PRELIMINARY STUDY

FOR

EXPANSION OF MANANDONA HYDROELECTRIC

POWER PLANT IN MADAGASCAR

STUDY REPORT

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ENGINEERING AND CONSULTING FIRMS ASSOCIATION, JAPAN

NEWJEC INC.

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Location Map

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Abbreviation

Abbrev.	English
ADER	Agency for Rural Electrification
AfDB	African Development Bank
AGOA	African Growth Opportunity Act
APIPA	Authority for Protection against the Floods of the Plain of Antananarivo
AU	African Union
BHN	Basic Human Needs
BNGRC	National office of Risk and Catastrophe Management
°C	Centigrade
EIA	Environment Impact Assessment
EPZ	Economic Processing Zone
FTM	National Geographical and Hydrographic Institute
HEPP	Hydroelectric Power Plant
IEE	Initial Environmental Examination
INSTAT	National Institute of the Statistics
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
JIRAMA	Jiro sy Rano Malagasy
JETRO	Japan External Trade Organization
kW	Kilo Watt (1 thousand watt)
kWh	Kilo Watt hour (1 thousand watt hour)
MAP	Madagascar Action Plan
MEM	Ministry of Energy and Mines
MEEFT	Ministry of Tourism to be Ministry of Environment, Water, Forests and Tourism
MOE	Ministry of Energy (Integrated into MEM now.)
MTPM	Ministry of Public Work and Meteorology
MW	Mega Watt (1 million watt)
MWh	Mega Watt hour (1 million watt hour)
ONE	National Office for Environment
ORE	Electricity Sector Regulator
P/S	Power Station
PEMC	Least Cost Expansion Plan (Plan de Expansion Moindre Cout)
Tana	Antananarivo
TOR	Terms of Reference
WAPS	Wien Automatic System Planning Package

Executive Summary

The Republic of Madagascar is an island in the Indian Ocean, having an area of 587,014 km^2, and the length of 1,600 km from the north to south and of 570 km from the east to west. The capital, Antananarivo, is in the plateau with the elevation of about 1,500m of the center of the island.

The major industries are agriculture and stock farming such as rice, coffee, vanilla, sugar, clove, cattle, and fishery such as shrimp and tuna.

After Year 2003, with the stabilization of domestic administration, the economy in the country is improved by self-help effort by the Madagascar government. The Government of Madagascar has formulated the Madagascar Action Plan (MAP), a five year plan which establishes direction and priorities for the country from 2007 to 2012. Through formulation of MAP, the government sets up the value target of the economy and plans to activate the economy and to realize the affluence of the country.

Though the reliability and electrification rate have increased in the past 5 years, the electrification rate in the whole country is still only approximately 16% with access in rural areas lower than 5%. The goals set in MAP is that all urban and rural areas will have access to a reliable, sustainable and affordable electricity supply including increased urban coverage of 74% by 2011 and rural coverage of 10% by 2011. The Government has set another goal to have an increased use of alternative and/or renewable energy sources including hydro, solar, wind, wave, coal, gas and bio energies to reduce dependence on oil products as the Madagascar is a net oil importer.

Although there are abundant renewable energy sources such as hydropower in Madagascar, the developed source for power supply is so limited and electric power development corresponding to power demand increase related to economic growth has not yet been achieved. In this circumstance, while the existing power plants, transmission and distribution lines have been deteriorated, it is difficult to correspond to power demand increase in recent years any further. The ratio of thermal power plants has been more than half of all power sources, and the fuel depends on the import, therefore the sudden rise of fuel cost in recent years has been a serious issue.

As mentioned above, the power sector situation in Madagascar is in critical. Therefore, it is considered indispensable:

- that the power source to cope with the increase of power demand in the capital region shall be urgently developed as short-term solutions, and

- the power development master plan in the whole country considering hydro power as main source and its related transmission development plan for the main three transmission grid systems shall be prepared as mid/long-term solutions.

As the urgent power source in the capital region, the conventional type of diesel power plant will be effective in view of short-term measure. However it may create another issue for sustainable operation and maintenance due to the hike of fuel price. Compared to these, the expansion plan for the existing power plant is to reduce the construction cost by utilizing the existing facilities, the construction period and there is no necessity of fuel cost, and the operation and maintenance cost can be minimized. In addition, socio-environmental impacts are minor issues.

Expansion plan of Manandona Hydropower Plant, which is the objective of this study, is not only to satisfy the above-mentioned conditions, but also to be considered as the efficient project as it is connected to the Antananarivo Grid and it eases the power situation in the capital region though it is rather small.

Such being the situation, the preliminary study on Expansion plan of Manandona Hydropower Plant has been done by NEWJEC Inc. In the Study, the following 3 alternatives were studied:

Alternative Plan for Expansion Plan of Manandona Hydropower Plant

Alt	Existing P/S	Expansion P/S	Merit	Demerit
(i)	Existing condition	New construction (New waterway separately with the existing one)	Existing power plant can be operative even during construction period of the new one.	Construction cost becomes more expensive. Construction period will be longer compared to Alt. 3 which utilizes the existing penstock route.
(ii)	Implementation of Rehabilitation	New construction (New waterway separately with the existing one)	Scale of new plant is the smallest among the 3 alternatives. If the simultaneous construction were not done, there is no outage of power plant but the construction period would be longer.	Total construction cost of Rehabilitation of existing P/S and expansion P/S works becomes most expensive among 3 alternatives. Detailed survey and study on replacement, reinforcement of penstock, E/M equipment for rehabilitation is necessary.
(iii)	Disposal	New construction (New waterway after disposal of existing penstock)	As the existing penstock route is utilized, the civil work cost is the cheapest among 3 alternatives, and construction is also easier, construction period is shorter.	During the time of construction of new plant, the existing plant is stopped.

Of the above 3 alternatives, Alternative Plan 3, which is to dispose the deteriorated existing penstock and to install Fiberglass Reinforced Plastic Mortar (FRPM) pipes instead of steel pipes, is recommended from the view points of economical efficiency (construction cost), shortening of construction period, easiness of construction method, easy and simple maintenance, etc. In this expansion works, augment of weir height is not implemented. Therefore, there is no issue on the resettlement of the residents expropriation of land, inundation cultivated lands and residential houses, in addition, no impact is expected on the recession section of the river and to the downstream by the increasing maximum power discharge.

On the other hand, to improve the financial status of JIRAMA and the derogation of credibility which become a large burden to receive the financial assistance from various donors and investment by private developers, the World Bank has provided technical assistance for improvement of business performance of JIRAMA. Thereafter, JIRAMA concluded the management contract with the international consultant and now the financial status of JIRAMA seems to be recovering. In addition, by developing the hydro power potentials, the soundness of financial situation of JIRAMA is expected to improve further.

Chapter 1 Introduction

1.1 Background and Objectives

1.1.1 Background of the Study

a. Outline of Madagascar

The Republic of Madagascar is an island in the Indian Ocean, and it is the fourth largest island in the world, having an area of 587,014 km^2, about 1.6 times larger than that of Japan and the length of 1,600 km from the north to south and of 570 km from the east to west. The capital, Antananarivo, is in the plateau with the elevation of about 1,500m of the center of the island. The annual average temperature is 18 °C.

Table 1 Economic Indices in Madagascar (2005)

Item		Unit	Value
Population		million	18.6
GNI		USD million	4,979.39
GNI per capita		USD	290
Economic Growth Rate		%	4.9
Gross Trade*	Export	USD million	450.19
	Import		691.34

*Source: ODA reference of MOFA, Japan

Eastern region is a subtropical climate and high temperature and humidity, while the climate in the South region is a high temperature and dry, especially in the southern edge of the island it is a semi-dry land and often suffered from drought. Western region is a tropical climate and similar to the South region, however, the humidity is higher than the north-western region.

GNI in Madagascar is only US$290 per capita in 2005. The major industries are agriculture and stock farming such as rice, coffee, vanilla, sugar, clove, cattle, and fishery such as shrimp and tuna. Deregulation policies such as privatalization of government owned corporation, revision of investment law, deregulation of trade, etc. have been strengthened from the middle of 1990's and the economy in the country attains some progress. However, the political crisis in the year of 2002 gave a severe impact on the economy, and recorded minus growth (-12.7%). After that the economy is gradually improved though there were some impacts due to the recent hike of oil price, and the tourism industry shows good business prosperity and the investment in mining sector is also active.

Madagascar became independent in 1960 as republic country. The system of government at present is republican, though it is socialized for a period from 1975 to 1992.

b. Energy and Power Sector Situation in Madagascar

There are a large potential of renewable energy resource such as hydropower, wind power and photovoltaic power. Development of mineral resources and energy has just been commenced, and the mineral resources of rare metals such as nickel and cobalt are abundant. In the rural villages the firewood and charcoal are still being used as fuel source, and this traditional fuel gives impacts or damages to the forest and the health of residents. Therefore, the government of Madagascar worked out a policy for national energy to convert the traditional fuel to the modern fuel and to exploit the efficient energy.

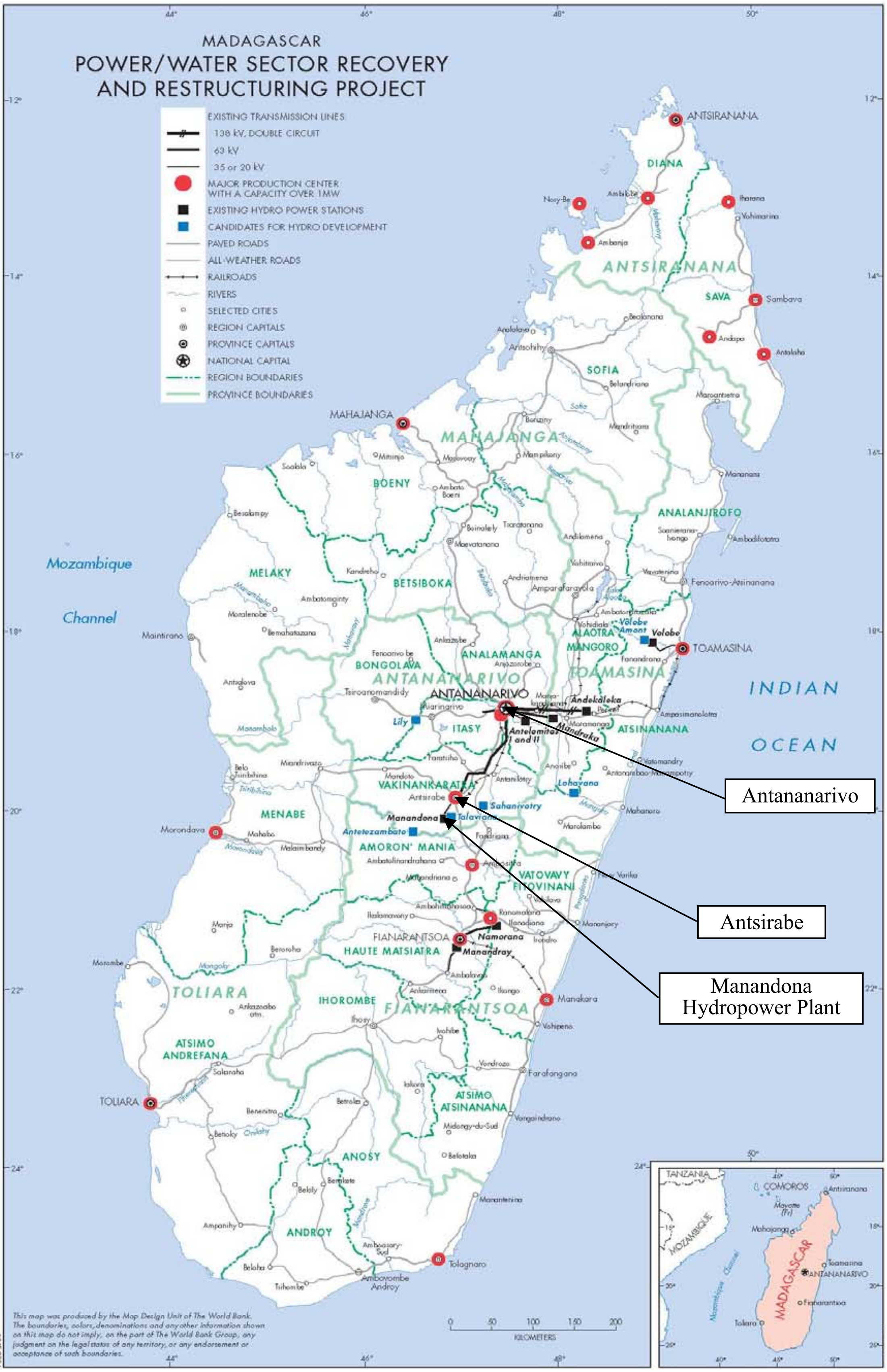
The power is supplied mainly by Jiro sy Rano Malagasy (JIRAMA). While reliability and coverage of electricity have increased over the past 5 years, the rate of access to the electricity is still only around 16% in the national level. In rural areas, it is lower than 5%. Since Madagascar is importing oil, the power sector is vulnerable to the fluctuation of the international oil price. In recent years, the proportion of power generation by hydropower is decreasing, while the proportion of thermal power generation is increasing, occupying 21% in 1997 and 35% in 2004 against the total generation.

