Iran

Ex-Post Evaluation of Japanese ODA Loan Project
"Godar-e-Landar Hydroelectric Power Project
and
Masjid-e-Soleiman Hydroelectric Power Project (II)[1]"

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0. Summary

The Project was planned as one of the measures of electric power development policy of Iran to meet rapidly increasing demand of power. There is still a strong need for a further increase of the generating capacity of the electric power because of the continual increase of the demand. As the Project was compatible with Japan's ODA policies, its relevance is high. The scale of the generating capacity of the constructed Masjid-e-Soleiman Hydroelectric Power Plant is as planned and the overall project cost was within the planned cost. However, the completion of the Project was delayed by 4 years due to the cancellation of part of the yen loan and some other reasons. Accordingly, the efficiency of the Project is judged to be medium. Although the achievement rate of volume of power generation is around 80% of the original plan, it is due to shortage of rainfall and decreases in water discharge of upstream dams. In consideration of the high economic validity (internal rate of return) of the Project, its effectiveness is judged to be high. The Project contributes to steady power supply in Iran as a whole by providing the power through the national grid. The facilities constructed under the Project are in good working condition and Khuzestan Water and Power Authority (KWPA) which operates these facilities is believed to possess an adequate operation and maintenance management system, technical expertise and financial strength. As such, the sustainability of the Project is judged to be high.

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

1. Project Profile

Location of the Project

Masjid-e-Soleiman Dam

[1] The yen loan was provided in two phases. At the time of the first phase, the name of the project was Godar-e-Landar Hydroelectric Power Project, and later changed to Masjid-e-Soleiman Hydroelectric Power Project in the second phase

1.1 Background

Around the year 1990, Iran suffered from serious shortage of electric power at peak hours, thus the Government had to impose planned power outage. Furthermore, increasing demand for power was expected with reconstruction of the economy after the Iran-Iraq War (1980-1988). Therefore electric power development projects were prioritized in the First Five Year Economic, Social and Cultural Development Plan (1989-1994), which was national development plan of Iran. Ministry of Energy implemented power development projects based on the Five Year Plan, and as in 1993, 17 thermal power plants were under construction and another 11 thermal plants and 8 hydro electric power plants were planned for construction.

Whereas Iran has abundant oil and natural gas which are prime energy resources for power generation, the country also has rich water resources in its mountain areas. It was considered to be important in the long run to promote hydroelectric power generation with the viewpoint of saving hydrocarbon resources. Especially it was identified by the master plan study in 1960s that the Karun River basin had extremely high potentials for development. The Masjid-e-Soleiman Hydroelectric Power Plant (hereafter HEPP) was planned as one of those development projects. After conducting a feasibility study in 1990, the Iranian Government officially requested for a yen loan for the Project in 1991 followed by the Loan Agreement in 1993 and the implementation of the Project from 1996 to 2006.

At the time of the appraisal of the Project in 1992[2], the total amount of foreign currency required for the Project was estimated at around 150 billion yen, which was planned to be provided in three phases. The first phase loan amounted to 38.6 billion yen (Phase 1 of the Project) for part of the civil works and consulting services. After that, the second loan for generators and other equipment was scheduled to be provided in 1994 and the third loan for the remaining civil works was planned to follow. However, because the United States of America strengthened its economic sanction against Iran and requested the Japanese Government to follow suit, the Japanese Government decided to cancel the second and third loans. Thus the Iranian Government financed the generators with its own resources. In the meantime, however, as the Project progressed, it became possible that the shortage of funds for civil works could have caused serious damage by floods with interruption of the construction. Therefore, the Iranian Government requested for another yen loan for the remaining civil works in 1998 and the Japanese Government provided an additional loan of 7.5 billion yen (Phase 2 of the Project) as "an emergency measure on the humanitarian ground.[3]"

1.2 Project Outline

The objective of this project is to upgrade Iran's capacity of supplying electric power by means of constructing a rockfill dam and an underground hydroelectric power plant with an installed generating capacity of 2,000 MW (of which the yen loan covers 1,000 MW, with annual power generation of 3,700 GWh) at some 20 km downstream of the existing Karun I Dam (also called Shahid Abbaspur Dam) along Karun River in the south west part of Iran, thereby contributing to steady power supply and a response to the increasing power demand.

Table-1 shows summary of loan agreement of the Project.

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[2] In this report "the appraisal" means to be an appraisal for Phase 1 of the Project, if not mentioned otherwise

[3] Based on JICA appraisal documents.

