanese ODA Loan Project
Electricity Transmission and Distribution Project

External Evaluator: Yasuhiro Kawabata, Sanshu Engineering Consultant

0. Summary

The project objectives were to enhance stability and reliability of electricity supply, reduce technical losses in the electricity transmission network and increase tariff collection rates by rehabilitating the transmission and distribution network and installing meters for consumers in Armenia, thereby contributing to improve the international trade balance through strengthening the financial condition of transmission and distribution enterprises, and using the energy resources more effectively. The project has been highly relevant to the development plans and needs of Armenia, as well as Japan's ODA policies. Regarding enhancement of stability and reliability of electricity supply, reduction of technical losses in the electricity transmission network and increase of tariff collection rates, which are the project's objectives, since the project has largely achieved its objectives, its effectiveness and impact are high. Even though the project's outputs changed substantially from the original plan, changes made are considered reasonable. Although the project cost was within the plan, the project period was significantly longer than planned. Therefore, the efficiency of the project is fair. Since some problems have been observed in terms of financial condition, therefore sustainability of the project effect is fair.

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

1. Project Description



Projection Location



Rehabilitated Echmiatsin Substation

1.1 Background

As the Armenian power sector had been developed as part of Pan-Caucasian¹ networks since the old Soviet era, the power generating capacity had an excess capacity against the country's demand. However, the electricity supply in 1993 dropped to the level of 40% of that in 1988 due to closure of Metzamor Nuclear Power Plant damaged by the earthquake occurred in December 1988, destruction of gas pipelines traversing the country because of conflict in Georgia, and reduction of the operational rate of thermal power plants due to increase of imported fuel price. Because of the power crisis occurred during 1993 – 1995, which arose from the above mentioned reasons, Armenia was forced to recommission the nuclear power plant, which was questionable in terms of safety. Because of recommission of a nuclear power plant (in December 1995) and lower electricity demand due to the economic recession, electricity has been supplied for 24 hours a day since 1996.

However, most of thermal plants, which were constructed between 1963 and 1976, had been deteriorated because of lack of proper maintenance since 1980's. Because of insufficient maintenance for a long time, and concentration of electricity consumption exceeding the facility capacity into a short period when supply was limited, transmission and distribution systems had been remarkably deteriorated causing burnout of transformers and meltdown of cables, resulting in voltage drop and unsecure supply. Under these circumstances, the Armenian government tackled the reform of the power sector, and split the old Armenergo, which has been a monopoly in the power sector, into generation, transmission and distribution parts and established an independent Energy Commission, which was responsible for licensing and tariff setting.

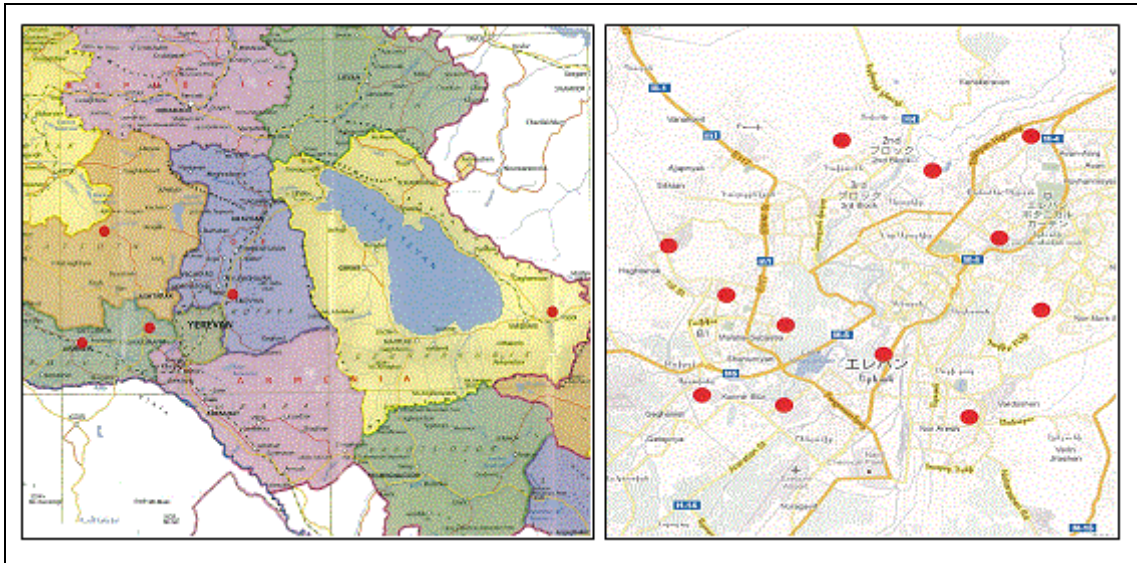
As mentioned above, the losses in the electricity supply system in Armenia were substantial due to aging of facilities and lack of proper maintenance. Thus, the government defined that together with new construction and rehabilitation of power plants, rehabilitation of the transmission and distribution system was the most priority project in the National Development Plans.

At the appraisal stage (in 1999), other aid agencies including international institutions had provided assistance to the Armenian power sector. Rehabilitation of existing plants, which were urgently needed to be implemented, had been assisted by the World Bank (WB) and German Reconstruction Credit Institute (KfW). Rehabilitation of a thermal plant (Hrazdan Thermal Plant Unit No.5), which would have been a replacement of a nuclear plant was originally planned to be completed with the funds from European Bank for Reconstruction and Development (EBRD) by end 1999.

¹ Region surrounded by Black Sea and Caspian Sea in the midst of Europe, Asia and Middle East.

1.2 Project Outline

The project objectives were to enhance stability and reliability of electricity supply, reduce technical losses in the electricity transmission network and increase tariff collection rates by rehabilitating the transmission and distribution network and installing meters for consumers in Armenia, thereby contribute to improve the international trade balance through strengthening the financial condition of transmission and distribution enterprises, and using the energy resources more effectively. The location of the project site is shown in Figure 1.



Note: Location of substations (110kV) rehabilitated under the project. The left map shows those in the Yerevan suburbs (5 sites), while the right map shows those in Yerevan district (12 sites). The project sites are located in the vicinity of Yerevan.