On the other hand, the surplus of power in the Antananarivo power system is almost 0%, especially in dry season. Because of the lack of power supply, the rotational brown out is continued for years in the power supply area from this Antananarivo power system.

To improve the power supply reliability in the Antananarivo power system, the construction of additional generation capacity is urgently required. For this purpose, this preliminary study was proposed to be carried out with the financial assistance by Engineering and Consulting Firms Association, Japan.

c. Development Plan in Madagascar

Following the completion of Poverty Reduction Strategy Paper (PRSP) in 2006, the Government of Madagascar has formulated the Madagascar Action Plan (MAP), a five year plan which establishes direction and priorities for the country from 2007 to 2012. Acceleration of hydropower development and promotion of rural electrification were committed in the MAP.



Reference: WB Implementation Completion Report for an Energy Sector Development Project /September 27, 2006

Figure 1 Power Generation Facilities and Power Systems in Madagascar

d. Assistance Strategy of Japanese Government to Madagascar

Madagascar has a great deal of potential in the industries of mining, tourism, agriculture, fishery, etc., as she has an extensive land, abundant underground mineral resources and rare fauna and flora. Besides, Madagascar is located in the middle of Asia and Africa, and historically and ethnically connected with Asia. It is expected that Madagascar is to act as a "Gateway" for delivering an Asian economic dynamism to African continent.

Since 2003 after stabilization of domestic politics, the government of Madagascar has been making tremendous efforts to recover the economy of the country, and by determining the target values in the MAP, the dynamisation of economy and the realization of richness are planned to be achieved. From the view point of partnership, the Japanese government intends to support such a self effort continuously for the government of Madagascar. Madagascar aims at asking foreign investors in the country and breaking away from poverty through economic growth by the dynamisation of private sector. To support for these, the Japanese government takes a policy to provide assistances with a focus on the acceleration of trade/investment and the agricultural development, etc. including Asia/Africa cooperation. On the other hand, as most of the people in the country lives with less than US$1 per day, the Japanese government continues to support for BHN such as education, medical care, water supply, etc. through various schemes of assistance.

The following sectors are listed up as the important areas:

1) Private sector development, development of industries, promotion of trade/investment,
2) Promotion of agriculture and fishery industries, exploitation of south to south (Asia/Africa) cooperation,
3) Improvement and development of infrastructures such as road, which will contribute to the economic growth, and
4) Human resource development as economic resources.

For the development of human related sectors, the followings are nominated as the important sectors:

1) Primary and secondary education,
2) Health and medical care, and
3) Water and sanitation.

e. Assistance Needs in Power Sector in Madagascar

From the result of "Energy Sector Study in the Southern African Region (Mozambique and Madagascar)" conducted by JICA in 2007, the following needs are considered in the power sector in Madagascar.

- Development of emergency power source in the capital region
- Preparation of power system development master plan
- Improvement of accuracy of hydro power development master plan
- Feasibility study of hydro power development project
- Improvement of accuracy of rural electrification master plan
- Capacity development of human resources, etc.

f. Outline of Antananarivo

Antananarivo, the capital of Madagascar, is the largest city in the country with the population of over 1.4 million and located at the elevation of about 1,500 m. The climate is comfortable with the annual average temperature of approx. 18 °C.

However, as described earlier, the rotational brown out is continued for years, especially in dry season. The peak load in the Antananarivo power system is soaring every year and by the end of 2008, the peak load is forecasted to be around 160MW, and the generation capacity of the power system at present is around 170MW.

g. Outline of Antsirabe

Antsirabe City is a table land located about 170 km south of Antananarivo City with the population of about 400,000 and the light industry is actively run in the city. Power is supplied to the city by the two power plants, i.e. Diesel Power Plant (11,200kW) and Manandona Hydroelectric Power Plant (1,600kW). However, about 4,000kW of power is in shortage. Therefore, the factories such as garment, cement, beer, tobacco and dairy products encounter curtailed operation. Accordingly, the numbers of men out of occupation are increased and this induces social instability. Such being the situation, from the view point of stabilization of people’s livelihood, reinforcement of power supply to Antsirabe City is urgently required for contribution to the economic growth such as private sector development and industrial development.

Further, the hospitals, clinics, government offices, etc. have difficulties in operation and management due to the shortage of power, therefore, the stable power supply is urgently needed in Antsirabe City for contribution to the BHN (basic human needs).

h. Outline of Manandona Hydroelectric Power Plant

Manandona Hydroelectric Power Plant is located about 10 km south of Antsirabe City having the following main features:

Weir Height	: 10.5 m
Weir Type	: Concrete and Wet Masonry

Crest Length : 66.0 m

Effective Head : 104.5 m

Effective Storage : 50,000 m^3 (planning stage)

Installed Capacity : 1,600 kW (The present capacity is limited to 1,200 kW due to degrading of plant facilities.)

Catchment Area : 375 km^2

The water intake of the existing power generation facility is located on the right bank side of the weir body, and the water is delivered to the powerhouse through the penstock of about 506m. The powerhouse is surface type and 3 units of turbine and generator are installed. The water is discharged to the right bank of Manandona River through the open channel tailrace of about 100m.

1.1.2 Objectives of the Study

The objective of the Study is to cope with the problems such as power crisis in the capital, Antananarivo, disincentive of economic growth by the unstable power supply and obstructions for operation and management of hospitals, clinics and government offices due to lack of power. To achieve this objective, the preliminary study for expansion of Manandona Hydroelectric Power Plant which is belonging to the Antananarivo power system to increase the generation capacity of the plant is proposed to be conducted, and to seek the possibility for short and medium/long-term solutions to the power sector in Madagascar, the information and reference on power situation in the capital region, transmission line master plan, etc. are collected.

Table 2 Conceptual Plan for Expansion of Generation Output (Rehabilitation)

Parameter		Exisiting Plant	Expansion Scheme	Total
High Water Level	m	1,497.50	1,499.50	-
Low Water Level	m	1,495.50	1,497.50	-
Effective Depth	m	2.00	2.00	-
Effective Storage	m^3	50,000	80,000	130,000
Effective Head	m	104.50	105.50	-
Maximum Discharge for Power	m^3/s	2.20 (2 × 0.70 + 0.80)	6.00 (2 × 3.00)	8.20
Maximum Output	kW	1,600 (2 × 500 + 600)	5,000 (2 × 2,500)	6,600
Annual Generation	MWh	5,838 (after regulated generation: 2,630)	32,850 (generation given priority to expansion scheme)	35,480 (after regulated generation of the existing plant)

Note: Planned before the Study is conducted

1.2 Scope of Works

The objective of this study: "**Preliminary Study for Expansion of Manandona Hydroelectric Power Plant in Madagascar**" is to draw up an reinforcement plan of power supply in the Antananarivo power system by means of adding up the generation capacity to the existing Manandona Hydroelectric Power Plant. Particular attention is paid to the economic design to minimize the project cost and construction period.

The followings are the scope of the works of this study.

1) Collection of data and information and preparation for field survey in Japan
2) Power sector survey
3) Collection of data and reference in Madagascar
4) Survey on capacity development
5) Site survey of Manandona Hydroelectric Power Plant
6) Preliminary study on expansion of Manandona Hydroelectric Power Plant
7) Proposal for short and mid/long-term development
8) Preparation of report

1.3 Study Area

The study was conducted at both in Japan and Madagascar. The Project site is located about 10 km south of Antsirabe City.

1.4 Study Schedule

Investigation in Madagascar including site reconnaissance to the Manandona Hydroelectric Power Plant was conducted from October 17 to November 1, 2008.

Refer to Appendix 1 for detailed itinerary in Madagascar.

1.5 Study Team Member

The following experts were dispatched to Madagascar for the Study.

Yuichi SANO	: Leader / Power & Hydropower Development Planning
Takao SARUHASHI	: Hydrology/ Socio-Environment
Masayoshi HAYASHI	: Civil Structures
Tomokazu KIMURA	: Economic and Financial Analysis

Chapter 2 Socio-economic Condition in Madagascar

2.1 People and Culture

Ethnically, though there is no unified opinion, it is widely known that the society of Madagascar is composed of two different groups, i.e. Malay and African.

Madagascar's population is predominantly with Indigenous beliefs (52%), Christian (41%) and Muslim (7%). The country has 3 official languages, namely Malagasy, French and English. All of the 3 languages are official.

2.2 Economy

Agriculture, fishery and forestry are the mainstay of the economy of Madagascar. Major export products are coffee, vanilla, sugarcane, cloves, cocoa, rice, cassava, beans, banana, peanuts and livestock.

Structural reforms began in the late 1980s, initially under pressure from international financial institutions. An initial privatization program (1988-1993) and the development of an export processing zone (EPZ) regime in the early 1990s were key milestones in this effort. A period of significant stagnation from 1991 to 96 was followed by 5 years of solid economic growth and accelerating foreign investment, driven by a second wave of privatizations and EPZ development. Although structural reforms advanced, governance remained weak. During the solid growth from 1997 to 2001, poverty levels still remained high, especially in the rural areas. A six month political crisis induced by a dispute over the result of the presidential elections held in December, 2001 virtually halted economic activity in much of the country in the first half of 2002. GDP dropped 12.7% for the year 2002, and inflow of foreign investment also dropped sharply. After the crisis, the economy rebounded with GDP growth of over 10% in 2003. Currency depreciation and rising inflation in 2004 have hampered economic performance, but growth for the year reached 5.3%, with inflation reaching around 25% at the end of the year. In 2005 inflation was brought under control by tight monetary policy raising the central bank rate to 16% and tightening reserve requirements for banks. As the result, the growth of 6.5% was recorded in 2005.

The government of President Ravalomanana is aggressively seeking foreign investment and is tackling many of the obstacles to such investment, including combating corruption, reforming landownership laws, etc.

Madagascar's sources of growth are tourism, textile and light manufacturing exports, agricultural products and mining. Madagascar is the world's leading producer of vanilla and accounts for about half of the world's export market. Tourism targets the eco-tourism market, capitalizing on Madagascar's unique biodiversity, undisturbed natural habitats, national parks, etc. Exports from the EPZs, located around Antananarivo and Antsirabe, consist the most part of garment manufacturers, targeting US and European markets. Agricultural exports consist of low-volume high-value products like vanilla, litchis and essential oils. A small but growing part of the economy is the mining. Several major projects are underway in the mining, oil and gas sectors. If successful, it will give a significant boost to the Malagasy economy.

