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Philippines

Mak-ban Geothermal Power Plant Complex Rehabilitation Project

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Field Study : September - October, 2008

1. The project outline and yen loan assistance

Location of the project site

Mak-ban Geothermal Power Plant

1.1 Background :

Demand of power in the Philippines is concentrated in Luzon Grid by about 75%, however, construction or addition of a new power generation facility didn't take place until the second half of 1980s. Due to the deterioration of facilities, power generation function was seriously deteriorated and chronic power-cut persisted due to the lack of electricity until the first half of 1990s. The basic idea of the 3 energy policies upheld by the government of Philippines were "reliable power supply at reasonable price", "promotion of efficient energy use" and "development of energy with minimum environmental impact". Based on the basic idea, the country targeted to reduce dependency on imported oil from 51.4% in 1986 to 46.9% in 1992 and strengthen geothermal power generation.

The Philippines has the second most abundant geothermal energy in the world after the U.S in production and utilization of geothermal energy.

1.2 Purpose

Enhance the efficiency and reliability of the power generation facilities by repair/replacement of the existing facilities of Mak-ban Geothermal Power Plant in the Philippines, effectively use indigenour energy, and ultimately strike the balance of

demand and supply of power at Luzon Grid.

1.3 Borrower/implementing organization：
Government of the Republic of Philippines/National Power Corporation：NPC

1.4 Outline of Yen Loan:

Approved loan amount/ Disbursement	6,630 mil yen / 5,644 mil yen
Exchange of notes/signing of loan agreement	November 1994 / December 1994
Lending terms	Interest rate: 3.0％, repayment period: 30 years (including grace period of 10 years), general untied loan
Disbursement completion	January 2006
Project agreement （worth of 1 billion yen or more）	Mitsubishi Corporation (Japan)
Consultant agreement （worth of 100 mil yen or more）	West Japan Engineering Consultant (West JEC)・ Philippines Geothermal, Inc.（PGI）
Feasibility Study (F/S), etc.	1991 Completion of F/S by Japan Consulting Institute 1992 Completion of JICA master plan（Study on Luzon Grid P/P facility repair/maintenance & control improvement plan）

2. Finding (Rating: B)

2.1 Relevance（Rating：a）

It was confirmed that the implementation of the project is consistent with the development needs and policy, both at appraisal and ex-post evaluation. Therefore, relevance of the project implementation is high.

2.1.1 Consistency with government policy and measures

(1) Appraisal

“Mid-term Philippine Development Plan (1987-1992)” at around the project appraisal (January 1993) period says that it is important to strengthen infrastructures because it is the base of sustainable social economic development. In particular, improvement of

reliability and efficiency of power supply was prioritized in power sector. The plan listed utilization of indigenous energy such as geothermal energy, and rehabilitation, improvement and repair of existing facilities as specific measures to be implemented. "Mid-term Philippine Development Plan (1993-1998)" continuously emphasized the use of domestically indigenous and encouraged diversification of energy sources for stable supply at low cost. Geothermal power generation was focused as one of the solutions.

The Philippines has continuously implemented a measure to strengthen the use of indigenous energy resources since 1970's. The country emphasized the need to expand power generation capacity based on domestic resources for stable and sufficient power supply at lower cost. In response to severe shortage of electricity since the second half of 1980's, the country positioned geothermal energy as the most promising domestic energy resource to lower the dependency on imported energy resources in "Philippines Energy Plan : PEP 1992-2000".

In response to the serious lack of electricity mentioned above, the country enacted BOT law in 1990 and Electricity Power Crisis Act in 1993 to promote private participation in power generation sector by deregulation.

Consistency of the project with government policy mentioned in "Mid-term Philippine Development Plan" and "Philippine Energy Plan" above is confirmable because the project emphasizes the importance of utilizing geothermal energy at appraisal. The project was implemented after the country introduced a policy to promote private investment, but this is because the government decided both public and private capitals were necessary to overcome the power crisis. From this perspective, the project is deemed to be consistent with the government's development policy.

(2) Evaluation phase

Similarly, "Mid-term Philippine Development Plan (2004-2010)" at around the time of evaluation (2008) focused on securing stable and sufficient power supply and promoted the use of domestically produced energy as government policy, while encouraging the reform of power sector led by private corporations. "Philippine Energy Plan (PEP) 2005-2014" upholds effective use of indigenous energy as a sector target, and specifically emphasized the utilization of reproductive energy including geothermal energy.