Figure 1: Location of Project Site

Loan Approved Amount/ Disbursed Amount	5,399 million yen/5,368 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	December 1998/February 1999
Terms and Conditions	For civil work and procurement: Interest Rate: 1.80%, Repayment Period: 30 years (Grace Period: 10 years) Conditions for Procurement: General untied For Consulting services: Interest Rate: 0.75% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: Bilateral tied
Borrower / Executing Agency(ies)	Government of Armenia /Energy Investment Project Implementation Office ² (during project implementation)
Final Disbursement Date	October 2010 (originally October 20, 2005)

² Energy Investment Project Implementation Office was an executing agency during the implementation stage. However, it was abolished due to the institutional reform in the energy sector in 2011.

Main Contractor (Over 1 billion yen)	ABB AB (Sweden)/ Eltel Networks Corporation (Finland) (JV), Heilongjiang No.1 Thermal Power Construction Corporation (China)
Main Consultant (Over 100 million yen)	Nippon Koei/TEPCO
Feasibility Studies, etc.	Feasibility Study by World Bank PHRD, USAID and EU (1996)
Related Projects	Cofinancing with World Bank / USAID

2. Outline of the Evaluation Study

2.1 External Evaluator

Yasuhiro Kawabata, Sanshu Engineering Consultant

2.2 Duration of Evaluation Study

Duration of the Study: September 2012 – August 2013

Duration of the Field Study: November 24 – December 9, 2012 and March 3 – 22, 2013

2.3 Constraints during the Evaluation Study

- (1) The project was cofinanced by JICA, US Agency for International Development (USAID), and the World Bank (WB), and consisted of all the components financed by three institutions. Thus, the evaluation was made on all the components funded by three agencies based on the DAC's five evaluation criteria in principle. Since examination of the effectiveness and impact of the project could not be made on each component funded by three agencies, all the components implemented by three institutions were assessed as one package. However, regarding the efficiency and sustainability, the analysis and assessment was made only on the project components funded by JICA.
- (2) The project scope is rehabilitation of the existing facilities, it is difficult to clarify the details on the following: which facilities were how rehabilitated; and how much the estimated costs of each work item under the rehabilitation work were. Moreover, since the project scope to be funded by JICA was substantially revised during the implementation, it is not feasible to compare the originally planned output (or the output revised during the project implementation) with the actual output. Thus, basically comparison between the originally planned output and actual output accomplished on the JICA funded components was made.

3. Results of the Evaluation (Overall Rating: B³)

3.1 Relevance (Rating: ③⁴)

3.1.1 Relevance with the Development Plan of Armenia

The most priority agenda for the Armenian government at the appraisal stage (1999) was to have secure electricity supply at the reasonable tariff in order to assist in improving the country's economic competitiveness and the well-being of the population. Thus, the rehabilitation of transmission and distribution system, together with new construction and rehabilitation of power plants was considered to be the most priority projects in National Development Plans. At the same time, the Government proposed to privatize the power sector enterprises in order to strengthen the efficient use of energy resources while ensuring secure energy supply.

In 2004, the Armenia Government enacted the Law on Energy Saving and Renewable Energy, aiming at: 1) strengthening the economic and energy independency of the country; 2) enhancing the economic and energy security, and the safety level of energy systems; 3) establishing and developing the new industrial infrastructure and institutions/agencies to promote energy savings and renewable energy; and 4) reduction of adverse technical impacts to the environment and human health. After the law was enacted, the following relevant strategies and plans were developed: Energy Sector Development Strategies in Economic Development (2005), National Program on Energy Savings and Renewable Energy (2007), and National Energy Efficiency Action Plan (2010). The Action Plan proposes a set of relevant regulatory and institutional reforms and capacity building together with targets in quantitative terms to be achieved by 2020, which aimed at improving energy efficiency in each sector including residential buildings, public and private services, industry, agriculture, and transport.

At the appraisal (1999) and ex-post evaluation stages, the importance of secure electric supply was/is emphasized in order to enhance the efficient use of energy resources in the power sector. Thus, the project is highly relevant with development policies.

3.1.2 Relevance with the Development Needs of Armenia

As discussed in 1.1 Background, in early 1990s, the electricity supply had been substantially reduced. Even after that, the losses in the electricity supply system in Armenia were substantial due to aging of facilities and lack of proper maintenance, and thus, the government defined that together with new construction and rehabilitation of power plants, rehabilitation of the transmission and distribution system was the most priority project in the National Development Plans. Since then, the government had made efforts to increase power supply. At the appraisal

³ A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

⁴ ③: High, ②: Fair, ①: Low

time (1999), rehabilitation of existing plants, which were urgently needed to be done, had been implemented with financial assistance from the World Bank and German KfW. Rehabilitation of a thermal plant (Hrazdan Thermo Plant Unit No.5), which would have been a replacement of a nuclear plant was under preparation with the funds from European Bank for Reconstruction and Development (EBRD). It was expected that by implementation of rehabilitation projects funded by WB and KfW, and improvement of losses through the JICA project, the operational generation capacity to meet the peak demand would be expanded, resulting in a surplus until 2005, and that the needed generation capacity would be secured. Therefore, at the appraisal stage, in order to further reforms of the power sector and enhancement of quality, rehabilitation and modernization of the transmission and distribution system had to be quickly implemented with purposes to improve non-technical losses by enhancing secure electricity supply, reducing technical losses and increasing tariff collection rates.

The Armenian government issued the National Energy Efficiency Action Plan in 2010 by further expanding policies on energy saving, energy efficiency and renewable energy issued in 2007 and in 2008, and has made efforts to improve the energy savings and enhance efficiency. The System Control and Data Acquisition (SCADA), which was introduced under the project aims at helping use the generated electricity effectively and efficiently. However, SCADA can moreover optimize the operation of generation, transmission and distribution more comprehensively. Through rehabilitation and modernization of the transmission and distribution facilities under the project, enhancement of secure electricity supply and improvement of technical losses has been achieved, and the project has contributed to enhance the energy savings and efficiency, which is the government's primary objective. Thus, the project is highly relevant to development needs as well even at the ex-post evaluation stage.