2.3 Key Statistics

(1) Demographic Factors

- Population : 18.6 million
- Antananarivo City : over 1.4 million
- Population growth rate : 3.03% (2006 est.)
- Literacy rate : 80%

(2) Surface Area

- Total area : 587,014 km^2

(3) Economy

- GDP : Purchasing Power Parity - US$ 5.5 billions (2006)
- GDP growth rate : 4.9% (2006)
- GNI per capita : US$ 280 (2006)
- GDP composition by sector : Agriculture: 27.5%; industry: 15.3%; and service: 57.2% (2006)
- Inflation rate : 11.3% (2006, World Bank)

2.4 Investment Climate

Following the 2002 political crisis, the government attempted to set a new course and build confidence, in coordination with international financial institutions and donors. Madagascar developed a recovery plan in collaboration with the private sector and donors.

Donor countries demonstrated their confidence in the new government by pledging $1 billion in assistance over five years. The Malagasy Government identified road infrastructure as its principle priority and underlined its commitment to public-private partnership by establishing a joint public-private sector steering committee.

2.5 Administrative System

2.5.1 Republic of Madagascar[1]

(1) Country Name

Republic of Madagascar

(2) Government of Madagascar

Republic: presidential, multiparty system

(3) Capital

Name	: Antananarivo
Geographic coordinates	: 18° 55′ 0″ S, 47° 31′ 0″ E

(4) Independence

June 26, 1960

(5) Constitution

The constitution of Madagascar was adopted on August 19, 1992.
Amendments were on March 15, 1998 and April 27, 2007, respectively.

(6) Executive Branch[2]

- President : President Marc Ravalomanana (since February 22, 2002)
- Prime Minister : Prime Minister Charles Rabemananjara (since January 25, 2007)
- Cabinet : Council of Ministers appointed by the President
- Elections : President was elected by direct universal vote for a 5-year term in December, 2001, and was re-elected in the presidential election held on December 3, 2006.

(7) Legislative Branch[2]

The Parliament has two chambers. The National Assembly has 127 members, elected for a five year term in single-member and two-member constituencies. The Senate has 90 members, of which 60 members are elected for a six year term, 10 for representing each province by provincial electors, and 30 members are appointed by the President.

1 : The World Fact Book, CIA (https://www.cia.gov/library/publications/the-world-factbook/geos/rw.html)
2 : Wikipedia, the free encyclopaedia (http://en.wikipedia.org/wiki/Madagascar)

(8) Political Parties[2]

Abbreviation of the parties		Official name of the parties
TIM	:	I Love Madagascar (Tiako I Madagasikara)
AREMA	:	Association for the Rebirth of Madagascar or Pillar and Structure for the Salvation of Madagascar (Andry sy Rihana Enti-Manavotra an'i Madagasikara)
LEADER-Fanilo	:	Economic Liberalism and Democratic Action for National Recovery
RPSD	:	Rebirth of the Social Democratic Party (Renaissance du Parti Social-Democratique)
RPSD-Vaovao	:	New Rebirth of the Social Democratic Party (Faction that left RPSD in 2003)
AVI	:	Judged By Your Work Party (Asa Vita no Ifampitsarana)
MFM	:	Activists for Madagascar Progress (Mpitolona ho an'ny Fandrosoan'i Madagasikara)
AKFM	:	Party of the Independence Congress of Madagascar (Antokon'ny Kongresy ho an'ny Fahafahan'i Madagasikara)
AKFM/Fanavaozana	:	Antokon'ny Kongresy ho an'ny Fahafahan'i Madagasikara Fanavaozana
PFM	:	Parti federaliste de Madagascar
TTM	:	Toamasina Tonga Saina
GRAD Iloafo	:	Groupe de reflexion et d'action pour le developpement
MONIMA	:	Madagascar for the Malagasy (Madagasikara otronin'ny Malagasy) or (Mouvement nationaliste et independant de Madagascar)
FANORENANA	:	-

2.5.2 Administrative Divisions

Madagascar is divided into 6 autonomous provinces, and 22 regions. The regions will be the highest subdivision level when the provinces are dissolved by 2009.

(1) Antananarivo Province
(2) Antsiranana Province
(3) Fianarantsoa Province
(4) Mahajanga
(5) Toamasina
(6) Toliara

2.6 Development Plans

Following the completion of Poverty Reduction Strategy Paper (PRSP) in 2006, the

Government of Madagascar has formulated the Madagascar Action Plan (MAP), a five year plan which establishes direction and priorities for the country from 2007 to 2012. The MAP reflects the following 8 commitments required to extricate the country from poverty and launch a quantum leap in the medium-term development.

(1) Responsible Governance
(2) Connected Infrastructure
(3) Educational Transformation
(4) Rural Development and a Green Revolution
(5) Health, Family Planning and the Fight Against HIV/AIDS
(6) High Growth Economy
(7) Cherish the Environment
(8) National Solidarity

Though the reliability and electrification rate have increased in the past 5 years, the electrification rate in the whole country is still only approximately 16% with access in rural areas lower than 5%. The goals set in MAP is that all urban and rural areas will have access to a reliable, sustainable and affordable electricity supply including increased urban coverage of 74% by 2011 and rural coverage of 10% by 2011. The Government has set another goal to have an increased use of alternative and/or renewable energy sources including hydro, solar, wind, wave, coal, gas and bio energies to reduce dependence on oil products as the Madagascar is a net oil importer.

Chapter 3　Present Status of Power Sector in Madagascar

3.1 Introduction

Although there are abundant renewable energy sources such as hydropower in Madagascar, the developed source for power supply is so limited and electric power development corresponding to power demand increase related to economic growth has not yet been achieved.

In this circumstance, while the existing power plants and transmission / distribution lines have been deteriorated, it is difficult to correspond to power demand increase in recent years any further.

The ratio of thermal power plants has been more than half of total power sources, and the fuel depends on the import, therefore the sudden rise of fuel cost in recent years has been a serious problem.

Mandroseza thermal power plant (37MW) has been constructed in Antananarivo grid by the beginning of 2008, therefore the blackout frequency in Antananarivo has been decreased than before.　However the rotational blackout has been still implemented in Antananarivo and the electric tariff has been just hiked in these days.

On the other hand, the electrification rate in Madagascar is still low, and electrification of the non-electrified rural area has been enumerated as one of the priority issues.

3.2 Law and Organizations

3.2.1 Law

As for the law related to power sector, there is Law No.98-032 (Portant Réforme du Secteur de l'Électricité: Structural Reform of the Electricity Sector) which was enacted in December, 1998 and enforced in January, 1999.　This law consists of 69 articles and shows regulations related to Authorization and Concession, restriction organization, and the electric tariff, concerning the entry to the electric utility of the private sector.　The composition of the law is shown below;

PROGRESSING OF MOTIVE
TITLE 1　DEFINITIONS AND GENERAL PROVISIONS
　Chapter 1　DEFINITIONS
　Chapter 2　GENERAL PROVISIONS
TITLE 2　APPLICABLE MODES TO PRODUCTION, TRANSPORT AND DISTRIBUTION

Chapter 1 AUTHORIZATION
Chapter 2 CONCESSION
Chapter 3 COMMON PROVISIONS TO AUTHORIZATION AND CONCESSIONS
TITLE 3 PRIVATE POWER GENERATION
TITLE 4 REGULATION ORGANIZATION
TITLE 5 REGULATION OF TARIFFS
Chapter 1 GENERAL
Chapter 2 TARIFF SYSTEMS
Section 1 INTER-CONNECT NETWORKS
Section 2 AUTONOMOUS CENTERS
Section 3 OTHER EXPENSES
TITLE 6 MONITORING, CONTROL AND SANCTIONS
TITLE 7 TRANSITIONAL PROVISIONS

The practices are shown in Decree No.2001-173 (Fixant les conditions et modalités d'application de la Loi n°98-032 du 20 janvier 1999 portant réforme du secteur de l'électricité: Fixing the condition and applicable mode of the Law No.98-032 enforced on January 20, 1999 for structural reform of the electricity sector) which consists of 78 articles. The composition of the decree is shown below;

Forwards
TITLE 1 ASSIGNMENT PROCEDURE OF AUTHORIZATIONS AND CONCESSIONS
Chapter 1 AUTHORIZATION
Section 1 Invitation to tender
Under section 1 Procedures
Under section 2 Assignment
Section 2 Spontaneous Candidature
Under section 1 Procedures
Under section 2 Assignment of Authorizations
Chapter 2 CONCESSIONS
Section 1 Procedures
Section 2 Assignment
Chapter 3 PRIVATE POWER GENERATION
Section 1 Declarations
Section 2 Authorizations
TITLE 2 COMMON PROVISIONS TO AUTHORIZATION AND CONCESSIONS

Chapter 1 Occupation of the lands

Chapter 2 Transfer, cession and hypothecation of rights, Renunciation, cancellation of Concession or Authorization

Section 1 Transfer, cession and hypothecation of rights

Section 2 Renunciation of Concession or Authorization

Section 3 Cancellation of Concession or Authorization

Chapter 3 Construction, Exploitation and Maintenance of the Electric Installations

TITLE 3 CONTROL AND ADMINISTRATIVE MONITORING

TITLE 4 FINAL PROVISIONS

The contents expressed in these law and decree are three of the following.

1) Creation of new organizational structures:
- Creation of bodies of regulation for electricity (Electricity Sector Regulator: ORE)
- Definition of the three segments of activities (Production, Transport and Distribution)
- Abolition of the national monopoly for the JIRAMA as regards production
- Fixing of the tariffs on the basis of economic principle
- Creation of the Agency of Development of the Rural Electrification (ADER) with the mechanism of subsidy for the underprivileged zones

2) Redefinition of the role of the State:
- The State has a role of conceding Authority and has mechanisms to promote the development of the national resources to satisfy the increasing requirements of electric power to stimulate the economic growth.

3) New concept of Private Public Partnership and the increased role of the communes
- Private sector and/or the communes are encouraged to gradually relay the State in the financing of the infrastructures of electricity under a diagram of private public partnership.

Based on these law and decree, the private organizations have been able to generate electricity since 1999, and some organizations that described hereunder were established.

3.2.2 Ministry of Energy and Mines (MEM)

Ministry of Energy and Mines, hereafter MEM, is the ministry having jurisdiction over energy sector including power sector and mine resources. Though Ministry of Energy (hereinafter, MOE) that separated from Ministry of Energy and Mines at that time have had a jurisdiction over the energy sector including power sector since January in 2007, it amalgamates recently and is returning to MEM again now. MEM takes charge of the investment and the development strategy policy including a foreign assistance request, etc., while JIRAMA takes charge of the technical part in the power sector.

3.2.3 Electricity Sector Regulator (ORE)

Electricity Sector Regulator (hereinafter, ORE) was established by the above-mentioned Law No.98-032, and its in 2005. In Article 35 of Law No.98-032, it is shown that the role is; (1) To control prices of electricity and the amount of the royalties of transit, (2) To supervise the respect of the standards of quality of the service, and (3) To control and make respect the principles of competition.

ORE is composed of Electricity Council and Executive Secretariat, and Electricity Council is organized with seven total people who are three indicated by the Administration, two representatives of the owners and two representatives of the users (refer to Article 40 and 41 of Law No.98-032).

In Article 48 of Law No.98-032, it is shown that the activity capital of ORE is covered from the parts of the sales incomes of JIRAMA and IPP electric power entrepreneur etc.