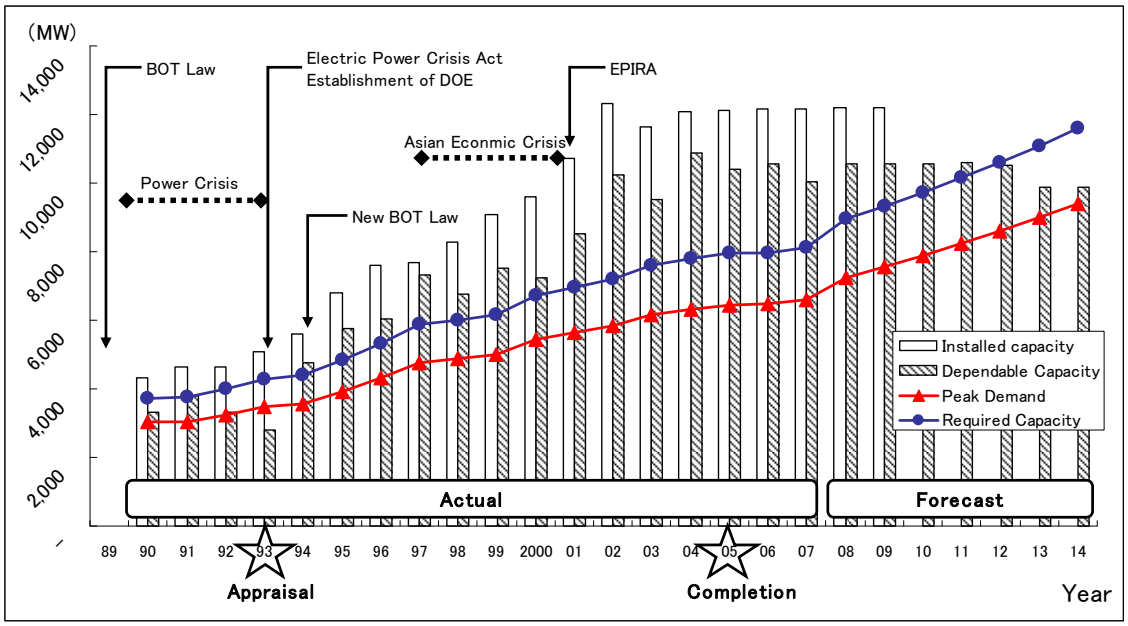
Securing power supply and effective use of domestic energy were emphasized in "Mid-term Development Plan" and "Philippines Energy Plan" continuously at evaluation phases, which underpin the project's consistency with measures/policy.

2.1.2 Consistency with development needs

Power shortage persisted in the Philippines since the second half of 1980's and peaked by power crisis in 1992-1993, during which power-cut that lasts 5 hours or longer occurred frequently. Development of power supply source, recovery of output and improvement of obsolete power generation facilities were needed for stable power supply. The project was requested by the country as an emergency measure to counter the power crisis by rehabilitating power generation facilities. Accordingly, needs of the project is deemed to have been quite high at appraisal phase.

However, thanks to an active introduction of Independent Power Producer : IPP centering foreign capital, power shortage was resolved by 1994. As shown in Figure-1, power generation facility always had additional capacity of 3,000MW or more beyond the demand, since economic crisis in Asia and at appraisal in 2008. Nevertheless, Power Supply and Demand Outlook (2006-2014) compiled by the Department of Energy: DOE, estimates that power shortage will occur again around 2010, and therefore, strengthening of power generation facility is necessary. Since the target of the project is to promote an effective use of geothermal energy for balanced use of resources and stable power supply, there was a need for the project in times of evaluation, too.

Figure-1 Actual and trend of peak power demand at Luzon Grid, capacity of power generation facility and power generation capacity



Note : Compiled based on NPC document, DOE document, appraisal materials, "Philippines Power Sector Study 1994" from World Bank, and baseline research on power sector by JICA (2001). (Statistics during 1995~2000 was based on NPC and DOE documents) Figures for estimate were based on "Power Supply and Demand Outlook 2006-2014" by DOE. Required Capacity refers to the peak demand plus the reserve margin above the peak demand of 23.4%.

2.1.3 Relevance of the project plan

The project was planned to repair/improve 6 units out of the units of existing power plants A, B and C (total 330MW output) of Mak-ban geothermal power plant, listed in Table-1 below, which was under operation in times of the appraisal.

Table-1 Outline of Mak-ban Geothermal Power Plant

Plant	Power generator	Start of operation	Rated output
Plant A	Unit 1	January 1979	55MW
	Unit 2	May 1979	55MW
Plant B	Unit 3	January 1980	55MW
	Unit 4	April 1980	55MW
Plant C	Unit 5	December 1981	55MW
	Unit 6	March 1982	55MW
Total			330MW

Note: Based on Mak-ban geothermal power plant materials. Plant D and E were built by the support from Asia Development Bank.

At appraisal, analysis was done on the information of geothermal reservoir including the size but could not confirm the fact that steam supply was on decline. The all 6 units were expected to be used efficiently for a long time.

Due to long delay in the project implementation (details are explained hereinafter), the project was reviewed in 2001. The review proposed to focus on the repair of unit 1-4 because "unit 5 and 6 are relatively new and do not require repair"[1] and the project budget was limited. However, since early review in 1993 concluded that these units also necessitated repair, and if that is the case, the need must have become stronger by 2001 due to deterioration of units by the elapse of time. Therefore, decisions made at appraisal and at review in 2001 are contradictory. According to an operation status during 2000-2002, capacity factor fell to less than 60% many times. Unit 6 was especially in bad condition for it almost stopped power generation in 2004 and thereafter, and capacity factor of unit 5 is less than 30%. Based on this, it is clear that unit 5 and 6 were actually in need of repair. NPC accepted this recognition at evaluation and obliged the repair of units 5 and 6 to their new owner[2]. Therefore, units 5 and 6 were necessary to be repaired/improved in times of the plan review, too.