3.1.3 Relevance with Japan's ODA Policy

In the Mid-Term Strategy for Overseas Economic Cooperation Operations (December 1999), the following agendas were defined as the priority assistance targets in the Caucasian region: rehabilitation of deteriorated social infrastructure, which was caused by lack of maintenance from the old Soviet era; countermeasures for environmental problems; development of social infrastructure needed for the self-supporting economic development; and capacity building needed for market-oriented economy.

Accordingly, the project has been highly relevant to the development plans and needs of Armenia, as well as Japan's ODA policies. Its relevance is therefore considered high.

3.2 Effectiveness ⁵(Rating: ③)

3.2.1 Quantitative Effects (Operation and Effect Indicators)

The project development objectives were to enhance stability and reliability of electricity supply, reduce technical losses and increase tariff collection rates by rehabilitating the transmission and distribution network and installing meters for consumers in Armenia, thereby contributing to improve the international trade balance through strengthening the financial condition of transmission and distribution enterprises, and using the energy resources more effectively. Under the cofinancing scheme (among JICA, WB and USAID)⁶, the original scope of work assigned to JICA was rehabilitation of transmission and distribution system. The project was consisted of all the components financed by three institutions. Since examination of the effectiveness of the project could not be made separately on each component funded by three agencies, all the components implemented by three institutions were assessed as one package. Since the project's outcome is to enhance stability and reliability of electricity supply, to reduce technical losses in the electricity transmission network and to increase tariff collection rates, the quantified effects on these are examined below.

- (1) Reduction of Technical⁷/Commercial⁸ Losses in the Distribution System (enhancement of stability of electricity supply)

Reduction of technical/commercial losses in the distribution system after completion of the project is shown in Table 1.

Table 1: Reduction of Technical/Commercial Losses

	Baseline	Original Target	Actual			
	1999	2007	2009	2010	2011	2012
Technical/ Commercial Losses	Assumed to be 33% of the total electricity distributed	Less than 18% of the total electricity distributed	12.9%	13.2%	12.9%	12.9%

Source: The baseline and original target numbers are taken from the World Bank Implementation Completion Report. Actual figures are shown in the responses to the Questionnaire.

Note: According to the World Bank Implementation Completion Report issued on June 30, 2008, the reduced amount of technical/commercial losses of the distribution system in 2003 and in 2006 was 21.7% and 15.1%, respectively.

⁵ Sub-rating for Effectiveness is to be put with consideration of Impact.

⁶ Main components funded by WB were rehabilitation of transmission and distribution system and consulting services. USAID funded the replacement of meters for consumers.

⁷ Phenomenon, in which the electric energy is partially dissipated as heat due to resistance of the transmission and distribution cables.

⁸ Pilferage, non-payment of tariffs by users, and errors in billing process

According to the WB Implementation Completion Report, it was considered that the total amount of losses before the project was about 33% of the total electricity supply, and it was planned that the original target in 2007 was less than 18%. The actual figure for the immediate past two years after completion of the project is 12.9%, which is lower than the original target by 5%.

The reason why the loss rate had been lowered in 2009 before the JICA-funded components were completed is considered that components financed by the World Bank and part of the JICA project components had been already operational.

(2) Reduction of Technical Losses in the Transmission System (enhancement of stability of electricity supply)

Reduction of technical losses after completion of the project is shown in Table 2.

Table 2: Reduction of Technical Losses

	Baseline	Actual				
	2003	2006	2009	2010	2011	2012
Technical Losses	4.2% of total electricity transmitted	1.4%	1.36%	1.68%	2.01%	2.05%

Source: The baseline and original target numbers are taken from the World Bank Implementation Completion Report. Actual figures are shown in the responses to the Questionnaire.

Note: According to the World Bank Implementation Completion Report issued on June 30, 2008, the reduced amount of technical losses of the transmission system in 2003 and in 2006 was 4.2% and 1.4%, respectively.

The amount of technical losses in the transmission system in 2003 before commencement of full-scale operations was 4.2%. Actual amount of losses in 2012 was 2.05%, which is about half of that in 2003. The reason why the loss rate had been lowered in 2009 before the JICA-funded components were completed is considered that components financed by the World Bank had been already operational.

(3) Increase of Tariff Collection Rates (improvement of the commercial performance and financial condition of High Voltage Electric Network Company and Distribution Company) (Replacement of meters for consumers⁹)

The tariff collection rate at the appraisal stage (1999) was 85%, and the target upon completion of the project was set to be 95%. After meters for consumers, which were partly funded by USAID, were installed at user's homes (households), the actual tariff collection rate has been 100% since 2009.

⁹ As discussed in 3.4 Efficiency, part of replacement of meters was to be funded by the ODA loan. However, this component was canceled from the project and locally funded.

(4) Facility Operational Ratio (enhancement of stability of electricity supply)

The operational ratio of transformers in substations has been almost 100%. However, even after the project completion, the planned outage has partly continued.

(5) Annual Average Outage Hours (enhancement of stability of electricity supply)

The impact on outage hours after completion of the project is shown in Table 3.

Table 3: Annual Average Outage Hours

Unit: minutes /consumer

	2008	2009	2010	2011	2012
Planned Outage	91	95	186	174	123
Unplanned Outage	816	774	1,013	599	401
Total	907	869	1,199	773	524

Source: Responses to the Questionnaire

Note 1: The reason why the unplanned outage hours for the past two years (2011, 2012) are longer than those in 2008 and 2009 is that the regular inspection has been implemented in order to undertake further rehabilitation.

Note 2: The reason why the outage hours in 2010 are high is that it took a long time to repair the electric lines cut due to the adverse weather condition (heavy snow in winter and storms in spring).

Since the project was completed in October 2010, the annual average outage hours have been steadily decreasing.

The current technical/commercial losses in the distribution system are lower than the original target by 5% and the technical losses in the transmission system is about half of the baseline. Thus, the project contributes to the enhancement of stability of electricity supply. The tariff collection rate has been 100% since 2009. This means that tariffs could be unfailingly collected from users so that the project has helped improve the commercial performance and financial condition of relevant power sector companies.