3.2.4 Agency for Rural Electrification (ADER)

In Article 3 of Law No.98-032, it is shown that the promotion of rural electrification by the Minister in charge of the electric power (MEM). Agency for Rural Electrification (hereafter, ADER) was started in 2002 as the organization under the control of MEM who promote rural electrification. While ORE has the authority to decide the electric tariff for the grid electrification regions, ADER takes charge of the rural electrification promotion in the off-grid region, and has the electric tariff adjustment function and the authority between local governments and electric power entrepreneurs when the off grid is electrified.

3.2.5 Jiro sy Rano Malagasy (JIRAMA)

Jiro sy Rano Malagasy is the state-managed company that supplies electricity and water service. The electricity section of JIRAMA operates and maintains power station, transmission line and distribution line in the comparatively widespread electrification region, and obtains the income based on the electric tariff.

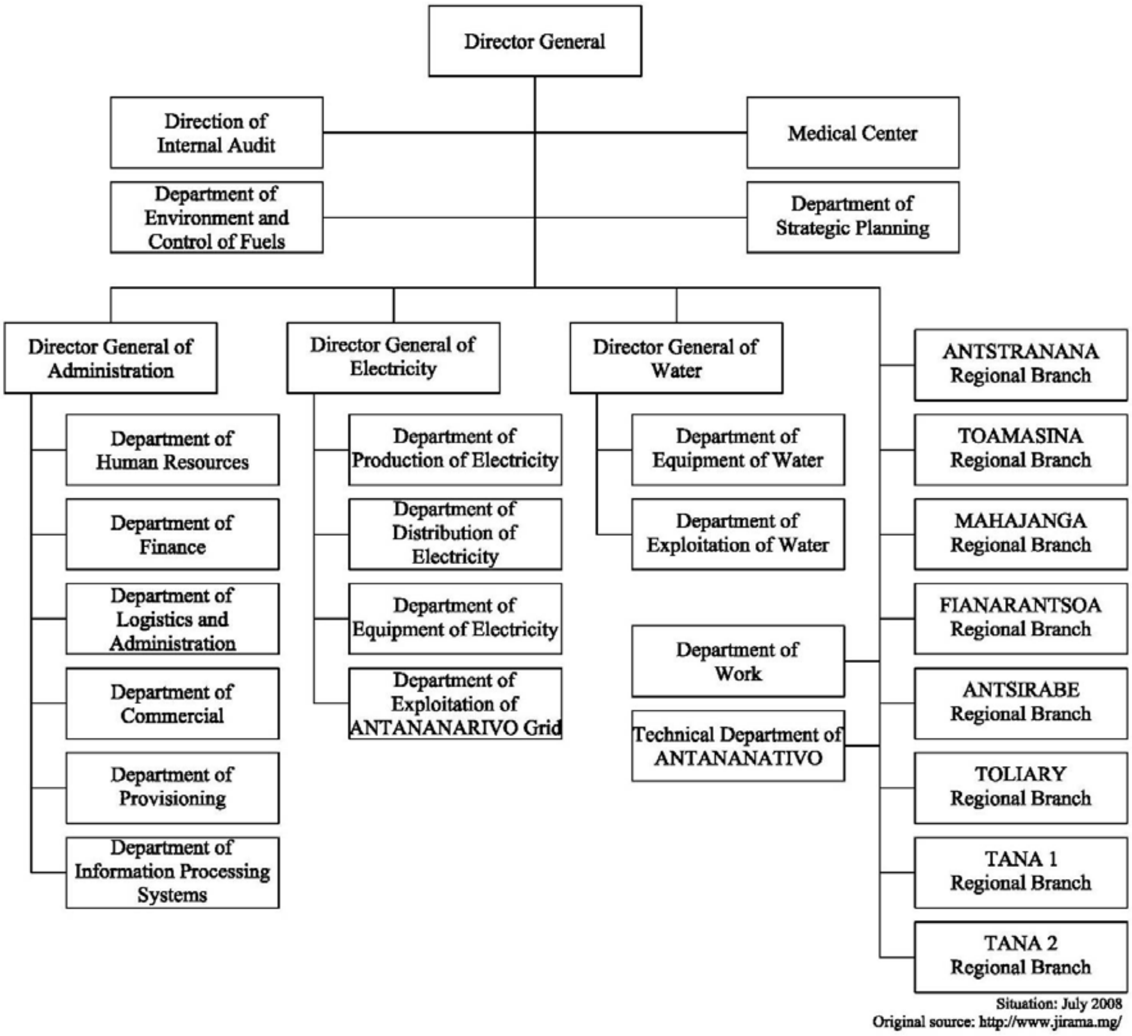


Figure 2 Organization Chart of JIRAMA

The electricity section under Director General of Electricity is composed of Department of Production of Electricity that manages power station and transmission line other than Antananarivo Grid, Department of Exploitation of Antananarivo Grid that manages Antananarivo Grid, Department of Distribution of Electricity that manages supply of electricity, and Department of Equipment of Electricity that manages the attached equipments such as the transmission lines. Department of Strategic Planning under Director General takes responsibility of management in the strategic planning in JIRAMA and the electric tariff table, etc. Under Regional Branch, there are divisions such as Electricity Production Service, Distribution System, and Administration and Commercial, etc. Division of Electricity Production Service has jurisdiction over the equipments for generation and transformation in each region. The organization chart of JIRAMA is shown in Figure 2.

Though the privatization (shifting to joint-stock company) of JIRAMA combining with the management rebuilding through the World Bank project had been tried to be implemented from 1997 to 2001, it was not achieved successfully, and JIRAMA has been decided not to be privatized by the new government that started in 2002.

3.3 Management and Financial Situation of Power Sector, and Power Tariff

3.3.1 Outline

The number of electric supply consumers by JIRAMA increased by 4.5% on the annual rate average for ten years until 1996 and by 7.9% from 1996 to 2004, and became 320,000 in 2005. However, there had been lack of turning on new power sources from 2005 to 2007 and a capacity limit in the Antananarivo Grid, therefore, the number of the consumers had been stagnated. After 2008, it aims to secure stable capacity of power sources to achieve 8%[3] in the annual growth rate for power source capacity corresponding to the economic growth. The change of the electrification rate for the last three years is shown in Table 3.

After 1999, the investment in the power sector has not been processing.

Table 3 Rate of Access to Electricity

	2005	2006	2007
Population of Madagascar	17,719,649	18,255,841	18,808,342
Population served in electricity from JIRAMA	2,932,417	2,950,372	2,943,960
Electrification rate	16.5%	16.2%	15.7%

Source originale: JIRAMA

3.3.2 Latest financial situation

Director General of JIRAM said that the financial situation of JIRAMA has deteriorated by the fall of the exchange rate of Malagasy Ariary to USD[4] and the worldwide sudden rise of oil price, etc., however the financial situation of JIRAMA is being improved due to the organizational reformation now, and 14 million EUR is invested in the plant and equipment by the government budget in 2008.

Person in charge of energy in the World Bank Madagascar office said it is certain that the financial situation has been improved compared with several years ago though JIRAMA has not yet reached at the place where the development investment can be done by his own fund.

3 :It is actually assumed 8% or more.
4 : Although the exchange rate of Malagasy Ariary to USD was fallen to 2,000MGA/USDin 2005 from 1,200MGA/USDin 2003, it is recovered to around 1,700MGA/USD in 2008.

The income statement and the balance sheet made based on financial statements for the last three years obtained from JIRAMA are shown in Table 4 and Table 5. According to the income statement shown in Table 4, the net income was a minus and financial situation was almost going bankruptcy in 2005, but went out of a minus in 2006, and then entered into plus in 2007. It seems that the net income in 2006 was gone out of a minus by the installation of the subsidies and the deferred taxes, while the effect of the increase of operating revenues was the largest. In 2007, the operating revenues were increased further and the net income turned positive without the allotment of the subsidies.

According to the balance sheet shown in Table 5, the net assets was a minus in 2005, but turned positive in 2006. Although the effects of the increase of non current credits and the decrease of non current liabilities were large, the current ratio[5] was over 100% in 2006 and it is understood that the integrity on the management capital is recovering.

An unstable element by the oil price cannot be removed in the future under the current state of the high dependency to thermal power generation because Madagascar relies on the import for all oil.

Such being the situation, the policy of the developments of hydropower sources is published by the government, and the improvement of a stable integrity of the financial situation of JIRAMA through the achievement of the policy is desired.

5 :Less than 100% means that the amount of current liabilities to be restored within one year is over the that of current credits to be cashable in a short term, the equity is used for a short-term repayment, loan and financial debts will be increased, and then the integrity of the cash flow decreases. In general, it is assumed that 200% or more is a standard of the integrity.

Table 4 Income Statement

Currency Unit : MGA

	2005	2006	2007
Sales turnover	164,884,670,277.57	255,213,727,284.12	274,880,093,462.80
Production by Fixed assets	24,585,946,996.95	6,213,100,702.54	61,567,948,304.00
I- OPERATING REVENUES	**189,470,617,274.52**	**261,426,827,986.66**	**336,448,041,766.80**
Consumed purchases	175,270,667,415.77	213,722,551,534.88	175,046,648,824.00
External services and other consumputions	16,181,924,347.26	14,598,486,613.52	71,265,658,289.46
II- OPERATING CONSUMPTIONS	**191,452,591,763.03**	**228,321,038,148.40**	**246,312,307,113.46**
III- OPERATING EXPENDITURE AND RECEIPT (I - II)	**-1,981,974,488.51**	**33,105,789,838.26**	**90,135,734,653.34**
+ Subsidies	723,663,718.07	10,760,728,390.82	0.00
- Taxes and comparable payments	-841,697,942.73	-561,842,408.46	-834,117,243.47
- Personnel	-27,981,032,239.44	-38,393,087,783.43	-31,239,158,900.44
IV- GROSS SURPLUS	**-30,081,040,952.61**	**4,911,588,037.19**	**58,062,458,509.43**
+ Other operational products	3,961,959,820.49	3,368,792,689.72	2,403,672,565.19
+ Recoveries on provisions and losses in value	11,389,849,937.78	16,452,968,588.26	13,641,618,249.90
- Other operational charges	-1,735,907,176.81	-1,677,350,873.90	-1,105,109,984.00
- Equipments with depreciation and provisions	-33,178,736,647.82	-36,588,078,757.13	-39,025,755,820.77
V- OPERATING INCOME	**-49,643,875,018.97**	**-13,532,080,315.86**	**33,976,883,519.75**
+ Financial products (Investment & exchange profit, etc.)	367,654,778.61	4,467,863,957.80	5,892,930,278.82
- Financial expenses (Interest & exchange loss, etc.)	-19,507,702,806.72	-5,430,582,579.69	-1,436,769,810.58
VI- FINANTIAL RESULT	**-19,140,048,028.11**	**-962,718,621.89**	**4,456,160,468.24**
VII- RESULT BEFORE TAXES (V + VI)	**-68,783,923,047.08**	**-14,494,798,937.75**	**38,433,043,987.99**
Exigible taxes on results	-29,679,211,230.66	-1,276,168,636.42	-12,525,060,572.66
Deferred taxes (Variations)	0.00	15,770,967,574.17	43,427,375.63
VIII- NET INCOME	**-98,463,134,277.74**	**0.00**	**25,951,410,790.96**
IX- RATE OF RETURN ON ASSETS (V / A)	**-17.9%**	**-4.4%**	**8.2%**