Relevance of the project planning is somewhat questionable in appraisal and plan review phases, but based on facts that a new owner was obliged to repair/improve units that required to be done so, and the project is confirmed to be consistent with the "Mid-term Philippine Development Plan" and "Philippine Energy Plan" of the government policy/measures, and with development needs at appraisal and evaluation.

[1] Based on JICA materials

[2] As explained hereinafter (2.5.1 Implementing organization), the power plant will be transferred to a new owner (AP Renewables) around May 2009.

Therefore, the project is highly relevant.

2.2 Efficiency（Rating：c）

Project implementation was delayed substantially (293%) and project cost was slightly larger than planned (128% for one facility); therefore, the evaluation for efficiency is low.

2.2.1 Output

As aforementioned, the project was planned to repair/improve all the 6 units at appraisal but actually, partial repair was done to 4 units (1-4 units). As aforementioned, cale back of the project scope was the exclusion of units 5 and 6 from repair/improvement, for reasons that they were relatively new and the budget was limited. Repair to the 4 units was a partial one focused on recovering function of power plant and safety operation. In addition, after the partial repair, additional repair/improvement was required and the plan was changed as summarized in Table-2.

Picture-1：Power generation facilities

After changes to the scope explained above, actual output was reduced by 2 units from the original plan because repair of 2 units were excluded from the project. If technical analysis of the situation had been thoroughly conducted at the first scope change, the second change was less likely required.

Table-2 Summary of changes to project

	Contents	**Process/reason of planning/changes**
(1) Plan at appraisal (Jan. 1993)	Replacement, repair, installation etc. of turbine, power generator, gas extract device and cooling tower of Units 1~6 (55MW each)	Reviewed necessary scope of repair/ improvement aimed at recovering reliability and effectiveness of units 1~6.
(2) Output at the first contract (Related to the scope change Agreed by former JBIC: May 2001) Implementation period: Oct. 2003 -Jun. 2004	Limit repair to the recovery of function and stable operation of 4 units (Unit 1-4). Repaired units are strengthened to 63MW. Scope originally planned but excluded due to duplication of scope with NPC project: Replacement of turbine supervisory instrumentation, partial replacement of disconnecting switches for switchyard, electric switchboard protection measure, gas extractor equipment, replacement of auxiliary cooling water valve, installation of tube cleaner, purchase of honing machine and environment monitoring	Units 1-4 were subject to repair/improvement because units 5 and 6 were relatively new and the necessity or repair is lower. In addition, the government of Philippines shifted from “full repair” to “partial repair” based on their own review result, which concluded partial rehabilitation was sufficient to recover the function. According to technical examination by Yen Loan Division of former JBIC (current JICA), the change is reasonable because recovery of function is possible if rehabilitation planned by NPC is properly implemented. However, they pointed out the need to implement

	equipment. Newly added scope: 4 turbine related items including steam leak prevention, replacement of Turbine Drain Valves and Piping, and supervisory instrument at turbine start-up, 6 generator related items for its safe operation, and 12 items related to safe operation of other power generation facilities.	interim supervision at early stage, since actual condition of the plant was not confirmed by the review. Former JBIC requested the government not to make further reduction to the scope.
(3) Output at additional contract (Related to the second scope change Agreed by former JBIC: Feb. 2004) Implementation period: May 2004-Nov. 2005	Added the scope of repair for 4 units, Unit 1-4, because it is considered necessary for stable operation. There were 27 newly added repair/improvement items (facilities/parts) in total including replacement of cooling tower for Units 5 and 6, and purchase of Switchgear and motor for gas extract equipment for Units.2.	NPC, a contractor and a consultant jointly carried out a study in Dec. 2001 and May 2002, and confirmed stable operation is difficult, contrary to the expectation. Also, additional repairs turned out to be necessary to satisfy conditions of steam supply contract. The government of Philippines decided to exchange additional contract, to which former JBIC agreed because the addition was originally included as part of the scope and deemed necessary at appraisal, and therefore, necessary to achieve the target of the project.

Note: compiled based on JICA materials.

2.2.2 Project period

The project term was originally set at 45 months after the exchange of yen loan agreement, but it actually took 132 months until repair/improvement was completed and operation of 4 units got started (November 2005), much longer than planned (11 years: 293% of the plan). 92 months (7 years and 8 months) have passed after the exchange of loan agreement until receiving approval from the government of Philippines (contract coming into effect), and 40 months (3 years and 4 months) from the contract entry to the completion of the project. Reasons for the delay are as explained below.