3.2.2 Qualitative Effects

(1) Reduction of Facility Failure, Supply of Power with Stable Voltage, and Improvement of the Financial Condition of Transmission and Distribution Companies

The power sector business in Armenia is implemented under control and guidance of Ministry of Energy and Natural Resources as follows: Electro Power System Operator CJSC (EPSO) is responsible for comprehensively managing generation, transmission and distribution business in order to optimize the use of power. The Settling Center measures and confirms the amount of electricity actually generated, transmitted and distributed by the entities and companies in charge of generation, transmission and distribution. Establishment of this kind of system enabled the effective use of energy

resources and stable supply of energy. International financial control and auditing systems have been applied to Electricity Network of Armenia (ENA) and High Voltage Electric Network CJSC (HVEN), and external audits have been performed by international audit firms. Thus, these practice contributes to strengthen commercial performance and financial condition of both companies.

3.3 Impact

3.3.1 Intended Impacts

The project originally aimed at contributing to improve the international trade balance.

(1) Contribution to Increase of Direct Foreign Investment and International Trade Balance.

The increase of direct foreign investment after completion of the project is shown in Table 4 and the international trade balance in Table 5.

Table 4: Direct Foreign Investment

Unit: million USD

Year	1999	2008	2009	2010
Invested amount	122	935	777	935

Source: World Bank Project Appraisal Document (1999, 2012)

Table 5: International Trade Balance

Unit: million USD

Year	1999	2008	2009	2010
Imported amount	811	4,426	2,378	3,783
Exported amount	232	1,057	624	1,011
Trade Balance	579	3,369	1,754	2,772
Trade total	1,043	5,483	3,002	4,794

Source: World Bank Project Appraisal Document (1999, 2012)

Although the direct foreign investment amount once decreased in 2009 after the Lehman Shock, in 2010 the amount reached the level recorded in 2008, which is about 8 times of amount recorded in 1999, when the appraisal was made. Although the total trade amount once decreased in 2009, the amount recovered well in 2010, which is about 4.6 times of amount recorded in 1999, when an appraisal was made. However, the adverse trade balance has been still continuing because of the Armenian economic form. It is difficult to clarify whether or not the project contributed to increase of the direct foreign investment and international trade balance.

(2) Increase of Exported/Imported Amount of Electricity

The exported/imported amount of electricity after completion of the project is shown in Table 6.

Table 6: Exported/Imported Amount of Electricity

Unit: million kWh

Year	2007	2008	2009	2010	2011
Exported amount	313	360	336	1,061	1,383
Imported amount	409	338	246	157	71

Source: Responses to the Questionnaire

Electricity is currently exported to, and imported from only Iran. There is an agreement in which both countries accommodate each other on electricity depending on the demand/supply condition. Armenia exports electricity to Iran during summer time (April – September), while it imports during winter time (October – March).

3.3.2 Other Impacts

(1) Impacts on the natural environment

It is reported by the implementing agency that treatment of the existing facility waste (used oil, construction equipment and material, and others), which was pointed out at the appraisal stage was properly undertaken. It was confirmed that substations (for distribution) are doubly protected by fences (around the substation site and around the internal transformation facility) and protection measures for electric shock accidents are properly implemented. Since rehabilitation of substations (for distribution) and installation of SCADA was done within the existing facility, no adverse impact to environment is observed.

(2) Land Acquisition and Resettlement

The project scope is rehabilitation of the existing facilities, and no land acquisition and resettlement occurred.

(3) Other Positive and Negative Impacts

Since disconnectors in substations were changed from the oldg “oil” type to the modern “gas” type, consumption of oil was reduced resulting in cost reduction and improvement of environment around facilities within substations due to oil leakage.

It was confirmed that the project has achieved its objectives in terms of enhancement of stability and reliability of electricity supply, reduction of technical losses in the electricity transmission network, and increase of tariff collection rates. The project has largely achieved its objectives, and therefore, its effectiveness is high.

3.4 Efficiency (Rating: ②)

3.4.1 Project Outputs

The original and actual output of the project (Japanese ODA loan portion) is shown in Table 7.

Table 7: Output (original and actual)

Item	Project Scope at Appraisal	Revised Project Scope (August 2008)	Project Scope at Project Completion (Actual)
Transmission System Rehabilitation	<p>1) Rehabilitation of 6 units of 220kV substations (Ekhegnadzor, Shahumyan-2, Shinuhair, Vardashen, Vardashe and Shengavit, including replacement of disconnectors, breakers and air compressors.</p> <ul style="list-style-type: none"> • Procurement of equipment (vehicles, tools and testing apparatus). • Safety measures for substations (rehabilitation of safety facilities in substations.) <p>2) Installation of Communications and System Control and Data Acquisition (SCADA)</p>	<p>1) Rehabilitation of 33 units of 110kV substations (disconnectors, breakers, transformers and others)</p> <p>2) Installation of SCADA</p>	<p>1) Installation of SCADA: as planned except installation of a Video Wall (additional work)</p>
Distribution Rehabilitation	<p>1) Rehabilitation and modernization of facilities in Yerevan, Central and Southern Distribution Districts (breakers, fuse, transformers, and electric cable)</p> <p>2) Replacement of meters for consumers in 4 distribution districts.</p>	<p>1) Rehabilitation of distribution substations was canceled from the ODA loan project.</p> <p>2) Replacement of meters for consumers in Yerevan district.</p>	<p>1) Rehabilitation of 17 units of 110kV substations</p> <p>2) Replacement of meters for consumers in Yerevan district - canceled from the project.</p>
Consulting services	<p>1) Detailed signs (power supply control system), review of detailed designs, assistance in tendering and supervision</p> <p>2) Environmental protection related work:</p> <ul style="list-style-type: none"> • Advice on designs and bid documents on environmental issues and protection of living environment. • Inventory survey on equipment needed for environmental monitoring • Advice on environmental protection during construction stage. <p>Foreign: 81 M/M, Local: 59 M/M, Local Office staff: 237 M/M</p>	<p>1) Detailed signs (power supply control system), review of detailed designs, assistance in tendering and supervision</p> <p>2) Addition of detailed designs for rehabilitation of 110kV substations</p> <p>3) Environmental protection related work:</p> <ul style="list-style-type: none"> • Advice on designs and bid documents on environmental issues and protection of living environment. • Inventory survey on equipment needed for environmental monitoring • Advice on environmental protection during construction stage. 	<p>Scope of work for consulting services was almost as planned.</p> <p>Foreign: 69 M/M, Local: 229 M/M, Local Office staff: 483 M/M</p>