Original source: JIRAMA

Table 5 Balance Sheet

Currency Unit : MGA

	2005	2006	2007
Intangible fixed assets	94,952,430.27	43,648,115.92	94,628,171.23
Tangible fixed assets	7,935,114,428.07	6,821,682,304.34	8,696,412,392.83
Fixed assets put in concession	256,674,008,157.32	269,588,070,431.45	282,477,354,367.15
Fixed assets in progress	12,070,394,994.55	11,612,875,659.99	74,388,463,588.78
Financial fixed assets	390,252,330.80	180,685,451.60	127,781,607.80
Deferred taxes asset non currents	0.00	17,792,854,912.67	48,046,594,159.61
A- NONCURRENT CREDITS	**277,164,722,341.01**	**306,039,816,875.98**	**413,831,234,287.40**
Stocks and in progress works	22,327,798,163.73	21,366,544,244.47	25,861,889,360.81
Accounts receivable	119,495,718,004.54	85,540,199,846.91	94,589,058,387.28
Treasury and deposits	19,358,997,582.74	41,315,930,147.30	71,778,916,026.85
B- CURRENT CREDITS	**161,182,513,751.01**	**148,222,674,238.68**	**192,229,863,774.94**
C- TOTAL ASSETS (A + B)	**438,347,236,092.02**	**454,262,491,114.66**	**606,061,098,062.34**
Deferred products: subsidies of investment	110,298,904,791.45	128,028,752,548.72	162,863,984,893.07
Loans and financial debts	292,859,041,826.41	15,920,342,736.25	47,843,979,345.42
Other noncurrent debts	81,743,778,991.44	134,663,408,511.22	104,351,309,220.37
D- NONCURRENT LIABILITIES	**484,901,725,609.30**	**278,612,503,796.19**	**315,059,273,458.86**
Debts short term	75,122,597,266.75	25,236,833,546.44	981,117,250.93
Accounts payable	140,883,002,759.65	98,280,192,630.44	130,236,726,328.15
Other current debts	615,043,095.19	122,881,141.59	86,414,894.97
E- CURRENT LIABILITIES	**216,620,643,121.59**	**123,639,907,318.47**	**131,304,258,474.05**
F- TOTAL LIABILITIES (D + E)	**701,522,368,730.89**	**402,252,411,114.66**	**446,363,531,932.91**
G- NET ASSETS: EQUITY AND ASSIMILATED (C - F)	**-263,175,132,638.87**	**52,010,080,000.00**	**159,697,566,129.43**
H- CURRENT RATIO (B / E)	**74.4%**	**119.9%**	**146.4%**

Original source: JIRAMA

3.3.3 Strategies and actions

In power sector, for the purpose of (i) To contribute to the economic growth of the country, (ii) To accelerate the access to drinking water and the electricity for the population, and (iii) To reduce the weight of the sector on the public finance, the actions shown in Table 6 are committed by the government.

Table 6 Action committed by Government

Items	Committed Action
Institutional reform	- Contract of management of JIRAMA from 2009, for a length of 5 years with measurable indicators of performance; - Implementation of reinforced partnership between the JIRAMA and the Private from 2014; - Actions for the rectification of JIRAMA: + Continuation of fresh funds injection for the need of recapitalization, until the structural deficit is restored; + Continuation of auditing operations for late Administration etc. with the installation of a mechanism so that the problem does not reproduce any more; + Increasing the collection rate of debts to industrialists and private individuals; + Generalization of the system of prepaid meters; + Intensification of ranking operations within the exploitations of the JIRAMA - Amending of the legal and lawful framework for electricity sector to facilitate the development of medium-sized hydropower projects; - Reinforcement of the management and the administration of electricity sector in MEM.
Investment	- Development of hydropower sites on the basis of PEMC*; - Continuation of actions in progress to increase the access to electricity.
Price	- Adaption and implementation of adjustment mechanism of tariffs.

*: Plan d'Expansion au Moindre Coût… Plan of Expansion at Lower Cost

Source: Lettre de Politique Sectorielle Eau et Electricité à Madagascar, Ministère de l'Energie et des Mines

3.3.4 Electricity tariff

The tariff for the electricity supplied by JIRAMA is shown in Table 7.

There are the tariffs for the high and medium voltage power users such as factories, which are divided into three categories by time zone, while the tariff for the low voltage power users such as households doesn't change through a day. Daytime means between 6:00AM-6:00PM, Peak Hour means between 6:00PM-10:00PM, and Nighttime means between 10:00PM-6:00AM.

Table 7 Electricity Tariff of JIRAMA

From November 2007

CATEGORIES			Unit	Zone 1	Zone 2	Zone 3
HIGH VOLTAGE	Tariff HV LONG USE	Service charge	MGA/kW	27,500		
		Meter rate	MGA/kWh	110		
		Basic charge	MGA	130,000		
	Tariff HV TIMETABLE	Service charge	MGA/kW	27,500		
		Meter rate (PEEK HOUR)	MGA/kWh	390		
		Meter ratee (DAYTIME)	MGA/kWh	95		
		Meter rate (NIGHTTIME)	MGA/kWh	55		
		Basic charge	MGA	150,000		
MV Industrialists	Tariff MV LONG USE	Service charge	MGA/kW	28,500	19,000	15,500
		Meter rate	MGA/kWh	125	275	455
		Basic charge	MGA	115,500	115,500	115,500
	Tariff MV SHORT UTILISATION	Service charge	MGA/kW	28,500	19,000	15,500
		Meter rate	MGA/kWh	170	295	475
		Basic charge	MGA	115,500	115,500	115,500
	Tariff MV TIMETABLE	Service charge	MGA/kW	28,500	19,000	15,500
		Meter rate (PEEK HOUR)	MGA/kWh	500	600	660
		Meter ratee (DAYTIME)	MGA/kWh	110	280	430
		Meter rate (NIGHTTIME)	MGA/kWh	90	240	410
		Basic charge	MGA	141,000	141,000	141,000
MV Others	Tariff MV LONG USE	Service charge	MGA/kW	34,300	24,000	19,500
		Meter rate	MGA/kWh	190	365	555
		Basic charge	MGA	115,500	115,500	115,500
	Tariff MV SHORT UTILISATION	Service charge	MGA/kW	30,100	19,000	15,100
		Meter rate	MGA/kWh	210	370	560
		Basic charge	MGA	115,500	115,500	115,500
	Tariff MV TIMETABLE	Service charge	MGA/kW	28,500	19,000	15,100
		Meter rate (PEEK HOUR)	MGA/kWh	545	600	660
		Meter ratee (DAYTIME)	MGA/kWh	150	340	525
		Meter rate (NIGHTTIME)	MGA/kWh	95	330	515
		Basic charge	MGA	141,000	141,000	141,000
LOW VOLTAGE	Tariff LV GENERAL Others	Service charge	MGA/kW	2,900	2,500	1,500
		Meter rate	MGA/kWh	230	395	535
		Basic charge	MGA	7,500	7,500	7,500
	Tariff LV GENERAL Residential	Service charge	MGA/kW	2,650	1,700	1,250
		Meter rate (Energy < 130kWh)	MGA/kWh	200	360	480
		Meter rate (Energy > 130kWh)	MGA/kWh	270	400	540
		Basic charge	MGA	6,300	6,300	6,300
	Tariff LV Eco Non Residential Output < 3 kW	Meter rate (Energy < 25kWh)	MGA/kWh	150	150	150
		Meter rate (Energy > 25kWh)	MGA/kWh	630	705	755
		Basic charge	MGA	760	760	760
	Tariff LV Eco Residential Output < 3 kW	Meter rate (Energy < 25kWh)	MGA/kWh	140	140	140
		Meter rate (Energy > 25kWh)	MGA/kWh	605	675	725
		Basic charge	MGA	760	760	760

Source: Department of Strategic Planning, JIRAMA

Zone 1 is applied for three grid areas of Antananarivo Grid, Toamasina Grid and Fianarantsoa Grid whose main power source is hydropower, Zone 2 is applied for Mahajanga district and Toliary district whose main power source is thermal power by fuel oil combustion with comparatively large capacity, and Zone 3 is applied for the area whose power source is diesel thermal power. Although the differences of base charge by zone are small, service charge rises in order of Zone 1, Zone 2 and Zone 3, meter rate rises reversely in order of Zone 3, Zone 2 and Zone 1. This seems to be reflected the characteristics of Zone 1 which has a lot of big customers such as factories and high share of hydropower sources, and the that of Zone 2 and Zone 3 whose power sources is thermal power and the fuel cost is large.

Although electricity tariff had been frozen for four years from 2001 to 2005, after 2005 it has been raised as shown in Table 8 by ORE that started in 2005. This is corresponding to the approach time of the management improvement of JIRAMA.

Table 8 Adjustment of Electricity Tariff in Past

Adjustment years	2001	Jul, 2005	Nov, 2005	Apr, 2006	Nov, 2007
Increased rate	-	30%	35%	10%	15%
Magnification from 2001	100%	130%	176%	193%	222%
Increased rate from 2001	-	130%	176%	193%	222%

Source: Lettre de Politique Sectorielle Eau et Electricité à Madagascar, Ministère de l'Energie et des Mines

Proportion of electric business in the revenue and expenditure of JIRAMA is assumed to be 80%[6], and the average electricity tariff and the power generation cost is calculated from the result of 2007 income statement (shown in Table 4) as shown in Table 9.

On the revenue and expenditure in 2007, the income based on electricity tariff cannot cover the power generation cost, and it is necessary to decrease the share of thermal power and raise the electricity tariff.

Table 9 Calculation of Average Electricity Tariff and Power Generation Cost

Calculation of Average Electricity Tariff			Calculation of Power Generation Cost		
Sales turnover	274,880,093,463	MGA	Consumed purchases	246,312,307,113	MGA
			Personnel	31,239,158,900	MGA
			Other operational charg	1,105,109,984	MGA
			Equipments with deprec	39,025,755,821	MGA
			Total cost	317,682,331,819	MGA
Sales of electricity	219,904,074,770	MGA	Total Cost for electricity	254,145,865,455	MGA
Gross Production	1,051,752	MWh	Gross Production	1,051,752	MWh
Average electricity tariff	209	MGA/kWh	Power generation cost	242	MGA/kWh
	0.123	USD/kWh		0.142	USD/kWh

Note:
Proportion of electricity operation in business revenue and expenditure of JIRAMA: 80%
Exchange rate: 1,700 MGA/USD

Source: Financial values - JIRAMA, Gross Production - http://www.jirama.mg/

6 :This value is assumed from the ratio of amount of the electricity sales and water sales mentioned in the report of "Project Appraisal Document on A Proposed Credit in The Amount of SDR6.8million to The Republic of Madagascar for A Power/Water Sectors Recovery and Restructuring Project in Support of The First Phase of the Power/Water Sectors Recovery and Restructuring Program, June 14, 2006, The World Bank"

3.4 Power Demand

3.4.1 Present situation

The electrification rate in whole Madagascar is about 16% now.

The battery charging is hardly widespread, because the fuel source in the rural area is firewood and charcoal, the source of light in non-electrified villages is only candle, and each house is scattered.

On the other hand, power dispatching in the urban area electrified by the grids, etc. is executed by JIRAMA, and after the increases of 7.9% on the annual rate average until 2004, the number of electric supply consumers has stagnated shown in Table 3. It is because the electric power supply to new large customers had been refused after 2006, due to the lack of construction of new power plants and the limited power generation capacity.

Actually the electric power supply to a Chinese steel mill hoping to receive the power supply of 10MW from JIRAMA has been suspended due to lack of supply capacity. It is a current actual condition that in the mining and manufacturing project to be able to expect the profit, the private power generation of thermal power by oil combustion, etc. is set up on the project site for the stable and enough power supply, and the project entrepreneur doesn't rely on the power supply by JIRAMA.