(1) Reasons for the delay before contract becoming effective, after yen loan agreement

(1)-1 Lawsuit over Steam Supply Service Agreement

Steam Supply Service Company filed a lawsuit at a court of arbitration against NPC that owns Tiwi/Mak-ban Geothermal Power Plants [3], complaining NPC rejected renewal of steam supply contract (25 years of contract. Expiration in 1996). NPC also brought the case to a domestic court. Steam Supply Service Company offered to drop charges on condition that Tiwi/Mak-ban Geothermal Power Plants was transferred to them and repair cost was burdened by them in exchange. In this situation, the government of Philippines decided to suspended implementation of the project because they needed time to review

[3] Tiwi Geothermal Power Plant belongs to Luzon Grid that was repaired by yen loan in the same period of this project implementation. One steam supply service company used to supply geothermal steam to both Tiwi Geothermal Power Plant and Mak-ban Geothermal Power Plant under the same steam supply service contract.

many things including whether or not to implement the project, at all. Considering the fact that negotiation of the project contract was completed in April 1999, the project could have been completed 3 years or more earlier if the government had not decided the suspension.

(1)-2 Privatization of power plant

As breakup and privatization of power sector was being promoted in the Philippines, the government spent considerable time reviewing which was more efficient to sell/privatize Tiwi Geothermal Power Plant via yen loan (repair/improvement by direct control of NPC) or privatization (repair/improvement by private company after purchase of the power plant). (Procedure for the project was interrupted[4] until September 2000 (69 months or 5 years and 9 months after the exchange of yen loan agreement), due to the lawsuit and the review of privatization) Facing such circumstances, NPC and former JBIC regularly discussed to advance procurement procedure.

(1)-3 Review for the scope change

While discussions over the aforementioned lawsuit and privatization delayed the project implementation, deterioration of power plant progressed and additional repair/improvement became necessary according to the degree of deterioration. It took additional time to review the scope change and to receive approval for that. The government of Philippines approved the scope change and exchanged the project contract in July 2002 (contract became effective).

(2) Development from contract entering into force until the project completion

After the contract became effective, original scope of the project was once fixed in June 2004. However, field study conducted by NPC, the consultant and the contractor concluded that an additional repair was deemed necessary for stable operation of the power plant. Further, additional repair/improvement became necessary to achieve a certain level of power generation capacity and reliability under conditions of Geothermal Resource Sales Contract : GRSC[5]. In response to this, additional contract was concluded in March 2004 and the repair work was completed in December 2005.

2.2.3 Project cost

The actual total project cost (for 4 units) was 5,679 billion yen (of which 5,644 billion

[4] The government of the Philippine announced former JBIC the intention to cancel the yen loan project, but they retracted it later and decided to continue the project. Exchanges like this caused the delay too.

[5] GRSC will be applied after completion of Tiwi Geothermal Power Plant and Mak-ban Geothermal Power Plant repair/improvement. Repair by yen loan is positioned as “partial repair”. The two power plants will be owned 100% by private company around May 2009, and fully repaired by the company within the subsequent 4 years.

yen is yen loan), which fell within the plan of 6,796 billion yen (for 6 units) (of which 6, 63 billion yen is yen loan). Cost per unit was 1,415 billion, which slightly exceeded the plan of 1, 15 billion yen (increase of 128%). This was mainly due to an extended project period that led to incur additional cost to repair deterioration that took place in the meantime, beyond the scope assumed at appraisal.

2.3 Effectiveness（Rating：a）

The project has achieved 80% of the plan (target figure) despite exclusion of the 2 units and effectiveness of repaired/improved unit is high. Therefore, this project has largely achieved its objectives, and its effectiveness is high.

2.3.1 Status and effectiveness of operating power plant

In the original plan, repair/improvement of 6 units was expected to achieve 85% of capacity factor and volume of gross power generation at 2,457GWh/year. However, actual volume of power generation is barely half of the target, 1,714GWh (2006) and 2,047GWh (2007).

Table-3 Operation status/initial plan (for all 6 units)

Indicator (unit)	Base (1992)	Target	Actual (2006)	Actual (2007)
Total gross generation（GWh）	**2,473**	**2,457**	**1,714**	**2,047**
Total net generation（GWh）	2,306	2,292	1,630	1,945
Total rated output（MW）	330	330	362	362
Dependable capacity（MW）	308	280.5	196	234
Unit average of capacity factor（%）	**84.1**	**85.0**	**52.0**	**62.4**
Average availability factor（%）	91.8	-	61.2	76.9
Total operation time（hour）	48,374	-	32,178	40,436
Total forced outage（hour）	1,437	-	558	1,847
Total interruption time due to external factors（hour）	36	-	16,009	9,981

Source : Appraisal materials for base and target of capacity factor, calculated based on capacity factor and station use rate for other targets. NPC for actual.

Table-4 Operation status/initial plan (for 4 units subject to repair/improvement)