Source: JICA appraisal documents, JICA internal documents, Project Completion Report, Responses to Questionnaire

Note 1: In the scope of work revised in August 2000, rehabilitation of 33 units of 110kV substations was classified as part of components under the rehabilitation of transmission system. However, in the project completion report prepared by the executing agency and the World Bank Implementation Completion Report, it was classified as part of components under the rehabilitation of distribution system. Thus, under the row for "actual" in Table 7, it is shown in the components under the rehabilitation of distribution system. As a result of discussions with the World Bank on the demarcation, it was agreed that the World Bank would be responsible for rehabilitation of transmission system, and it financed 8 units of 220 kV substations.

The whole project was implemented with the cofinancing arrangements by three institutions including US Agency for International Development (USAID), the World Bank (WB) and JICA. However, due to the impact of the structural reform (e.g. privatization) of the power sector in Armenia, discussions on components to be implemented by each institution were made during the project implementation and revisions were made. The JICA-funded rehabilitation work was implemented by diverting funds among categories. Although the project's outputs of JICA-funded components were substantially changed, their changes were unavoidable and they are considered reasonable. Main changes made and their reasons are as follows:

- 1) Rehabilitation of 6 units of 220kV substations was originally planned to be done. However, revisions on components to be funded were made through discussions with WB, and this component was changed to rehabilitation of 33 units of 110kV substations. Further, it was changed from partial rehabilitation of 33 units of substations to overall/fundamental rehabilitation of 17 units of substations. Rehabilitation of substations of the transmission system (including 8 units of 220kV substations) was undertaken with the WB financing.
- 2) Replacement of meters for consumers was to be undertaken by the Armenian government, and thus, this component was canceled from the JICA-funded components.
- 3) A video wall (control panel) was installed as an additional work.
- 4) Since the project implementation period was substantially extended, the man-months (M/M) of local experts and local staff under the consulting services were substantially increased.



Instrument rehabilitated at Kirza Substation



SCADA Video Wall

3.4.2 Project Inputs

3.4.2.1 Project Cost

The estimated project cost of the JICA-funded portion at appraisal was 5.838 billion yen, of which the total Japanese ODA loan of 5.399 billion yen was to be used for foreign currency and part of local currency portions, and the remaining 438 million yen was to be own-funded. Even

though the project scope was substantially changed, the actual project cost was 5.368 billion yen, which was about sufficient to cover the revised project scope. Thus, the actual cost was lower than planned, which is equivalent to 92% of the planned cost.

Major changes of the project scope made on the JICA-funded portions are discussed under 3.4.1 Outputs.

The total project cost, which was estimated and partly included the actual costs as of 2008, after JICA decided to participate in the cofinancing scheme with USAID and WB was 89.82 million dollars (about 9.398 billion yen using the exchange rate of 1US\$ = 104.64 yen as of May 3, 2008). The actual project cost at the JICA's loan closing date (October 2010) was 89.52 million dollars (about 9.367 billion yen using the same exchange), which is equivalent to about 100% of the planned cost.

Table 8: Comparison of Project Cost (Planned and Actual) - ODA Yen Portion

unit: million yen

Item	Originally planned					Planned after revision Yen loan	Actual				
	Foreign Yen loan	Local		Total			Foreign Yen loan	Local		Total	
		Own fund	Yen loan	Total	Yen loan	Own fund		Yen loan	Total	Yen loan	
1) Transmission System Rehabilitation	1,555	79	479	2,113	2,035	616	1,482	0	0	1,482	1,482
• Rehabilitation of substations	972	34	360	1,366	1,333	0	0	0	0	0	0
• Rehabilitation of SCADA	583	45	119	747	702	616	1,482	0	0	1,482	1,482
2) Distribution Rehabilitation	2,486	314	0	2,800	2,486	4,211	3,576	0	0	3,576	3,576
• Improvement of substations	1,490	184	0	1,674	1,490	3,213	3,576	0	0	3,576	3,576
• Replacement of meters for consumers	9986	130	0	1,126	996	998	0	0	0	0	0
3) Consulting services	281	0	43	324	324	214	305	0	0	305	305
4) Physical contingency	216	21	26	263	242	358					
5) Price escalation	275	25	38	339	313						
6) JICA commitment charge						0	5	0	0	5	5
Total	4,813	438	586	5,838	5,399	5,399	5,368	0	0	5,368	5,368

Source : JICA appraisal documents, JICA internal documents, Project Completion Report, Responses to Questionnaire

Exchange rates : At appraisal US\$ = 119 yen (June 1997), During implementation 1 US\$ = 104.64 yen (May 31, 2008)

Note 1 : In the scope of work revised in August 2000, rehabilitation of 33 units of 110kV substations was classified as part of components under the rehabilitation of transmission system. However, in the project completion report prepared by the executing agency and the World Bank Implementation Completion Report, it was classified as part of components under the rehabilitation of distribution system. Thus, under the row for "actual" in Table 8, it is shown in the components under the rehabilitation of distribution system.

3.4.2.2 Project Period

The project period was much longer than planned. The project period planned at appraisal was from February 1999 (signing of the Loan Agreement) to December 2003 (completion of civil work) with a total period of 59 months. The actual project period was from February 1999 (signing of the Loan Agreement) to October 2010 (revised loan expiry date) with a total period of 141 months, or equivalent to 239% of the plan. Consulting services were also completed in October 2010.