Table 1 Summary of Loan Agreement

Approved Loan Amount / Disbursed Loan Amount	Approved 46,108 million yen (Phase 1: 38,614million yen, Phase 2: 7,494million yen) Disbursed 45,955 million yen (Phase 1: 38,471million yen, Phase 2: 7,484million yen)
Exchange of Notes / Loan Agreement	Phase 1: May 1993/ June 1993 Phase 2: October 2000 / October 2000
Terms and Conditions	Phase 1: Interest Rate: 3.0% Repayment Period: 25 years (Grace Period:7 years) Conditions for Procurement: Mixed Phase 2: Interest Rate: 2.2% Repayment Period: 25 years (Grace Period:7 years) Conditions for Procurement: General Untied
Borrower / Implementing Agency	Government of the Islamic Republic of Iran / Iran Water and Power Resources Development Company (IWPC)
Final Disbursement Date	Phase 1: August 2005 Phase 2: January 2006
Main Contractors (contract amount of 1 billion yen or more)	Daelim Industrial Co., Ltd. (South Korea) and Sato Kogyo Co., Ltd. (Japan) (JV)
Consultant (contract amount of 100 million yen or more)	Nippon Koei Co., Ltd. (Japan) and Lahmeyer International GMBH (Germany) (JV)
Feasibility Study (F/S)	Feasibility Study was conducted jointly by Lahmeyer International GMBH (Germany) and Moshanir Power Engineering Consultants Services Co. in 1990. Special Assistance for Project Formation Study (SAPROF) was conducted by Nippon Koei Co., Ltd. (Japan) in 1992.

2. Outline of the Evaluation Study

2.1 External Evaluator

Izumi Sakaya (Global Group 21 Japan, Inc.)

2.2 Duration of Evaluation Study

The ex-post evaluation study of the Project was conducted over the following period.

Study Period: November, 2010 – September, 2011
Field Survey: January 13th to 28th, 2011 – May 28th April to 6th, 2011

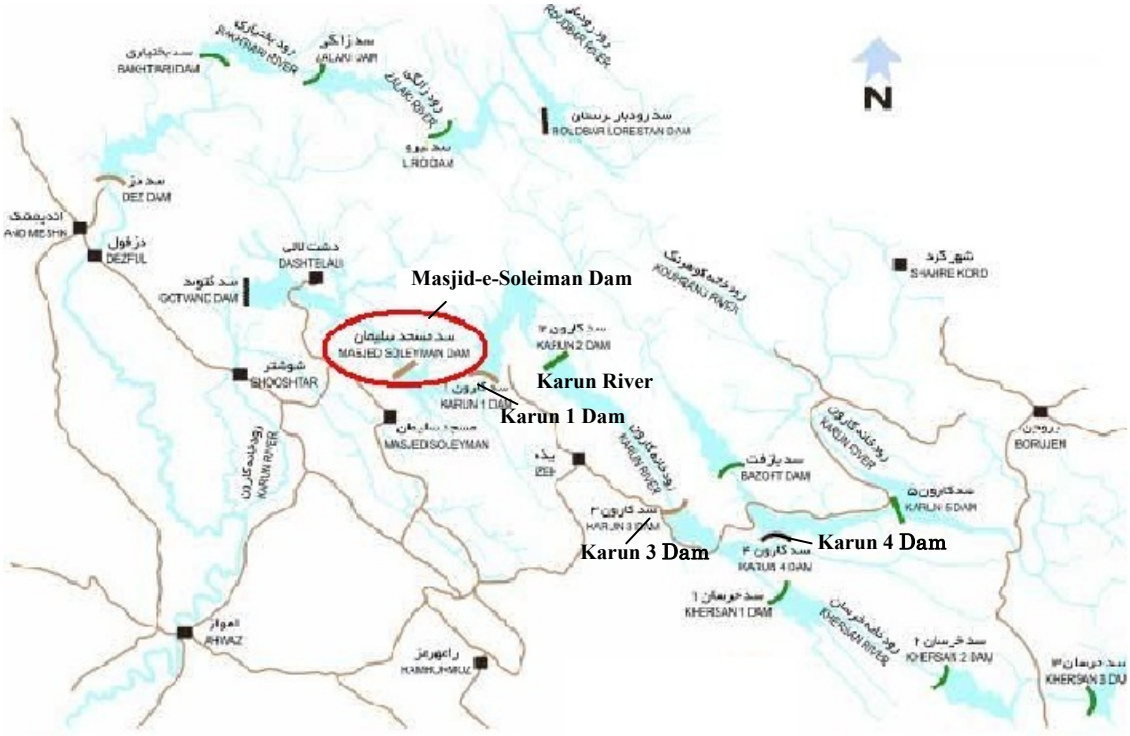

Figure-1 Karun River Basin and Masjid-e-Soleiman HEPP

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

3.1 Relevance (Rating: ③[5])

3.1.1 Relevance with the Development Plan of Iran

As mentioned in "1.1 Background", the Project was one of power development projects based on the national development plan and, as such, was highly compatible with the development policy of then Government.