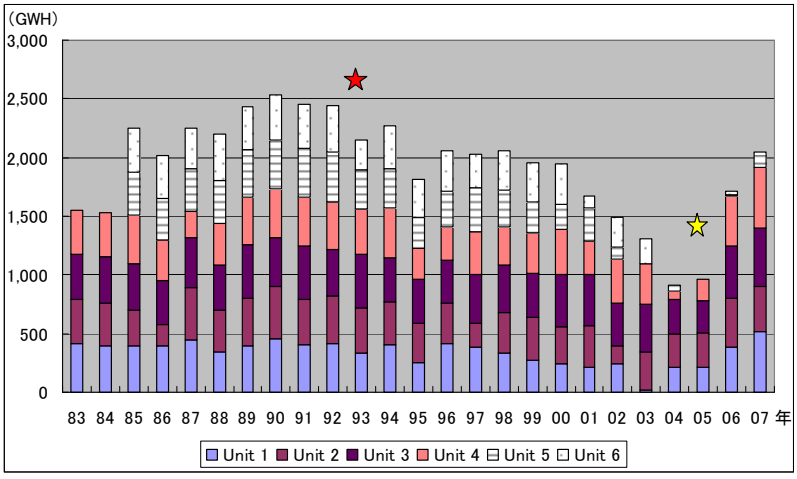
Indicator (unit)	Base (1992)	Target	Actual (2006)	Actual (2007)
Total gross generation（GWh）	**1,623**	**1,638**	**1,676**	**1,915**
Total net generation（GWh）	1,536	1,528	1,595	1,827
Total rated output（MW）	220	220	252	252
Dependable capacity（MW）	208	187	181	217
Unit average of capacity factor（%）	**84.0**	**85.0**	**75.9**	**86.8**
Average availability factor（%）	90.7	-	87.8	98.7
Total operation time（hour）	31,866	-	30,749	34,580
Total forced outage（hour）	1,056	-	524	99
Total interruption time due to external factors（hour）	11	-	62	43

Source : Appraisal materials for base and target of capacity factor, calculated based on capacity factor and station use rate for other targets. NPC for actual.

In comparison, rated output of units 1-4 increased by 32MW from appraisal (1992) to after the project completion (2006), but actual output was increased by 3-18% on average per unit.

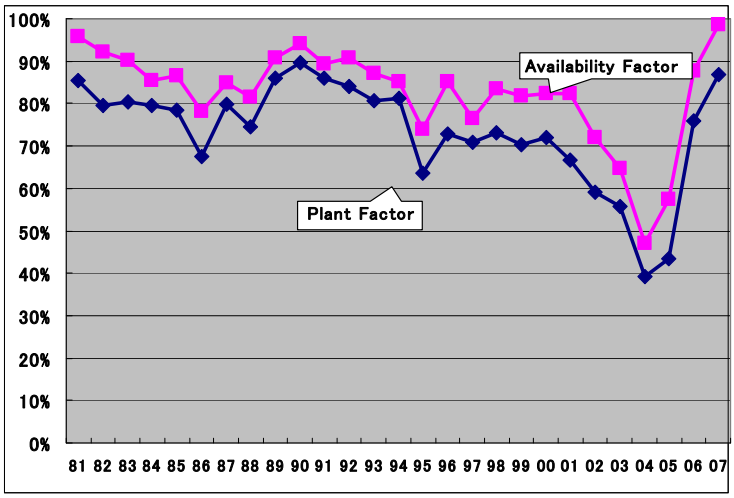
As shown in Figure-2, output of repaired 4 units has increased after the project completion. Also, as shown in Figure-3, capacity factor has improved to 90% and availability factor reached almost 100% after the project completion; therefore, effectiveness of the repair/improvement is high.

Figure-2 Trend of generation



Source : NPC
Note: Red star and yellow star show the timing of appraisal and completion of the project, respectively.

Figure-3 Trend of plant load (capacity) factor and availability factor of facilities (rehabilitated 4 units)



Source： NPC

2.3.2 Recalculation of Financial Internal Rate of Return（FIRR）

FIRR increased from 8.2% at planning (appraisal) to 35.2% at evaluation. EIRR (Economic Internal Rate of Return) is difficult to be calculated and analyzed by comparison for evaluation, due to restriction on calculation measures applied for appraisal.

Increase in FIRR was mainly due to (i) increase of fuel cost and maintenance cost by 60%, increase of wholesale power cost to 2 times or more in contrast, and no increase in initial investment because the project scope was narrowed from 6 to 4 units, (ii) substantial delay in the procurement of materials/equipment and the start of repair work, deterioration progressed in the meantime and volume of electricity sold at a point of project completion was reduced in case the project had not been implemented. Also because 4 units have almost achieved the output targets after the project completion, amount of increase estimated at evaluation was greater than that at appraisal, (iii) regardless of substantial delay in starting procurement of materials/equipment and repair work, there w no cost incurred in the meantime, and (iv) repair work was completed as planned and succeeded in temporarily starting operation in 1.5 years of the first contract. Precondition of FIRR at planning phase was that capacity factor would be maintained at 79% without the project, but actually it declined to around 60% in 2001.

Table-5 Assumptions of IRR

	At planning	At evaluation
FIRR cost	Investment cost, fuel cost and operation maintenance cost (for rehabilitatede portion)	Same as on the left. (Apply unit cost as of Nov. 2008 for fuel and maintenance costs in 2008 and thereafter)
FIRR benefit	Income from electricity sales (increase after repair/ improvement) Output was calculated based on capacity factor of 79% for actual, 85% for post rehabilitation and 79% for Without. Assumed 2 units will be closed in 2011 and another 2 in 2012.	Same as on the left. Applied actual output after project implementation until 2007. Based on the current status, output was assumed based on capacity factor of 85% for unit 1~4 during 2008~2013, 80% during 2014~2017, 75% during 2018~2020 and reduction of 6% year on year during 2021~2023. For Without, applied actual until 2002 and assumed output got lower than the actual output of the preceding year by 6% since 2003.
Project life	21 years (18 years after rehabilitation)	18 years after rehabilitation
Fiscal year	Calendar year	Same as on the left.