3.4.2 Daily load curve

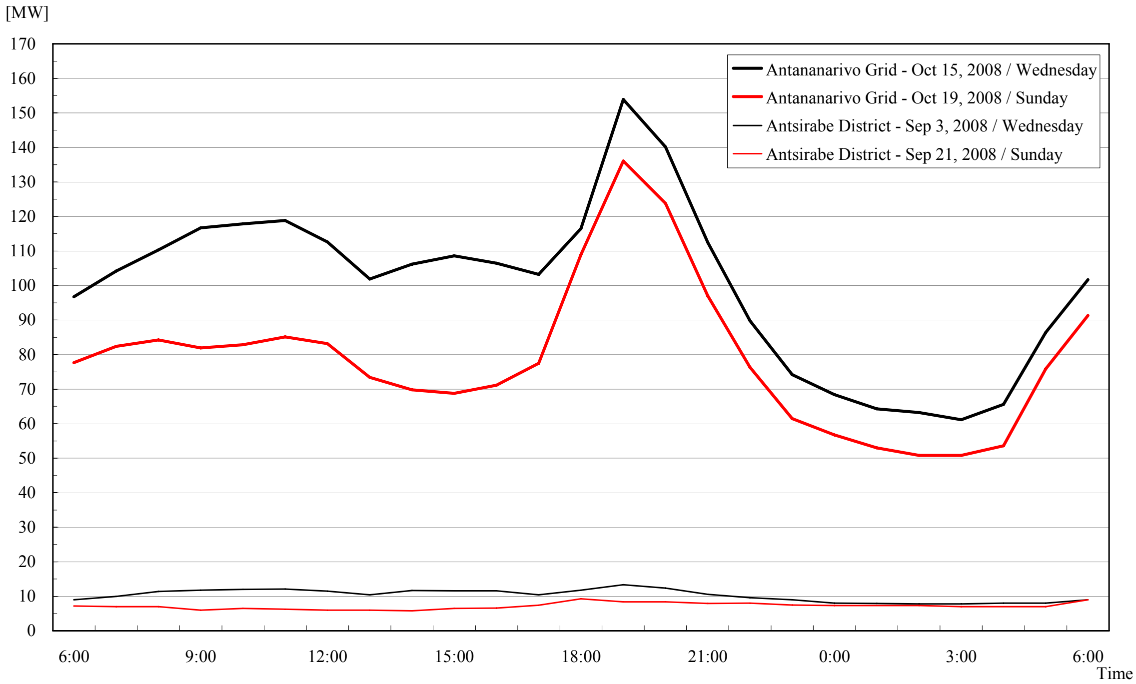
The daily load curve of Antananarivo Grid and Antsirabe district that is the main power supply area of Manandona hydropower plant is shown in Figure 3. The daily load curve in weekday is shown in black and that in holiday is shown in red.

The daily peak of Antananarivo Grid including Antsirabe district is from 6:00PM to 10:00PM whose demand of electricity is almost occupied by the night light, therefore it is forecasted that the power consumption in each home is the main demand for peak time.

The present peak demand of Antananarivo Grid is assumed to be about 160MW. On the other hand, the available capacity of Antananarivo Grid is around 170MW including about 100MW by hydropower and the remainder by thermal power. Especially, the possibility that the power shortage is caused is high, because the available capacity of hydropower is reduced by about 20 percent in December that is the end of dry season. Actually, the rotational blackout is executed in Antananarivo in case of power shortage.

The peak demand of Antsirabe district located in the southern edge of Antananarivo Grid and is the second largest city in Madagascar, is about 15MW, and about half of the peak demand is covered by the transmitted electricity from Antananarivo. However, due to technical problems for the load dispatching instruction to use the telephone line and the radio, in case of power shortage in Antananarivo Grid, the rotational blackout in the Antsirabe[7] district is not executed.

The present number of receipt customers (number of counter meters) of Antananarivo Grid is about 235,000, including about 19,000 of Antsirabe district.



Source: JIRAMA

Figure 3 Daily load curve of Antananarivo Grid and Antsirabe district

3.4.3 Demand forecast

The demand forecast of the electricity supply by JIRAMA and Antananarivo Grid as of December, 2007 is shown in Table 10 and Figure 4.

Table 10 Demand forecast

Base: December 2007

Item		Year												Average
PRODUCTION	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Gross Output	[GWh]	**1,474.65**	**1,571.32**	**1,682.49**	**1,832.56**	**1,958.34**	**2,098.27**	**2,241.79**	**2,395.58**	**2,560.67**	**2,738.73**	**2,931.14**	**3,135.68**	-
Growth rato	[%]	-	6.6%	7.1%	8.9%	6.9%	7.1%	6.8%	6.9%	6.9%	7.0%	7.0%	7.0%	7.1%
Load Factor	[%]	56.3%	55.1%	55.0%	55.6%	55.6%	55.4%	55.3%	55.2%	55.2%	55.2%	55.2%	55.2%	55.4%
Peak Demand	[MW]	**299.10**	**325.43**	**349.38**	**376.42**	**402.29**	**432.62**	**462.65**	**495.04**	**529.70**	**566.24**	**606.31**	**648.66**	-
Output to be developed	[MW]	-	26.32	23.95	27.05	25.86	30.33	30.03	32.39	34.66	36.53	40.07	42.35	31.78
Growth rato	[%]	-	8.8%	7.4%	7.7%	6.9%	7.5%	6.9%	7.0%	7.0%	6.9%	7.1%	7.0%	7.3%
Gross Output (Antananarivo Grid)	[GWh]	**968.85**	**1,018.47**	**1,099.95**	**1,187.94**	**1,282.98**	**1,385.62**	**1,496.46**	**1,616.18**	**1,745.48**	**1,885.11**	**2,035.92**	**2,198.80**	-
Growth rato	[%]	-	5.1%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	7.7%
Load Factor	[%]	57.9%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.3%	56.4%
Peak Demand (Antananarivo Grid)	[MW]	**191.00**	**206.60**	**223.13**	**240.98**	**260.26**	**281.08**	**303.56**	**327.85**	**354.08**	**382.40**	**412.99**	**446.03**	-
Output to be developed	[MW]	-	15.60	16.53	17.85	19.28	20.82	22.49	24.29	26.23	28.33	30.59	33.04	23.18
Growth rato	[%]	-	8.2%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%

Source: Estimated from the information in Plans de Developpement des Equipements de Production Electricite, Table from JIRAMA for Antananarivo Grid

7 : There is also a political reason in Antsirabe district as the important factories are located in the region.

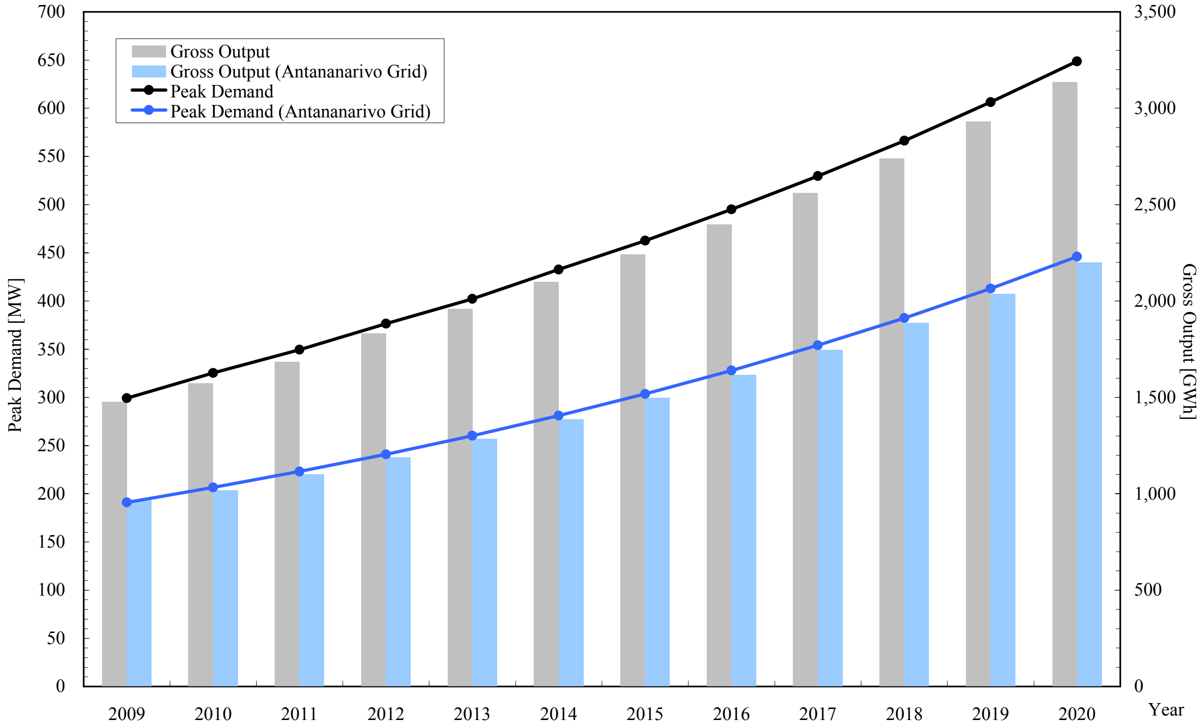


Figure 4 Demand forecast

In Table 10 and Figure 4, the peak demand capacity is simulated based on the assumption of annual electric power demand. Though the electric power demand is expected to increase by the annual averaged growth rate of about 8%, on the other hand, the growth rate is assumed to be more than 8%, considering the past GDP rose by 10% in 2003 after the recession and new demands has been repressed for the three years from 2005, etc.

Especially, in Toamasina located in the eastern coastal area, the President is announcing the establishment of the special economic zone, therefore, a large growth of the electric power demand in the future is expected. Japanese government also has decided to provide the yen loan to the port improvement project of Toamasina.

It is necessary to install the new power capacities of about 32MW (about 23MW for Antananarivo Grid) every year in average by 2020, in case that the power capacity will be developed along the scenario. However, not only human support to JIRAMA but also assistance from each country and private investment are indispensable under the situation that development by own funds such as Madagascar government or JIRAMA is difficult.

3.5 Existing Facilities

3.5.1 Present power source

Installed capacity and result of all electricity production of JIRAMA are shown in Table 11 and Table 12, respectively.

According to these tables, the ratio of renewable energies from 2006 to 2007 increases by electricity production, while decreases by the power capacity. In spite of new installation of thermal power, the effort to raise the utilization rates of hydropower is seen.

Table 11 Installed Capacity of JIRAMA

	Unit	2006	2007	Growth rate
Hydropower Capacity JIRAMA	MW	104.83	104.83	0.0%
Solar System Capacity JIRAMA	MW	0.01	0.01	0.0%
Thermal Power Capacity JIRAMA	MW	115.04	118.23	2.8%
Thermal Power Capacity PRIVATE - (Purchase of energy)	MW	63.67	68.43	7.5%
Thermal Power Capacity PRIVATE - (Renting)	MW	24.46	24.46	0.0%
Total Installed Capacity	**MW**	**308.01**	**315.96**	**2.6%**
Ratio of Renewable Energy (Hydropower + Solar System)		34.0%	33.2%	-2.5%

Source: http://www.jirama.mg/

Table 12 Electricity Production of JIRAMA

	Unit	2006	2007	Growth rate
Hydropower Production JIRAMA	MWh	637,922	719,082	12.7%
Solar System Production JIRAMA	MWh	4.03	3.99	-1.0%
Thermal Power Production JIRAMA	MWh	175,994	162,013	-7.9%
Thermal Power Production PRIVATE (Purchase of energy)	MWh	50,159	24,203	-51.7%
Thermal Power Production PRIVATE (Renting)	MWh	139,483	146,450	5.0%
Total Gross Production	**MWh**	**1,003,562**	**1,051,752**	**4.8%**
Ratio of Renewable Energy (Hydropower + Solar System)		63.6%	68.4%	7.6%

Source: http://www.jirama.mg/

Details of the existing power capacity connected to the three grids of Antananarivo Grid, Toamasina Grid and Fianarantsoa Grid are shown in Table 13. And the operation result and schedule in 2008 of power plants connected to Antananarivo Grid at the end of September in 2008 is shown in Table 14 and Figure 5. As for the operation in the period from October to December in 2008, the schedule is shown.