In the current Fifth Five Year Development Plan (2010-2015), the power sector aims to diversification of energy sources, optimization of power generation, an increase in efficiency of power plants and reduction of energy loss, and simultaneous production of electricity and heat. According to Ministry of Energy, the Government attaches importance to development of renewable energy including hydroelectric power, with a plan to increase the share of hydroelectric power in the total installed

[4] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[5] ③: High, ② Fair, ① Low

capacity of power generation in Iran from 13.7% in 2009 to 18.5% in 2025. The Project remains highly compatible with the present policy.

3.1.2 Relevance with the Development Needs of Iran

Iran suffered from shortage of power supply during 1986 to 1990 as more than 15% of the maximum power demand was in shortage and planned outage was imposed every year. In 1990, maximum power supply was only 8,182MW as against maximum power demand 10,407MW at peak hours. Furthermore, increasing demand for power was expected with reconstruction of the economy after the Iran-Iraq War (1980-1988). As a matter of fact, maximum power demand reached 18,425MW in March 1999. It was an urgent task for the Government to upgrade capacity of supplying power to respond to the rapidly increasing demand for power. As such, the Project was compatible with development needs.

According to the current long term electric power development plan (2000-2025) by Ministry of Energy, the demand is estimated to increase by about 8% annually by average during the period. The development of power generating facilities are planned to meet the increasing demand, with a plan to expand installed capacity of power generation to 13,600MW in 2025 from 58,705MW in March 2011. Because of the continual increase of the demand for power, the Project is highly compatible with development needs.

3.1.3 Relevance with Japan's ODA Policy

While Iran is important for Japan as an oil producing country, Japanese Government basically considers that it is necessary for Iran to adopt realistic and amicable policies and act so as to realize stable relations with neighbouring countries and other countries in view of peace and stability of the Gulf Region. The Japanese Government, at the time of the appraisal, needed to take an approach where Japan's cooperation would make contribution to recovery of Iran's devastated economy by providing appropriate support to the efforts for economic reform made by the then government, through which Iran's foreign relations would be improved and the stability of the Gulf Region would be increased. The Project was implemented in line with this approach. Therefore it was compatible with Japan's ODA policies toward Iran at the time of the appraisal[6].

As seen above, this Project has been highly relevant with the country's development plan, development needs, as well as Japan's ODA policy, therefore its relevance is high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

According to the plan put forward at the time of appraisal, the Project would consist of three components; 1) construction of dam, 2) construction of power station and 3) consulting services.
As shown in the table "Comparison between Original Plan and Actual Results" in the last page, every component was completed almost as planned. Although it appears that actual crest length of the dam is 38m shorter than the original plan, this is because the original plan included the spillway in crest length and there is no significant difference between planned and actual output.
Whereas the Masjid-e-Soleiman HEPP has a power station with an installed power generating capacity of 1,000MW (4 units of generators with a capacity of 250MW for each) within the scope of the yen loan Project, Iranian Government, as had been planned from the initial stage, added another 1,000MW (4 units of generators with a capacity of 250MW for each) by its own financial resources at the expansion stage, completing the plant with an installed capacity of 2,000MW (8 units of generators

[6] The description of this section is based on 1993-98 issues of "ODA White Paper" by Ministry of Foreign Affairs of Japan,

with a capacity of 250MW for each) in total[7].

Surrounding area

Dam Lake

Generators

Turbine

3.2.2 Project Inputs

3.2.2.1 Project Cost

The planned project cost at the time of appraisal was approximately 222.7 billion yen (of which yen loan amounts to 151.4 billion) and the actual cost ended up at approximately 130.1 billion yen (of which yen loan amounts to 45.9 billion) which was only 58% of the original budget (Table 2). The main reasons for a significant decrease in project cost despite the fact that outputs were completed as planned are:

- In general, intense international competition brought about the huge difference between the estimated cost and the actual contracted cost[8].
- As a results of negotiation between the implementation agency (Iran Water and Power Resources

[7] As mentioned in 1.1 Background, because the second yen loan for 4 generators, which had been previously planned at the time of the appraisal, was cancelled, the Iranian Government shifted 4 generators for the expansion stage (units 5-8), which had been contracted for procurement with its own fund, to generators for the yen loan Project (units 1-4).

[8] Although the cost for the civil work was estimated assuming that Japanese contractors would be engaged, no Japanese companies made a bid and Daelim Industrial, of South Korea, won the contract. Actually, Daelim formed a joint venture with Sato Kogyo of Japan for the bidding, but the financial portion of Sato Kogyo was only 5%.

Development Company; IWPC) and contractors, the procurement costs for power generation equipment were lowered by concluding contracts as a part of many contractual packages related to other national dam projects. Further, contract prices were reduced by replacing some of foreign-manufactured equipment with local-manufactured equipment with lower manufacturing and transport costs.