2.4 Impact

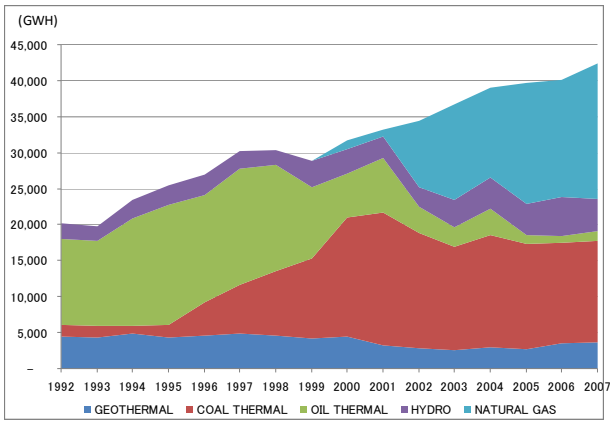
2.4.1 Contribution to the stabilization of Luzon Grid, diversification of energy sources and use of domestic energy

Compared to the planning stage, output of all 6 units of Mak-ban Geothermal Power Plant has decreased as a whole as shown in Table-3 above. Positive impact of the output increase to Luzon Grid as a whole could not be confirmed. Generation share of the power plant to the whole Luzon Grid was 4.1% in 2006 and 4.7% in 2007, which is lower than 12.9% in 1992 when the project was planned. However, if the project had not been implemented, all 6 units of Mak-ban Geothermal Power Plant is considered to have almost lost the power generating capacity. The project aimed at promoting an effective use of geothermal energy, which is highly valued as a renewable domestic energy. Since rated output of Mak-ban Geothermal Power Plant (1-6 units) makes up 40% of the total geothermal power generation at the Luzon Grid (based on rated output), the percentage of geothermal energy to the whole energy produced at the Luzon Grid could have been dramatically reduced without the project.

2.4.2 Economic impact

Geothermal power is an indigenous energy and had positive economic impact to lower fuel cost. Generation of 1kWh of electricity costs 6 times more in case of oil-fired power generation and 1.7 times more for gas-fired power generation in comparison to the cost of steam needed for geothermal power generation. The project was effective in cutting back fuel cost equivalent to 720 mil pesos (in case of gas-fired power generation) – 49.6 billion pesos (in case of oil-fired power generation).

Figure-4 Trend of Luzon Grid generation by power source



Source : NPC

2.4.3 Others

2.4.3.1 Impact to the environment

At first, acquisition of Environment Compliance Certificate : ECC was considered not necessary for the project, because it is a rehabilitation project to recover the function, not involving establishment of a new plant. However, ECC was actually issued in November 2002, and based on that, NPC has been implementing environmental monitoring during and after the project implementation. The result was compiled by NPC every quarter. Environment Control Bureau, local government, power plants, Steam Supply Service Company and NGOs also have started joint monitoring activities.

Picture-2 : Environment around the power plant

According to the monitoring results, the project satisfies the standard of the country, and so far, no specific problem has been pointed out in compiled reports. This is not directly related to the project but Mak-ban geothermal power plant is located in a crowded residential area and steam pipes are laid around the area as shown in picture 2. Therefore, there are concerns on safety (impact to the health condition of residents and bad smells caused by hydrogen sulfide, damages possibly caused by accident in times of excavation of wells) and spoiling the scenic beauty. However, measures are taken by NPC or a steam supply company to temporarily evacuate residents when excavation takes place.

According to NPC, no serious problem was reported when they visited local residents to hear on their health condition. They said local residents were used to the situation and no serious damages were reported.

2.4.3.2 Impact to social environment, land acquisition and relocation of residents

The project does not involve land acquisition or resettlement because it is a rehabilitation project of existing facilities.

According to the provision on tax payment to the local government, 0.01 pesos are taxed per the sale of 1kWh electricity. The project contributed to increase earnings from electricity sales and tax revenue for the local government, resulting in improvement to the standard of living and introduction of social welfare programs for residents in the area.

2.5 Sustainability（Rating：a）

No major problem has been observed in the capacity of the executing agency nor its operation and maintenance system; therefore, sustainability of this project is high.