In Madagascar, the rainy season is from the end of December to April, the river discharge decreases gradually after April, and then the dry season starts at the middle of October and continues to the end of December. So the outputs of most of the hydropower plants decrease in November and December, due to the reduction of river discharge. On the other hand, the rated outputs of hydropower plants are adjusted to the river discharge in rainy season, because the consumptions of fuel for thermal power are able to save by the available output of hydropower except in dry season.

The electric shortage and the rolling blackout in Antananarivo were somewhat eased in the first quarter of 2008 due to the operational start of Mandroseza thermal power plant[8], while Loc HFF Ambohimanambola thermal power has been stopped to improve the efficiency.

In September, 2008, Sahanivotry hydroelectric power plant[9] newly starts to operate in the suburban of Antsirabe. The maximum output of this plant is 15MW, and the output in December when the river discharge becomes the lowest is 3.7MW. The plant supplies electric power of 2MW to the cement factory located between this plant and Antsirabe substation, and surplus electric power to the consumers of JIRAMA via the Antsirabe substation, although until December in 2008, the plant supplies electric power only to the cement factory of 2MW for trial operation.

On the other hand, the electric power generated in IPP EDM thermal power plant located in Antsirabe district has not been purchased in 2008, due to the sudden rise of the fuel cost. As the electric power increase from the Sahanivotry hydropower plant will be expected, no electric power purchase from the EDM thermal power plant will continue in the future.
However, the emergency situation likely at the end of the 2008 will still be encountered, because there is only the margin of about 3MW under the condition of the demand expectancy of 160MW and available output of 163.3MW

8 :Constructed with the financing of the Netherlands.
9 : The first IPP hydropower in Madagascar. The construction cost is 16 million Euro, that African Development Bank finances 8 million Euro, local banks finance 4 million Euro and the remainder is the capital of the developer (Hydelec Co.).

Table 13 Power Stations connected to JIRAMA's Grids

Grid / Power Station		Capacity	Note
Antananarivo Grid (RI-TANA)		**199.9MW**	
	Hydropower (Share: 55.2%)	**110.4MW**	**Owner :Situation**
	Andekaleka	62.0MW	JIRAMA
	Antelomita	8.2MW	JIRAMA
	Manandona	1.2MW	JIRAMA
	Mandraka	24.0MW	JIRAMA
	Sahanivotry	15.0MW	HYDELEC :IPP
	Thermal Power (Share: 44.8%)	**89.5MW**	**Fuel / Owner :Situation**
	CT Ambohimanambola (CTA)	13.0MW	Fuel oil / JIRAMA
	CT Antsirabe (CTAB)	6.0MW	Gas oil & Fuel oil / JIRAMA
	CT Mandroseza (CTM)	37.0MW	Fuel oil / JIRAMA
	IPP HFF Ambohimanambola (IPP20)	20.0MW	Gas oil / HFF :IPP
	Loc HYDELEC Ambohimanambola (CTHD)	8.5MW	Gas oil / HYDELEC :rental
	Loc EDM Antsirabe (EDM)	5.0MW	Gas oil / EDM :rental
Tonamasina Grid (RI-TOAMASINA)		**24.9MW**	
	Hydropower (Share: 24.1%)	**6.0MW**	**Owner :Situation**
	Volobe	6.0MW	JIRAMA
	Thermal Power (Share: 75.9%)	**18.9MW**	**Fuel / Owner :Situation**
	TMIII	7.6MW	Gas oil / JIRAMA
	HFF	3.8MW	Gas oil / HFF :rental
	ENELEC	7.5MW	Fuel oil / ENELEC :rental
Fianarantsoa Grid (RI-FIANARANTSOA)		**9.6MW**	
	Hydropower (Share: 56.3%)	**5.4MW**	**Owner :Situation**
	Namorana	5.0MW	JIRAMA
	Manandray	0.4MW	JIRAMA
	Thermal Power (Share: 43.8%)	**4.2MW**	**Fuel / Owner :Situation**
	Ankidona	4.2MW	Gas oil / JIRAMA

As of Oct, 2008

Source: Hearing and documents from JIRAMA

Table 14 Operation situation of Power Station on Antananarivo Grid

Year		2008											
Month		**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	0.8	0.8	0.8	0.8	0.0	0.0
Mandraka	MW	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	21.0	18.0
Sahanivotry	MW									2.0	2.0	2.0	2.0
TOTAL HYDROPOWER	**MW**	**95.4**	**95.4**	**95.4**	**95.4**	**95.4**	**95.4**	**95.0**	**95.0**	**97.0**	**97.0**	**91.2**	**84.2**
CT Ambohimanambola	MW	8.0	8.0	8.0	8.0	8.0	8.0	8.7	8.7	8.5	8.5	8.5	8.5
CT Antsirabe	MW	6.0	6.0	6.0	6.0	6.0	6.0	5.6	5.6	5.6	5.6	5.6	5.6
CT Mandroseza	MW		18.0	27.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
IPP HFF Ambohimanambola	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Loc HYDELEC Ambohimanambola	MW	7.0	7.0	7.0	7.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
EDM	MW												
Loc HFF Ambohimanambola	MW	4.5	4.5	4.5	4.5	4.5	4.5						
TOTAL THERMAL POWER	**MW**	**45.5**	**63.5**	**72.5**	**82.5**	**82.5**	**83.5**	**79.3**	**79.3**	**79.1**	**79.1**	**79.1**	**79.1**
TOTAL AVAILABLE OUTPUT	**MW**	**140.9**	**158.9**	**167.9**	**177.9**	**177.9**	**178.9**	**174.3**	**174.3**	**176.1**	**176.1**	**170.3**	**163.3**
RATIO OF HYDROPOWER OUTPUT	**%**	**67.7%**	**60.0%**	**56.8%**	**53.6%**	**53.6%**	**53.3%**	**54.5%**	**54.5%**	**55.1%**	**55.1%**	**53.6%**	**51.6%**
Peak Demand	**MW**	**146.7**	**145.5**	**145.9**	**150.1**	**155.3**	**158.0**	**157.7**	**153.5**	**153.6**	**158.0**	**159.0**	**160.0**
MARGIN	**MW**	**-5.8**	**13.4**	**22.0**	**27.8**	**22.6**	**20.9**	**16.6**	**20.8**	**22.5**	**18.1**	**11.3**	**3.3**

As of Oct, 2008 — Source: Tables from JIRAMA

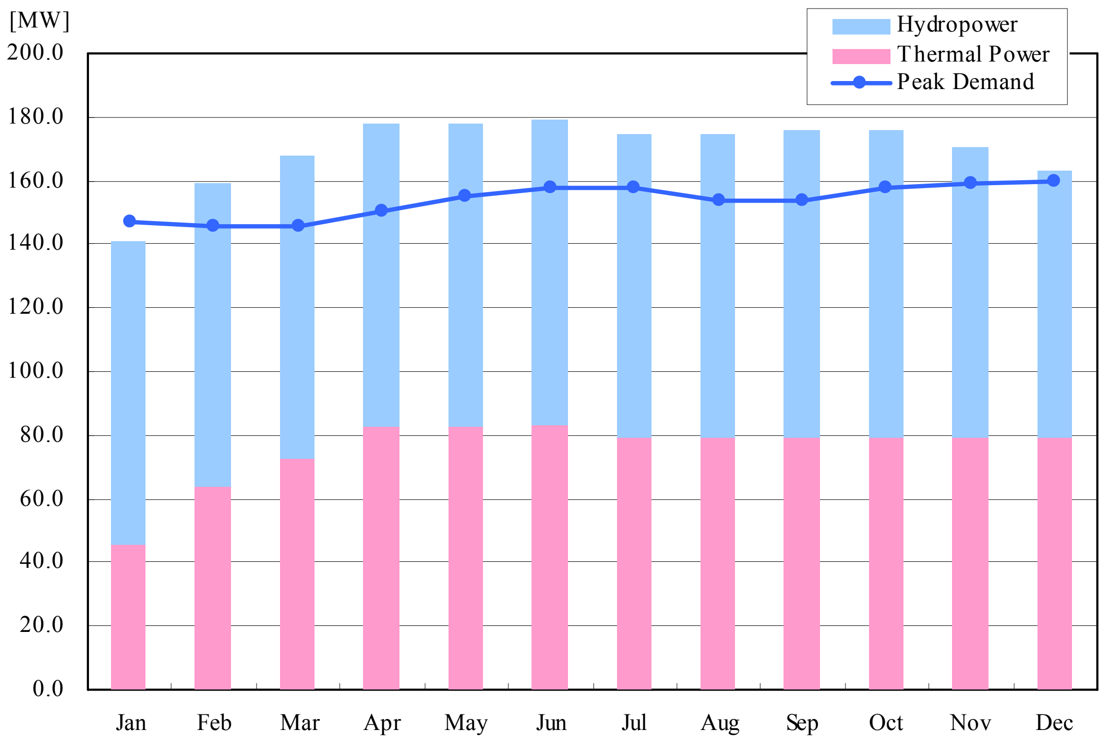


Figure 5 Operation situation of Power Station on Antananarivo Grid

3.5.2 Existing grid

There are now three grids of Antananarivo Grid, Toamasina Grid and Fianarantsoa Grid in Madagascar, and all the equipments for transmission is administrated by JIRAMA. The location map of the grids is shown in Figure 6, and the features of transmission line is shown in Table 15. And the single diagrams of each grad are shown in Figure 7, Figure 8 and Figure 9 respectively. Neither Sahanivotry hydropower completed in October, 2008 nor the connected transmission line have been described to Figure 7 yet. The transmission line from Sahanivotry hydropower is connected to Antsirabe substation by the voltage of 63kV, the transmission line to the cement factory that has priority of Sahanivotry hydropower supply is divided on the way of the Antsirabe substation.

The transmission loss of Antananarivo Grid is around 4.5-5.0%.

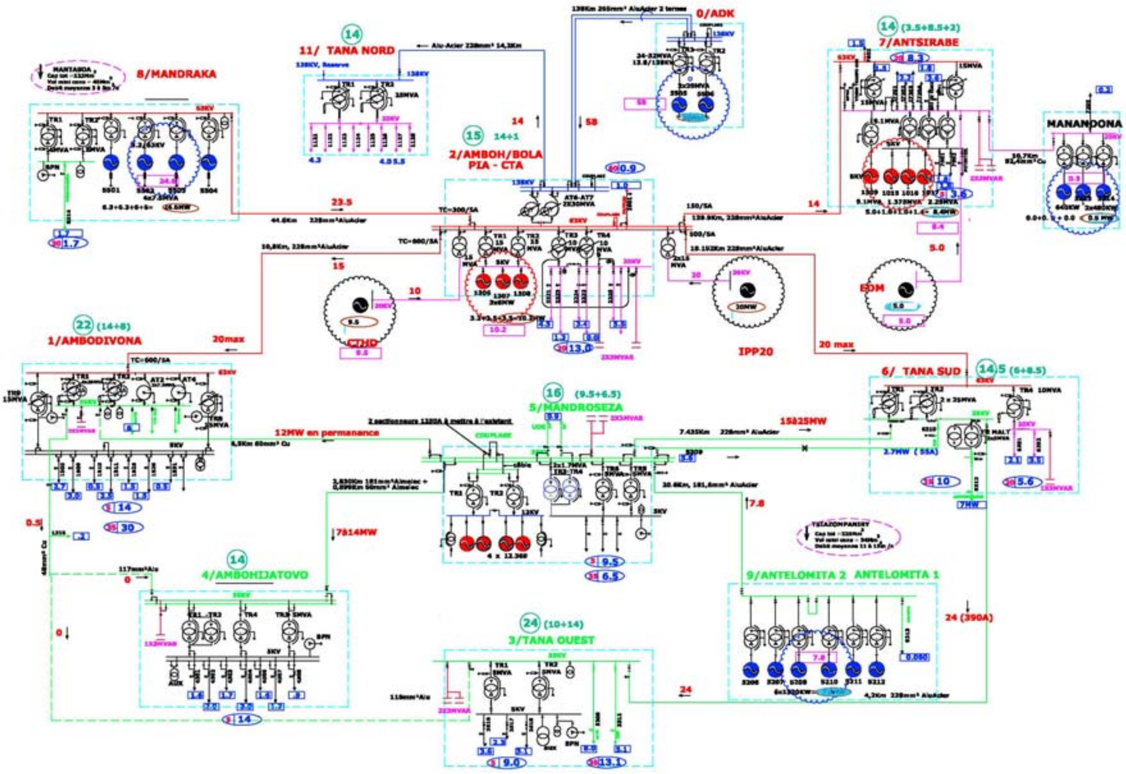
Original Source: WB Implementation Completion Report for an Energy Sector Development Project, Sep 27, 2006
Revised by the information got by hearing at site