Table-2 Planned and Actual Project Costs

	Planned at the Time of Appraisal				Actual		
	Foreign Currency Portion (million yen)	Of which Yen Loan	Local Currency Portion (million IRR)	Total (million yen)	Foreign Currency Portion (million yen)	Local Currency Portion (million IRR)	Total (million yen)
Pre-construction works	8,269	0	23,726	12,065	0	35,884	1,669
Main civil works	89,400	89,400	234,826	126,972	40,614	598,202	68,437
Power generation equipment, etc.	44,420	44,420	19,349	47,516	0	744,248	34,616
Contingency	11,574	11,161	26,116	15,753	0	0	0
Consulting Services	6,462	6,462	27,689	10,892	5,322	349,164	21,562
Tax	0	0	50,036	8,006	0	0	0
Land acquisition	0	0	9,614	1,539	0	81,202	3,777
Total	160,125	151,443	391,356	222,742	45,936	1,808,700	130,062

Note 1: Exchange rate - ¥1=IRR6.25 (September 1992) at the time of appraisal
¥1=IRR21.50 (Weighted average during 1991–2006) at the time of evaluation

Note 2: Refer to footnote for other explanations'[9].

3.2.2.2 Project Period

The actual project period significantly exceeded the original plan. Whereas the original plan was to implement the Project in 92 months from June 1993 to December 2000, the Project was in reality implemented in 140 months from June 1993 to December 2000. The overall project period was 152% of the originally planned period and completion was delayed by 4 years.

The most prominent reason for the delay of completion was the fact that the Project fell in shortage of foreign currency to procure power generators because the second and the third yen loans which were originally planned were suspended. It took time for Iranian Government to make decision to purchase generators by its own financial sources since information was not available on whether and when the suspension of the loans would be lifted. Because of this reason, the Project delayed by approximately two years.

Other reasons for the delay are as follows:

[9] The following should be noted for actual project cost:
- Because the data for project cost by item by year were not available, it was not possible to calculate an exchange rate item-wise. Here, the weighted exchange rate for total project cost (¥1=IRR21.50) was also applied for calculation of project cost of each item in terms of yen, for convenience.
- The foreign currency portion of the actual project cost only refers to yen loan and other foreign currency portion is included in the local currency portion. For example, although the power generators and turbines, which were financed by Iranian Government with financial sources form China because of cancellation of yen loan (second loan), were purchased with foreign currency, they were calculated as local currency portion in the table. While procurement contract of hydraulic steel structures was agreed in terms of local currency, the contractor actually prepared foreign currency necessary for purchase of the equipment. This is also included in the local currency in the table.

- Under the severe competition in international competitive bidding, the contractor proposed dam construction method with low costs. As a result, discussion with regard to appropriateness of the method took a long time before final decision was made, causing the delay.

- Construction of diversion tunnel took time due to difficulty in procurement of materials

- Impounding of dam by the contractor delayed due to floods, which took place twice, and hardness of work because of high temperature in Khuzestan province.

- It was the first experience for IWPC, which was established in 1989, to implement a project with international contractors and consultants. Lack of experience of project management might have been one of causes of the delay.

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

3.3 Effectiveness (Rating: ③)

3.3.1 Quantitative Effects

3.3.1.1 Results from Operation and Effect Indicators

The Masjid-e-Soleiman HEPP has 8 units of power generators with a total installed capacity of 2,000MW (250MW x 8). Four units of generators, which are under the scope of the yen loan Project, started operation one by one from 2002, and another 4 generators, which are outside the scope of the Project started operation one by one from 2007 at the expansion stage. However, as of May 2011, 4 units of the expansion stage were under repair due to technical problems, of which it would take a long period to repair one unit[10]. The 4 units under the scope of the yen loan Project have been being operated without any problems so far.

Operational data of Masjid-e-Soleiman HEPP are shown in Table-3. All 4 units of generators under the scope of the yen loan Project were installed before the end of 2003 and in 2004 all of them started operation from the beginning of the year. Annual average power generation was planned to be 3,700GWh with these original 4 units and this target figure of power generation, 3,700GWh, has remained the same after additional 4 units of generators had installed[11]. In reality, annual average power generation during the years 2004 to 2010 stood at 2,997GWh, or just 81% of the planned figure. This is not because power station facility had any troubles, but because there was a decrease in annual river discharge from 2008. The river discharge decreased because i) the amount of rainfall in the Karun river basin was smaller in 2008 and 2010, ii) cold winter in 2007 caused a significant increase in power demand, hence hydroelectric power plants (Karun 1 Dam and Karun 3 Dam, see Figure-1) of upstream of the river generated much power and decreased the storage of their reservoirs, which resulted in less discharge of water in the following years, and iii) Impounding to newly constructed Karun 4 Dam, located upstream, started in 2010[12]. It is considered that these reasons have only short

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[10] According to IWPC and a consultant responsible for the expansion stage, the repair of one unit would take a long period because of difficulty in procuring some parts with the effect of economic sanction. For other three units, they are under repair due to troubles in turbine. The manufacturer of 4 units of generators of the Project is different from these generators of the expansion stage.