Table 9: Comparison of Project Period (Original Plan and Actual) of ODA Yen portion

Activity	Plan (at L/A signing)	Actual
Loan effectiveness	1999.05	1999.10
Transmission System Rehabilitation: Rehabilitation of substations	2000.09 - 2003.10	Deleted from the project
Bidding for SCADA installation	1999.09 - 2000.08	Bidding (including PQ process) commenced in June 2002. However, the bidding was canceled in 2006. Re-bidding was made during February 2007 - February 2008.
Installation of SCADA Installation of a Video Wall (additional work)	2001.07 - 2003.12	2008.04 - 2010.09 (installation of SCADA) 2010.06 - 2010.09 (installation of a Video Wall) Calibration and test run during September 2010 - September 2011.
Rehabilitation of Distribution System: Bidding for rehabilitation of 33 distribution substations	1999.09 - 2000.08	Bidding commenced in April 2002. However, the bidding was canceled in 2005. Re-bidding was made during April 2007 – August 2008.
Rehabilitation of Distribution System: Rehabilitation of 33 distribution substations	2000.07 - 2001.10	2008.09 – 2010.09 (17 substations (110kV only) were rehabilitated)
Replacement of meters for consumers	2000.10 - 2001.11	Deleted from the project.
Selection of consultants	1999.02 - 1999.07	2000.12 - 2001. 03
Consulting services	1999.05 - 2003.12	2001.03 - 2010.10

Source: JICA appraisal documents, Project Completion Report, Responses to the Questionnaire

The main reasons for the delay are as follows:

- 1) 5 months delay during the Loan Agreement effectiveness process, since it took a longer time to prepare the required documents needed for the loan effectiveness.
- 2) 20 months delay at the stage of selection of consultants, since the executing agency was unfamiliar with the international competitive procurement procedure (preparation of TOR and short lists)
- 3) More time than expected was needed to prepare detailed designs and bidding documents (for International Competitive Bidding procedure) after commencing the consulting

services. Those for SCADA and 17 substations (110kV) were completed in November 2004 and in February 2004, respectively.

- 4) In order to procure the latest model of facility, specifications and its corresponding bill of quantities for SCADA were revised after commencing the bidding. The Project Management Board reviewed the bid evaluation results based on the revised specifications and canceled the bidding in 2006. Re-bidding was implemented during February 2007 and February 2008.
- 5) Regarding the bidding for rehabilitation of 17 substations (110kV), only one bidder among prequalified bidders submitted the bid and their bid price was higher than the estimated cost by 60%. The Project Management Board canceled the bidding and suspended the procurement in 2005. Later, re-bidding was implemented without prequalification during April 2007 and August 2008.
- 6) While the selection of a consulting firm and procurement of contractors was being implemented after signing of the Loan Agreement, the electricity distribution business (less than 110 kV), which is one of project components was privatized in 2004 and was sold to a British steel manufacturer. The distribution company was sold to a Russian electric enterprise in 2005, and it took a long time for the executing agency to settle the sublease agreement with a private enterprise. Further delay of submission of documents required for clearance by JICA resulted in substantial impact to the project implementation schedule.
- 7) Replacement of meters for consumers was canceled by the Project Management Board after a contractor was selected. Later, the employer decided to procure meters with their own funds, resulting in the delay of project implementation to some extent.

3.4.3 Results of Calculations of Internal Rates of Return (all the project components) (for reference)

3.4.3.1 Financial Internal Rate of Return (FIRR)

FIRR (for the whole project) at the project completion stage (June 2008) of the WB-funded components was recalculated based on the same assumptions and conditions applied at the project appraisal stage as shown in Table 10.

Table 10: FIRR (at appraisal and project completion stage)

	At Appraisal (1999)	At project completion of World Bank funded portion
FIRR(%)	23	16

Source: The World Bank Implementation Completion Report)

Cost: construction costs, operation and maintenance costs

Benefits: enhancement of system stability, reduction of technical losses

It is considered that the lower FIRR at the project completion stage (June 2008) of the WB-funded components is partly due to the increase of the project cost (the total project costs in Armenia Dram including those financed by USAID, the World Bank and JICA).

3.4.3.2 Economic Internal Rate of Return (EIRR)

EIRR calculated at appraisal was 24%. Since the project scope has been substantially revised, it is difficult to recalculate EIRR at the ex-post evaluation stage.

The project cost was lower than planned, but the project period was significantly longer than planned. Therefore, the efficiency of the project is fair.

3.5 Sustainability (Rating: ②)

3.5.1 Structural Aspects of Operation and Maintenance

The Executing Agency for the project was Energy Investment Project Implementation Office, which was abolished due to the institutional reform in 2011, under Ministry of Energy and Natural Resources, and the Borrower is the Armenian Government represented by Ministry of Finance. At the appraisal stage, Armenergo and High Voltage Electric Network CJSC (HVEN) were to be responsible for operation and maintenance of the transmission system and four distribution companies for operation and maintenance of the distribution system. However, the organizational setup of the power sector was completely renewed in 2011 as shown in Figure 2. Relevant institutions and entities, which are currently responsible for operation and maintenance of facilities installed and rehabilitated under the project (JICA-funded components), are as follows.

Table 11: Responsible Agencies for Operation and Maintenance and their Role/Responsibility

Responsible agency	Role/Responsibility (operation and maintenance of the facilities rehabilitated under the project)
Ministry of Energy and Natural Resources	Policy and strategy for the power sector
Electro Power System Operator CJSC (EPSO)	Operation of system (Dispatching): The state-owned EPSO is responsible for operation and maintenance of SCADA installed under the project. Responsibility was transferred from Armenergo in December 2004.
Settling Center	Registration and confirmation of the amount of generation, transmission and distribution.
High Voltage Electric Network CJSC (HVEN)	Transmission of electricity generated at nuclear, thermal, hydro and renewable energy (wind, solar) plants through 220-110kV networks.
Electric Networks of Armenia (ENA)	Responsible for operation and maintenance of 17 substations (110kV), rehabilitated under the project. ENA distributes electricity to about 935,000 consumers with a total network length of about 36,000 km.
Public Services Regulatory Commission	Licensing for power sector business and setting tariff rates