2.5.1 Implementing organization

2.5.1.1 Structural organization for operation and maintenance

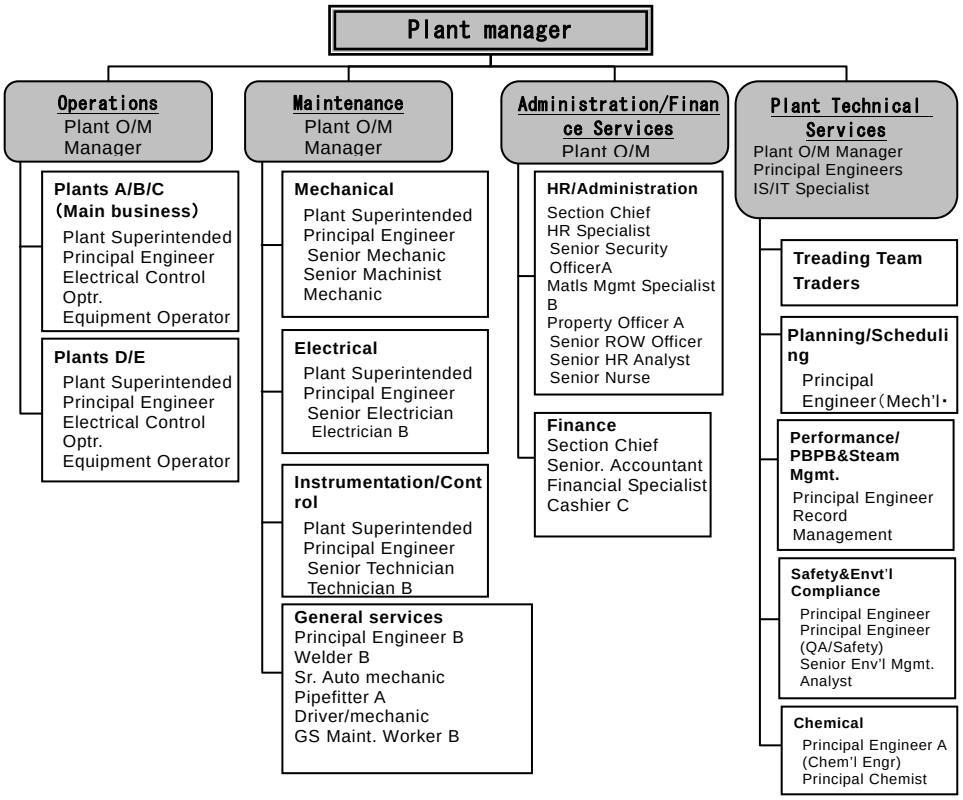
Environment surrounding power sector in the Philippines had dramatically changed from the time of the project appraisal to today. The impact is making changes to the operation and maintenance of the power plant. More specifically, Electric Power Industry Reform Act：EPIRA was enacted and entered into force in June 2001, and because of this, decision was made to split NPC, an implementing organization of the project, into a power generation company and a power transmission company, and privatize each (power generation asset is to be sold).

In response to the reorganization of power sector, bidding of both Tiwi and Mak-ban power plants took place at the end of July 2008, to sell their asset and privatize the two power plants together. AP Renewables (a company newly established to operate Tiwi/Mak-ban power plants), wholly owned subsidiary of Aboitiz Power Corporation（APC）successfully won the bidding.

As of December 2008, operation and maintenance of the power plants were continuously undertaken by Mak-ban Geothermal Power Plant Office under NPC, as pre-sellout transitional arrangement. Currently, 214 employees of NPC (4 supervisors, 97 operators, 76 maintenance staffs, 19 administration and finance services division staffs and 18 engineers) are working at Mak-ban Geothermal Power Plant (see Figure-5).

Handover of the power plant to AP Renewables is planned to take place around May 2009, and operation, maintenance, control and management of the power plants will also be completely transferred from NPC to AP Renewables by then.

Figure-5 Organization chart of Mak-ban Geothermal Power Plant



Sourse：Mak-ban Geothermal Power Plant

2.5.1.2 Technology for operation and maintenance

The power plant has accumulated experiences through 25 years of operation, and operation and maintenance are done based on their own knowhow and technology, without technical assistance from external parties.

According to the operation and maintenance plan of AP Renewables submitted in times of the bidding, the company basically maintains the current employees of Tiwi Geothermal Power Plant for the time being. Also abundant experiences of its parent company Aboitiz Power Corporation are expected to be reflected to the operation and maintenance of the power plant, accumulated by undertaking numerous projects of hydraulic power generation and power transmission projects in the country.

As stated above, there is no structural or technical problem with the current NPC structure. AP Renewables also has abundant power generation project experiences and since they intend to maintain the current employees of NPC, there is no specific concern in terms of technology/structure as of December 2008, in transitional phase.

2.5.1.3 Finance for operation and maintenance

As aforementioned, although output of the power plant was lower than planned (target) at

appraisal, wholesale power cost of the country has more than doubled compared to the plan. Since steam cost is stable, rate of return for geothermal power generation is high.

Table-6 Main financial performance

（Unit：million pesos）

	2005	2006	2007
Operation income	6,417	9,352	11,236
Steam cost	1,672	1,243	2,085
Operation & maintenance cost	37	46	39
Average selling price （pesos/kWh）	4.40	4.66	4.72
Average steam cost （pesos/kWh）	0.82	1.13	1.02

Source：Mak-ban Geothermal Power Plant materials

Note：Cost for operation and maintenance (and cost for drilling) of steamfield are necessary, separate from these costs of the power plant. NPC reimburses the cost to Steam Supply Service Company.

The power plant and Mak-ban Geothermal Power Plant were sold by bidding in July 2008 at 447 mil dollars, which is more than three times of the project cost and Mak-ban Geothermal Power Plant rehabilitation project cost combined.