[11] The amount of power generation of a hydro-electric power plant basically depends on river discharge. Because the Masjid-e-Soleiman HEPP is a dam of run-of-river type without a large scale reservoir where water reserve is only for daily adjustment, the excess river discharge which exceeds a capacity of power generation is not used for power generation. The plant increased the capacity of power generation by adding 4 units of generators to 8 units in total, and therefore became capable to utilize a larger amount of river discharge to respond to the increasing demand for power at the peak time.

[12] At the time of appraisal, this new Karun 4 Dam was not planned.

term effects (1 or 2 years), and not for a long period. If the years since 2008, during which period the river discharge was less, are excluded from calculation, annual average power generation is 3,871GWh, exceeding the planned figure.

Table-3 Operational data of Masjid-e-Soleiman HEPP

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Water used for power generation (m^3)	1,764	7,972	8,818	10,439	12,043	11,698	4,326	4,968	5,383
Installed Capacity of power generation (End of year, MW)	500	1,000	1,000	1,000	1,000	1,750	2,000	2,000	2,000
Total power generated (All 8 units, GWh)	686	2,906	3,136	3,697	4,392	4,259	1,496	1,728	2,272
units 1-4	686	2,907	3,136	3,697	4,392	3,550	1,109	1,074	1,887
units 5-8	0	0	0	0	0	709	387	653	386

Note 1: In this evaluation report, "year" refers to a period from March 21 of the current year to March 20 of the following year, based on Iranian calendar.
Note 2: First 9 months only for the data of water used in 2010.
Source: IWPC

3.3.1.2 Results of Calculations of Internal Rates of Return (IRR)

At the time of appraisal, the economic internal rate of return (EIRR) and financial internal rate of return (FIRR) of the Project were 17.2% and 7.8% respectively. The calculations were made based on the following assumptions.

EIRR
Project life: 50 years for dam and 25 years for power generation equipment
Costs : Construction cost and cost for operation and maintenance
Benefits: Cost for investment, operation and maintenance and fuels of a thermal power plant of the equivalent scale

FIRR
Project life: 50 years for dam and 25 years for power generation equipment
Costs : Construction cost and cost for operation and maintenance
Benefits: Income from electricity sales

For this ex-post evaluation, the EIRR and FIRR of the Project were recalculated based on the similar assumptions and actual figures available[13]. The results are; 14.35% for EIRR and 14.78% for FIRR[14]. Even though the figure of EIRR is slightly low compared with the figure at the time of appraisal[15], 14.35% is high enough for a public investment project, assuring economic adequacy of the Project.

3.3.2 Qualitative Effects

Quantitative effects include stable supply of power, economic promotion and improvement of living standards, employment creation and saving in hydrocarbon resources. They are regarded as impacts of

[13] Recalculations were conducted by IWPC and examined by the evaluator.
[14] The detailed calculation process of the appraisal is not precisely known, and for the recalculation, some pre-conditions were modified to acquire more realistic figures, such as calculation based on Iranian currency and application of price escalation, although basic assumptions were the same. Therefore, exact comparison is not available
[15] Main reason is that investment cost of the thermal plant, one of benefit factors, was lowered in accordance with real figures available.

the Project and evaluated in the next section "3.4 Impacts".

Based on the above results, the effectiveness of the Project is evaluated as high as the anticipated effects have been mostly achieved as planned.[16]

3.4 Impact

3.4.1 Intended Impacts

The Project was expected to have several impacts, such as 1) steady and increasing power supply nationwide to ease power shortage, 2) economic promotion and improvement in living standards with steady power supply, 3) creation of employment during construction works, and 4) saving of hydrocarbon resources.

1) Steady and increasing power supply

The status of the power sector in Iran has much improved as seen in Table-4. Both nominal capacity for power generation and annual consumption of power have been significantly increasing as the former in 2009 is 2.95 times as much as 1993 while the latter in 2009 is 2.92 times as much as 1993. Power generation by the Project accounts for more than 2% of the total except for years of draught, contributing to the improvement of the power sector as a whole. An installed capacity for power generation in Iran increased by 29,000MW between 2001 and 2009, of which the Project accounts for 6.9%. With steady power supply, shortage in power have been mostly resolved and there have been no planned outage in recent years[17].