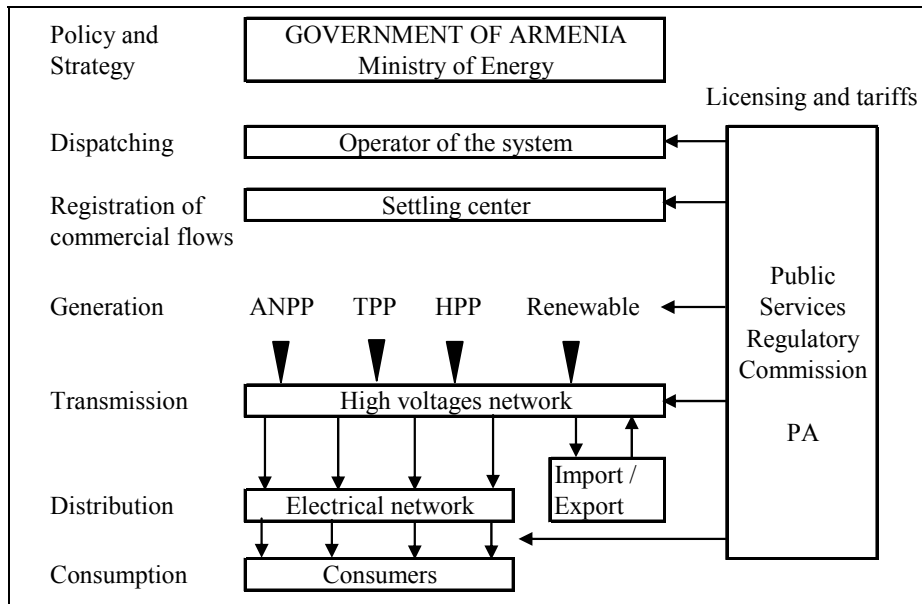


Figure 2: Organizational Setup of Armenian Power Sector

EPSO, which is responsible for operation and system management of the Armenian power sector is a 100% state-owned enterprise. It has about 80 staff in the headquarters and about 200 staff in branch offices. About 50 staffs of EPSO are in charge of operation and maintenance. EPSO is also in charge of operation and maintenance of SCADA, which was installed under the project. ENA, which is responsible for operation and maintenance of the distribution system, is a 100% privately owned company, which is an affiliate company of Russian OJSC “INTER RAO UES”. ENA has 11 branch offices and about 8,000 employees, among whom about 670 employees are assigned at the headquarters. About 80 staffs are responsible for operation and maintenance of 17 units of 110kV substations, which were rehabilitated under the project. The management of EPSO and ENA confirmed that appropriate number of staffs, including technical staffs are assigned to operation and maintenance of facilities installed/rehabilitated under the project by EPSO and ENA.



EPSO and Settling Center



SCADA-related Facility in Yerevan Power Plant

3.5.2 Technical Aspects of Operation and Maintenance

In the Headquarters Control Center for SCADA, a Controller and two Deputy Controllers are regularly assigned and they provide instructions to optimize the use of electricity. In the Control Center, various operation manuals are prepared, and a simulation desk for training is also equipped. The training for emergency operations is regularly undertaken.

A Control Center is installed at the ENA headquarters as well and is connected with substations. At each substation, about 4-5 maintenance staff are stationed in shifts for 24 hours and they monitor the operation status. A maintenance team consisting of about 5 staffs, who is responsible for several substations comes around regularly and undertake simple routine maintenance work. In the ENA compound, a sample facility for the training needed for field work is prepared. Staffs in charge of maintenance regularly take the lecture-type training (e.g. business/management improvement, company regulations and rules, accounting and tax treatment, IT and personnel management) and on-job-training on technical issues. In 2011, 792 employees took any of these special training courses and passed the final examination. It was confirmed during the field inspection that various operation and maintenance manuals (e.g. operation of relay protection, operation of power equipment) are prepared at each substation.

3.5.3 Financial Aspects of Operation and Maintenance

Entities responsible for operation and maintenance of facilities and equipment for transmission and distribution system, which were rehabilitated or installed under the project are EPSO and ENA. EPSO is a 100% state-owned enterprise and its main revenue source is the electricity tariffs collected from consumers. The flow of funds is that electricity tariffs collected by ENA are remitted to EPSO through High Voltage Electric Network CJSC and Settling Center. EPSO is responsible for repayment of the loan borrowed for the project. The income and expenditure statements including the repayment of loan for the past two years show the negative balance. The revenue gained in 2011 was 1,302.3 million AMD¹⁰ (about 260.5 million yen). The expenditure was 2,076.7 million AMD (about 415.3 million yen), resulting in loss of about 774.4 million AMD (about 154.9 million yen). In the expenditure, the labor cost for about 50 staffs with a total amount of about 90 million AMD is included.

Tariffs are set so that at least the operation and maintenance cost, and part of technical losses and debt service (interest payment plus repayment of principal) can be covered. However, Public Services Regulatory Commission has an authority to decide the revision and setting tariffs. A financial staff of EPSO reported that from the beginning of 2013, yen has been depreciated and thus repayment has become somewhat easier and that the financial balance

¹⁰ Armenian monetary unit, and abbreviation of Armenian Dram. 1AMD is about 0.2 yen (annual average exchange rate for 2011)

would improve. EPSO is a state-owned company and eventually the government, represented by Ministry of Finance is responsible for repayment of the loan, when repayment cannot be made by EPSO. However, at this moment it is not clear how EPSO would be financially assisted by the government under the new organizational structure for the power sector.

ENA is a private enterprise and has a sole license on the distribution service in Armenia. The operation and maintenance of the distribution business is implemented and managed using revenues collected as tariffs. ENA is one of largest tax payers in Romania. The income and expenditure statement of ENA for the past three years is shown in Table 12.

Table 12: Income and Expenditure Statement of ENA

Unit: million AMD

Item	2009	2010	2011
Sales/Revenue	92,090	99,329	108,681
Operation and Maintenance (excluding depreciation)	9,415	10,068	7,398
Labor Costs (including social payments)	14,029	14,762	15,717
Operational Profit (excluding depreciation)	16,686	25,362	16,673
Operational Profit	12,336	21,245	20,994
Net Profit	-21,540	11,670	2,826

Source : ENA Annual Report, Responses to the Questionnaire

Note: The table includes only the major financial items. Please refer to numbers on each item.