Financial condition of Aboitiz Power Corporation, a parent company of AP Renewables is deemed good since they are steadily increasing income from power generation and power transmission businesses, and the ratio of their current assets to current short-term liabilities exceeds 200%.

Table-7 PL Statement of Aboitiz Power Corporation

（million pesos）

	2005	2006	2007
Revenue	8,053	8,681	11,312
Profit before tax	2,872	2,275	4,882
Net income	2,444	1,850	4,138

Table-8 Financial ratio of Aboitiz Power Corporation

（times）

	2005	2006	2007
Current ratio	2.40	3.33	2.54
Debt-to-equity ratio	0.47	0.41	0.31

Source：（Table-7 and 8）Annual report of Aboitiz Power Corporation

2.5.2 Operation and maintenance status

Table-9 Steam supply capacity

(1) Max. steam supply	160-162 MW
(2)Total rated output after repair of units 1,2,5 and 6	234 MW
(3) Max. operation rate ((1)/(2)、based on 4 units)	68-69% (Exceeds total rated output for 3 units)

Source: Based on the hearing survey by NPC

Units subject to rehabilitation by the project go through detailed examination once in two years and regular check in every quarter. The power plant is operated for 8 hours a day in 3 shifts.

Although steam supply volume is confirmed to be in decline at about 6% a year, power generation is possible with unit 5 and units 7-10, which was constructed by other donor, in addition to units 1-4 repaired by the

project. Further, there is no specific concern to steam supply capacity for the time being because 2 steam fields are planned to be excavated. On the other hand, 6 power generation units are in operation (operation of unit 6 is suspended due to failure), in addition to the 4 units repaired by the project. Since steam is supplied to all these units, it is important to consider the balance with geothermal reservoir for sustainable operation of the power plant in the future.

3. Conclusion, lesson learned and recommendation

3.1 Conclusion（Rating：B）

Even though the project is relevant with government policy and development needs, the implementation was substantially delayed, and therefore, efficiency is low. However, although the project scope was reduced from the original 6 units to 4, effectiveness of the repaired 4 units is high and in consideration of maintenance structure, technical skills and status of steam resource sustainability is also high. In light of the above, this project is evaluated to be highly satisfactory.

3.2 Lessons learned

(1) A big factor that caused the long delay in the project implementation is confusion persisted in the wake of steam supply contract (25 years) expiration in 1996. For planning an energy development project like this, it is important to fully analyze risks and consider measures to control the risks associated with stable supply of fuel source, indispensable for smooth operation after completion of a project.

(2) Deterioration of the existing facilities continued while the project implementation was suspended, leading to increase repair cost per unit and delayed effects from being produced. Mixed with the reform of power sector, introduction of privatization policy and other complex political factors, the project implementation required considerable time for review. However, the government of a borrowing country should have committed more strongly to expedite the project and achieve the target of “stable power supply”. To avoid substantial delay in implementation of project like this, strong commitment of a borrowing country and effective measures of the government of a lending country and JICA are desired if any change to external conditions possibly seriously affecting the project is confirmed in times of progress status monitoring.

3.3 Recommendation

No recommendation.

Plan／Actual Comparison of performance

Item	Plan	Actual
(i)Output ・ Rehabilitation of the existing power generation facilities	Rehabilitation of 55MW×6 units Turbine: ・Procurement of turbine spare rotor etc, and replacement of control board recorders, etc. Generator: ・Special check of generator, repair of generator AVR, and procurement of tube cleaner for generator hydrogen gas cleaner, etc. ・Installation of a hybrid gas extraction system ・Procurement of various spare tools for repair and environmental monitoring equipment	Rehabilitation and reinforcement of 60MW×2 Units and 57MW×2 units Failure due to an obsolete facility was extensive and drastic revision to the original plan was required to address the situation.
・ Consulting service	Foreign : 60M/M Domestic : 46M/M Total : 106M/M	Foreign : 55.25M/M Domestic : 47.75M/M Total : 103M/M
(ii)Period		
Exchange of loan agreement	Planned in Aug. 1993	Dec 1994
Selection of consultant	Sep 1993-Apr 1994	Jan 1995-Jan 1997
Consulting service	May 1994-Dec 1997	(1)Apr. 1997-Apr 2004 (2)Sep.2004-Nov 2005
Bidding-Contract becomes effective	Sep 1994-Apr 1995	Apr 1997-Jul 2002
Material/equipment procurement/repair work	May 1995-Oct 1997	(1)Jun 2003-Feb 2004 (2)Jun 2004-Dec 2005
Exchange of loan agreement-Completion	Aug 1993-Oct 1997 (51 months)	Dec 1994-Dec 2005 (133 months)
(iii)Project cost		
Foreign currency	7,056 mil yen	6,409 mil yen
Domestic currency	209 mil yen （42 mil pesos）	25 mil yen （12 mil pesos）
Total	7,265 mil yen	6,434 mil yen
Yen loan	7,056mil yen	6,408 mil yen
Exchange rate	1 peso=5.00 yen （as of Nov 1993）	1peso＝2.13 yen （ weighed average during 1997-2005）