Table-4 Profile of Power Sector in Iran

Year	1993	2000	2005	2006	2007	2008	2009
Maximum Power Supply (MW)	13,308	20,609	30,694	32,997	34,583	34,270	37,878
Nominal Capacity (MW)	19,042	27,207	41,044	45,322	49,425	59,972	56,181
Annual Power Consumption (GWh)	58,115	90,366	132,898	144,582	152,329	161,058	169,781
Annual Gross Power Generation (GWh)	69,885	113,032	170,648	184,911	196,080	206,173	221,317
Per Capita Power Generation (KWh/Person)	1,261	1,845	2,566	2,733	2,852	2,956	n.a.

Sources: IWPC and Tavanir (State owned company for power generation, transmission and distribution management)

2) Economic promotion and improvement in living standards

Both households and industries benefit from the improvement of power supply. Power consumption per household increased from 2,265KWh in 1994 to 2,603KWh in 2009. The number of electrified village increased from 32,066 in 1994 to 51,595 in 2009. The share of electrified village reached 93.1% in 2009 as compared to 48.2% in 1994, and the rate of electrified household in villages reached 98.9% in 2009 as compared to 76.0% in 1994.[18]

3) Creation of employment during construction works

During the construction period, a large number of jobs were directly generated at the Project site and surrounding areas. In the cities of Masjid-e-Soleiman, Izeh and Andika, more than 12,000

[16] The rating of effectiveness was judged jointly with evaluation of impacts of the Project.
[17] Based on interviews with Ministry of Energy. Statistical data on outage was not available.
[18] Based on Tavanir, "Statistical Report on 43 Years of Activities of Iran electric Power Industry (1967-2009)",

employments were created in total, contributing to the regional economy[19]. If indirect job creation arising from economic prosperity is taken into consideration, the impact would be even larger. Many employees who worked for the Project found jobs elsewhere after completion of the construction by utilizing their skills acquired with the Project, or worked for the operating company of the Masjid-e-Soleiman HEPP. As such, impacts of the Project remain even now[20].

4) Saving of hydrocarbon resources.
By hydroelectric power generation of the Project, hydrocarbon resources such as oil and natural gas, which are required to generate thermal power of the same scale as the Project, have been saved. According to the calculation by IWPC, 18.1 billion m^3 of natural gas and 6 billion liters of diesel oil[21] are required to generate 24,155GWh, a total power generated by the Project up to December 2010. Therefore it is estimated the Project has had impact of saving this amount of fuels, as well as reducing adverse effects on environment[22].

3.4.2 Other Impacts

1) Benefit for local communities and regions
With implementation of the Project, various auxiliary activities were conducted, including construction of a bridge, construction of the access road to the Project site and other roads, and facilitation of supply of potable water to Masjid-e-Soleiman City. However, except for the construction of the access road, most activities were conducted at the expansion stage, outside of the scope of the yen loan Project. Moreover, with completion of the dam and construction of the roads, there have been an increase in the number of tourists and vitalization of local economy[23].

2) Impacts on the natural environment
Since the Project was started before environmental impact assessment system was introduced in Iran, environmental assessment procedure based on Iranian laws were not conducted. However, it was predicted at the time of appraisal that there would be no effects on ecological system and natural scenery as the Project site is in a desert with little vegetation. Actually no such effects have been reported.
During the construction period, negative impacts on environment such as noises and tremors were not reported. Since the completion of the Project, the operation company has conducted surveys of noises, air pollution and water quality in accordance with relevant laws and regulations, with which no adverse effects have been reported.

3) Resettlement and land acquisition
As the Project site is in a mountainous desert and impounding areas were limited within a glen, no farming areas became under water and the Project required only a small number of relocation of local residents. For the construction of the dam, around 150 persons of 30 households in two villages were required for relocation. Relocation to nearby villages and cities were smoothly conducted with money compensation, without any particular problems. Since many of relocated residents were nomadic people, their current status is not known.
As for land acquisition, there were difficulties in negotiations on compensation in some cases, causing

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[19] Based on estimates by IWPC.
[20] The information is based on interviews with authorities of Andika City, located 5 km north-west of the Project site, as well as IWPC.
[21] More precisely, 3.9 billion liters of Mazot (diesel oil of heavy gravity) and 2.2 billion liters of normal diesel oil.
[22] An emission of CO2 of approximately 53.9 billion kgCO2 has been reduced with the Project, according to the rough calculation based on "Guideline for calculation of greenhouse gas emissions for industries (ver. 1.5)" published by Ministry of Environment of Japan
[23] Based on interviews with authorities of Andika City and IWPC.

higher costs than planned. However, no particular problems were experienced[24].