The income and expenditure statement of ENA shows negative balance in 2009, but a surplus for the immediate past two years. The balance between income and expenditure of ENA depends on the sales (revenue source), which are affected by the basic tariff setting for electricity. As mentioned previously, regarding the tariffs to be charged, the Public Services Regulatory Commission has the authority to determine the tariffs taking into account the company's financial status, charges/tariffs charged under other public services, and other factors. The current (as of March 2013) tariffs for 35-110kV is 21 AMD/kWh during day time, and 17 AMD/kWh during night time. (1AMD=about 0.2 yen)

Since most of facilities and equipment rehabilitated or installed under the project are under the warranty period, costs for materials accrued are minimal. Only labor costs for maintenance staffs have accrued. The labor costs for about 80 staffs in charge of operation and maintenance work is about 117 million AMD and paid from the ENA annual budget. According to ENA, the maintenance costs after the expiration of the warranty period will not be substantially increased for a while, and there would be no problems taking into account the financial capability of ENA. ENA is an affiliate company of Russian OJSC "INTER RAO UES", which undertakes the power business in 14 foreign countries, and has no financial problem.

The revenue and expenditure sheets of EPSO, which is the core agency in the power sector show negative balance for the past two years. Since EPSO is a state-owned company, it can eventually obtain the financial assistance. However, under the current financial condition, it is

not clear how the government would provide the financial assistance.

3.5.4 Current Status of Operation and Maintenance

Since SCADA and 17 substations (under the distribution rehabilitation), which are operated and maintained by EPSO and ENA, respectively are still new after completion of the project, facilities and equipment have been functioning without major problems.

The warranty period for SCADA has expired only half a year ago, and a simple inspection has been undertaken once a year as routine maintenance for the substations. It is reported that ENA stores sufficient spare parts and keeps appropriate number of maintenance equipment. Maintenance work has been regularly undertaken according to manuals prepared for each facility and equipment.

Since some problems have been observed in terms of financial condition , therefore sustainability of the project effect is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The project objectives were to enhance stability and reliability of electricity supply, reduce technical losses in the electricity transmission network and increase tariff collection rates by rehabilitating the transmission and distribution network and installing meters for consumers in Armenia, thereby contributing to improve the international trade balance through strengthening the financial condition of transmission and distribution enterprises, and using the energy resources more effectively. The project has been highly relevant to the development plans and needs of Armenia, as well as Japan's ODA policies. Regarding enhancement of stability and reliability of electricity supply, reduction of technical losses in the electricity transmission network and increase of tariff collection rates, which are the project's objectives, since the project has largely achieved its objectives, its effectiveness and impact are high. Even though the project's outputs changed substantially from the original plan, changes made are considered reasonable. Although the project cost was within the plan, the project period was significantly longer than planned. Therefore, the efficiency of the project is fair. Since some problems have been observed in terms of financial condition, therefore sustainability of the project effect is fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

None.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

None.

Comparison of the Original and Actual Scope of the Project

Item	Original Plan at Appraisal	Revised Scope of Work (August 2000)	Actual
1. Output Transmission System Rehabilitation	<p>1) Rehabilitation of 6 units of 220kV substations (Ekhegnadzor, Shahumyan-2, Shinuhair, Vardashen, Vardashe and Shengavit, including replacement of disconnectors, breakers and air compressors.</p> <ul style="list-style-type: none"> · Procurement of equipment (vehicles, tools and testing apparatus). · Safety measures for substations (rehabilitation of safety facilities in substations.) <p>2) Installation of Communications and System Control and Data Acquisition (SCADA)</p>	<p>1) Rehabilitation of 33 units of 110kV substations (disconnectors, breakers, transformers and others)</p> <p>2) Installation of SCADA</p>	<p>1) Installation of SCADA: as planned except installation of a Video Wall (additional work)</p>
Distribution Rehabilitation	<p>1) Rehabilitation and modernization of facilities in Yerevan, Central and Southern Distribution Districts (breakers, fuse, transformers, and electric cable)</p> <p>2) Replacement of meters for consumers in 4 distribution districts.</p>	<p>1) Rehabilitation of distribution substations was canceled from the ODA loan project.</p> <p>2) Replacement of meters for consumers in Yerevan district.</p>	<p>1) Rehabilitation of 17 units of 110kV substations</p> <p>2) Replacement of meters for consumers in Yerevan district - canceled from the project.</p>
Consulting services	<p>1) Detailed signs (power supply control system), review of detailed designs, assistance in tendering and supervision</p> <p>2) Environmental protection related work:</p> <ul style="list-style-type: none"> · Advice on designs and bid documents on environmental issues and protection of living environment. · Inventory survey on equipment needed for environmental monitoring · Advice on environmental protection during construction stage. <p>Foreign: 81 M/M, Local: 59 M/M, Local Office staff: 237 M/M</p>	<p>1) Detailed signs (power supply control system), review of detailed designs, assistance in tendering and supervision</p> <p>2) Addition of detailed designs for rehabilitation of 110kV substations</p> <p>3) Environmental protection related work:</p> <ul style="list-style-type: none"> · Advice on designs and bid documents on environmental issues and protection of living environment. · Inventory survey on equipment needed for environmental monitoring · Advice on environmental protection during construction stage. 	<p>Scope of work for consulting services was almost as planned.</p> <p>Foreign: 69 M/M, Local: 229 M/M, Local Office staff: 483 M/M</p>
2. Project Period	February 1999 - December 2003 (59 months)	February 1999 - October 2010 (141 months)	February 1999 - October 2010 (141 months)
3. Project Cost	4,813 million yen	4,940 million yen	5,368 million yen
Amount paid in Foreign currency	1,024 million yen	459 million yen	0 million yen
Amount paid in Local currency	5,838 million yen	5,399 million yen	5,368 million yen
Total	5,838 million yen	5,399 million yen	5,368 million yen
Japanese ODA loan portion	5,399 million yen	5,399 million yen	5,368 million yen
Exchange rate	1US\$ = 119 yen (as of June 1997)	1US\$ = 119 yen (as of June 1997)	1US\$ = 119 yen (used the rate at appraisal)