4) Technology transfer effects
With the Project, it was the first experience for Iran to complete a construction project of a large scale hydroelectric power plant jointly with international experts. Through the Project Iranian side has acquired and improved technologies and techniques, such as design, manufacturing, construction and management of hydroelectric power plant[25]. IWPC claims that the technologies they learned through the Project has been utilized and applied to other projects. The construction projects of Daryan Dam, which is under construction, and Gotvand Dam, which is located downstream of the Karun River, are implemented by only Iranian contractors and consultants, without participation by foreign companies.

5) Power supply to neighboring countries
Since Iran has been increasing its export of electricity to neighboring countries such as Iraq, Turkey and Afghanistan, the Project indirectly contributes to steady power supply in these countries.

Table-5 Exports of Electricity by Iran (GWh)

To Year	2004	2005	2006	2007	2008	2009
Iraq	296	1,003	1,002	1,085	2,416	4,806
Turkey	491	535	576	608	453	508
Afghanistan	20	66	134	206	286	357
Other countries	1,030	1,156	1,062	621	721	483
Total	1,837	2,760	2,774	2,520	3,876	6,154

Source: Tavanir

As mentioned above, the Project has significant positive impacts while no negative impacts are observed.

3.5 Sustainability (Rating: ③)

3.5.1 Institutional Aspect
Khuzestan Water and Power Authority (hereafter KWPA) is responsible for operation and maintenance of the Project.

Although KWPA was supposed to take over the operation and maintenance of the Project after the completion from IWPC which was responsible for the construction, Ministry of Energy decided in 1998 that IWPC would continue to be engaged in the operation and maintenance even after the completion. Subsequently, for that purpose the Operation Company of Masjid-e-Soleiman HEPP (hereafter Operation Company) was established in 2001 as an affiliated company of IWPC. However, Ministry of Energy, by again changing its policy, decided in 2004 that KWPA should take over the task of operation and maintenance of the Project and Operation Company was transferred as an affiliated company of KWPA in March 2005. There was no monetary transaction in transfer process without any compensation. At present IWPC offers technical support gratuitously to Operation Company as and when requested.

KWPA was established in 1960 as a state owned company under Ministry of Energy. It has two departments; the Power Department is responsible of management of operation of power plants and transmission and distribution of electricity, and the Water Department is responsible of water supply

[24] Based on information by IWPC
[25] Examples of technologies and techniques newly introduced to Iran through the Project include; installation of aerators to prevent negative pressure in spillways, use of crushed ices for concrete placement under the high temperatures, and full-scale application of CAD for designing.

for agriculture, industries and households around Khuzestan Province. Currently KWPA is in charge of operation and maintenance of five hydroelectric power plants[26] in Provinces of Khuzestan, Kohkiloyeh va Boyerahmad.

KWPA, at the time of appraisal, had been a large scale national institution which had exclusively taken responsibility to operate hydroelectric power plants. The Operation Company, affiliated to KWPA, has well organized departments/sections and staffing plan with clear job descriptions. No particular problems are observed in terms of institutional aspect of the Project.

3.5.2 Technical Aspect

KWPA has accumulation of technical know-how in operation and maintenance of hydroelectric power plants with an experience of more than 50 years and highly evaluated by Ministry of Energy. For the operation and maintenance of Masjid-e-Soleiman HEPP, 14 types of manuals are prepared and used for each purpose. The number of staff engaged in operation and Maintenance is 45 in total, which is sufficient, according to KWPA, and no major technical problems have been identified. KWPA has a staff training system where internal training is conducted based on a training program, as well as external training at universities and other research institutions

Overall, because both KWPA and Operating Company have good technical resources and Masjid-e-Soleiman HEPP is well operated without major troubles, their technical standards are judged to be sufficiently high.

3.5.3 Financial Aspect

Expenditure for operation and maintenance of Masjid-e-Soleiman HEPP is shown in Table-6. The budget of Operation Company required for the operation and maintenance are expensed by KWPA. The amount of expense has been increasing because of i) inflation, ii) the fact that up to 2005 when Operation Company is transferred from IWPC to KWPA, part of expenses for operation and maintenance were directly paid by IWPC budget, which is not included in the table, and iii) 4 new generators were added in 2007 at the expansion stage.

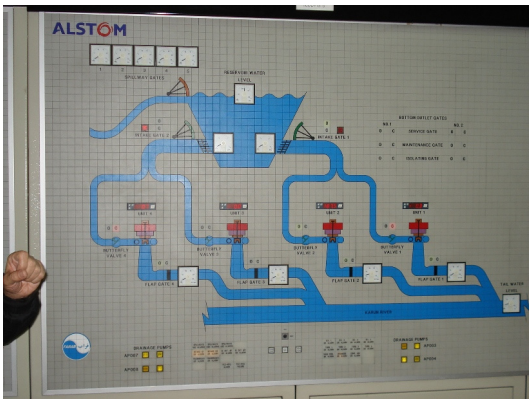
Table-6 Expenditure for Operation and Maintenance

Year	Expenditure (IRR million)
2001	709
2002	3,346
2003	16,389
2004	24,384
2005	31,677
2006	38,970
2007	48,080
2008	58,949
2009	70,000

Source: IWPC

The data on financial conditions of KWPA is not available to the evaluator. However, according to interviews with KWPA and Ministry of Energy, both power and water departments of KWPA have steady revenue and no financial problems are observed. Revenue of power department comes from electricity sales to Iran Grid Management Company[27]. KWPA does not receive any subsidies from the Government.

[26] Besides Masjid-e-Solieman HEPP, other 4 plants are Shahid Abbaspur, Dez, Karkheh and Marun.
[27] One of affiliated companies of Tavanir.

Operation Room in Power Plant

3.5.4 Current Status of Operation and Maintenance

Both the findings of the field survey and explanations given by IWPC and KWPA indicate that all of the facilities of the Project are in good working order, and properly operated and maintained in accordance with the operation and maintenance plan.

On the other hand, 4 generators installed at the expansion stage, which is not included in the scope of the yen loan Project, are under repair and not working for the moment. For the steady power supply of Masjid-e-Soleiman HEPP, full operation of all 8 units is desired to resume as soon as possible.

Based on the above evaluation, no major problems have been observed in the operation and maintenance system, therefore sustainability of the Project effect is high.

4. Conclusions, Recommendations and Lessons Learned

4.1 Conclusions

The Project was planned as one of the measures of electric power development policy of Iran to meet rapidly increasing demand of power. There is still a strong need for a further increase of the generating capacity of the electric power because of the continual increase of the demand. As the Project was compatible with Japan's ODA policies, its relevance is high. The scale of the generating capacity of the constructed Masjid-e-Soleiman Hydroelectric Power Plant is as planned and the overall project cost was within the planned cost. However, the completion of the Project was delayed by 4 years due to the cancellation of part of the yen loan and some other reasons. Accordingly, the efficiency of the Project is judged to be medium. Although the achievement rate of volume of power generation is around 80% of the original plan, it is due to shortage of rainfall and decreases in water discharge of upstream dams. In consideration of the high economic validity (internal rate of return) of the Project, its effectiveness is judged to be high. The Project contributes to steady power supply in Iran as a whole by providing the power through the national grid. The facilities constructed under the Project are in good working condition and Khuzestan Water and Power Authority (KWPA) which operates these facilities is believed to possess an adequate operation and maintenance management system, technical expertise and financial strength. As such, the sustainability of the Project is judged to be high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

All the 8 power generators are required to be in a good working condition in order to secure steady power supply of Masjid-e-Solieman HEPP, hence further strengthen effectiveness of the Project. The damaged 4 units of generators, which were installed at the expansion stage, should be repaired at the

earliest possible timing.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

For Iran, The Project was the first project with yen loan after the Islamic Revolution and also the unprecedented project to construct a large-scale hydroelectric power plant with new technologies. Furthermore, for IWPC, an executing agency, it was the first experience to implement a project with an international competitive bidding. Taking all the conditions into consideration, the implementation schedule of a project should be carefully prepared with time allowance, if all the problems in terms of finance, technology and management of the project are not fully anticipated.

Comparison between Original Plan and Actual Results

Item	Original	Actual
1. Outputs	1) Construction of dam (main dam, coffer dam, spillway, etc.) Type: rockfill Height: 170m Crest length: 535m Total reservoir volume: 228 million m^3 2) Construction of power station (power cavern, transformer cavern, etc.) Type: Underground plant Installed capacity: 1,000MW (4 x 250MW) with additional 1,000MW (4 x 250MW) for the extension stage Annual power generation: 3,700GWh 3) Consulting services Assistance to bidding, detailed design, construction management, etc.,	1) Construction of dam (main dam, coffer dam, spillway, etc.) Type: rockfill Height: 177m Crest length: 497m Total reservoir volume: 228 million m^3 2) Construction of power station (power cavern, transformer cavern, etc.) Type: Underground plant Installed capacity: 1,000MW (4 x 250MW) with additional 1,000MW (4 x 250MW) for the extension stage Annual power generation: 3,700GWh 3) Consulting services Assistance to bidding, detailed design, construction management, etc.,
2. Project Period	June 1993 - December 2000 (92 months)	June 1993 - December 2004 (140 months)
3. Project cost Foreign Currency Local Currency Total Of which JICA Loan Exchange Rate	 160,125 million yen 62,617 million yen (IRR391,356 million) 222,742 million yen 151,443 million yen 1yen=6.25 IRR (September 1992)	 45,936 million yen 84,126 million yen (IRR1,808,700 million) 130,062 million yen 45,936 million yen 1 yen = 21.50 IRR (Weighted average during 1991–2006)