Figure 6 Existing Transmission Grids in Madagascar

Table 15 Features of Existing Transmission Lines

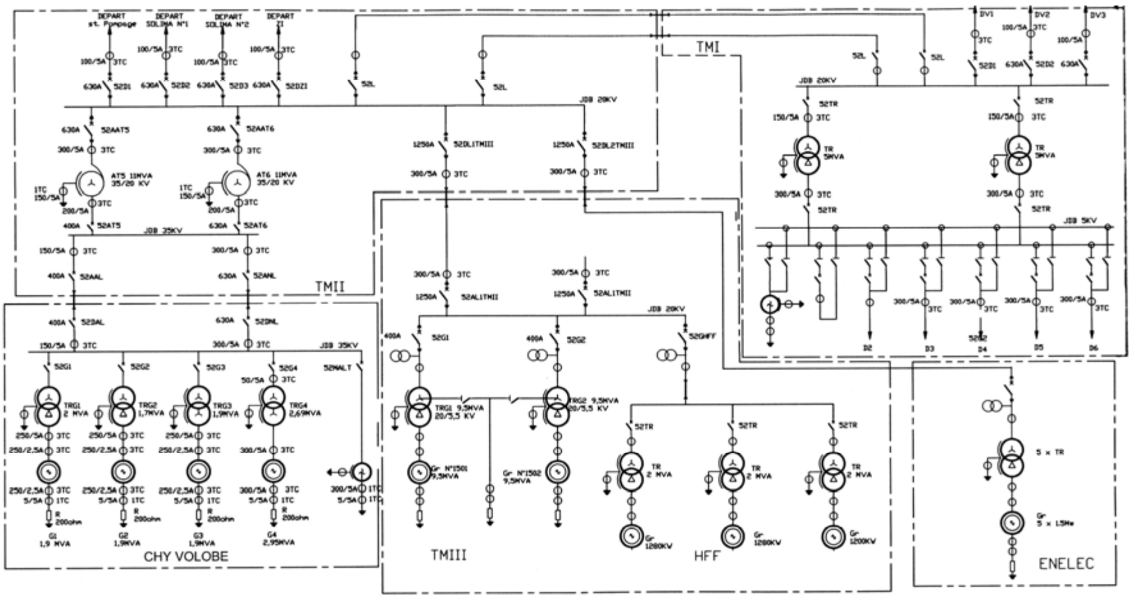
FROM	TO	CONDUCTOR			VOLTAGE	Startup
		Length [km]	Section [mm^2]	TYPE		
ANTANANARIVO Grid						
PIA	Andekaleka	138	375	Aluminum-steel	138	
PIA	Antsirabe	139.9	228	Aluminum-steel	63	
PIA	Mandaraka	44.6	228	Aluminum-steel	63	
PIA	Ambodivona	10.8	228	Aluminum-steel	63	
Ambodivona	Mandroseza	5.72	60	Copper	35	
Mandroseza	Antelomita	20.6	181.6	Almelec	35	
Antsirabe	Manandona	10.72	52.4	Copper	21	
Tana-ouest	Tana-sud	4.2	228	Aluminum-steel	35	
PIA	Tana-sud	22	228	Aluminum-steel	63	
Tana-sud	Mandroseza	10	228	Aluminum-steel	35	
Mandroseza	Ambohijatovo	2.83 + 0.899	60 + 181	Copper/Almelec	35	
Ambohijatovo	Tana-ouest		116	Aluminum-steel	35	
Ambohijatovo	Ambodivona		48.2	Copper	35	
PIA	Tana-nord	14.2	228	Aluminum-steel	138	
TOAMASINA Grid						
Volobe	TMII (AL)	31	29 + 148	Copper/Almelec	35	
Volobe	TMII (NL)	25	148 + 117	Almelec	35	
TMII	TMIII (D1)	1	117	Almelec	20	
TMII	TMIII (D2)	1	150	Almelec	20	
TMI	TMII (TSS1) (TSS2-3)	3	93	Almelec	20	
		1.605	150	Almelec	20	
		1.285	117	Almelec	20	
TMI	Edge of Line 5kV	12.799	117	Almelec	5	
TMII	Edge of Line 20kV	1.9649	118	Almelec	20	
FIANARANTSOA Grid						
Namorona	Ifanadiana	22	32	Aluminum-steel	21	1980
Namorona	Ampopoka	43	80	Aluminum-steel	63	1978
Ampopoka	Sopraex	5	80	Aluminum-steel	63	1978
Ampopoka	Ambohimahasoa	43	32	Aluminum-steel	21	1983
Ampopoka	Ankidona	10	116	Aluminum-steel	21	2002
Ankidona	Manandray	15	34.4	Copper	21	2000
Manandray	Ambalavoa	29	32	Aluminum-steel	21	1982

Source: JIRAMA, Department of Production of Electricity



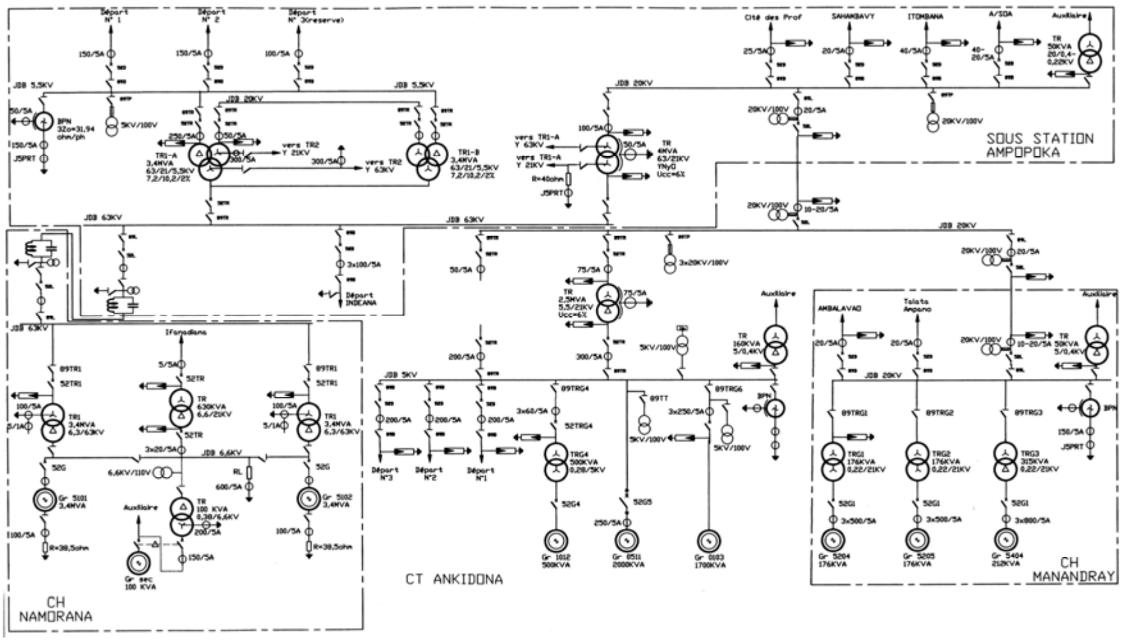
Source: JIRAMA

Figure 7 Single diagram of Antananarivo Grid



Source: JIRAMA

Figure 8 Single diagram of Toamasina Grid



Source: JIRAMA

Figure 9 Single diagram of Fianarantsoa Grid

3.6 Power Development Plan

3.6.1 Power source development plan

Almost of all power source in Madagascar are thermal powers for fuel to depend on import, especially in the area except for the three grids.

One of the most important subject for MEM is hydropower development, and Madagascar government and MEM have a policy to promote the development of hydropower using the abundant renewable energy potentials, and to replace the existing diesel thermal power to small or micro hydropower as for rural electrification, etc. Now, MEM is making the power source development plan in cooperation with ORE.

On the other hand, though there is the hydropower potential master plan prepared by Hydro Quebec, Canadian Company with the support of the World Bank in 2006, it has not enough information as this preliminary study was done at the level of desk study. It is the present common recognition among the people related to power sector in Madagascar (MEM, JIRAMA) that there is no available hydropower potential master plan.

It is said that there are more than 100 hydropower potential sites which have the output of more than 50MW, and more than 50 sites for the output of more than 1,000MW in Madagascar. But hydrological data are not collected or prepared for almost of all sites except for some sites. This condition is a big hurdle for hydropower development in Madagascar where the fuel cost of thermal power generation is high and the hydropower development is top priority.

JIRAMA is now planning the power demand and supply for each grid and district, through making Plan de Expansion Moindre Cout (PEMC: Least Cost Expansion Plan)[10] intended for JIRAMA's projects under the cooperation with MEM. In the purpose of "The development ordered of the hydropower potential in order to profit a competitive price of production of electricity, in front of the continual rise of the petroleum products, and to take care of the flexibility of the exploitation for better answering the change in the loads" and "The reduction of the production costs as well as the increase in power and the improvement of the quality of the service", PEMC is implemented using WASP[11], based on the demand in each district estimated by the growth of GDP, population and development plans of big customers as of December, 2007, the price of thermal power fuel as of April, 2008, and the situations of the power generating units in March, 2008.

The monthly planning of power demand and supply in Antananarivo Grid until 2020 is shown in Table 16, and the figure of the available output capacity and the peak demand forecast in Antananarivo Grid in rainy season and dry season (December) for each year is shown in Figure 10. The available output capacity in rainy season is estimated under the condition that there is enough river discharge and all hydropower output including that completed in the year is available.

10 :The title of the acquired document is "Plans de Developpement des Equipements de Production Electricite"
11 :Wien Automatic System Planning Package

Table 16 Plan for Demand and Supply of Antananarivo Grid

Year		2009												2010											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	**MW**	**110.4**	**110.4**	**110.4**	**110.4**	**110.4**	**79.4**	**109.4**	**107.4**	**105.4**	**103.4**	**95.2**	**60.9**	**110.4**	**110.4**	**110.4**	**110.4**	**110.4**	**110.4**	**109.4**	**107.4**	**105.4**	**103.4**	**95.2**	**85.9**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	31.0	62.0	62.0	62.0	62.0	60.0	31.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	21.0	18.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	21.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	**MW**													**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**5.2**	**3.0**
Lily	MW	Programmed sites (under development)																							
Tsiazompaniry	MW	Programmed sites (under development)												5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	Programmed sites (under development)																							
Andekaleka G3	MW	Programmed sites (under development)																							
Andekaleka G4	MW	Programmed sites (under development)																							
Sahofika I	MW	Sites suggested JIRAMA/Private																							
Mandraka II	MW	Sites suggested JIRAMA/Private																							
Antetezambato	MW	Sites suggested MEM																							
Ranomafana	MW	Sites suggested MEM																							
Sahofika II	MW	Sites without indication																							
TOTAL HYDROPOWER	**MW**	**110.4**	**110.4**	**110.4**	**110.4**	**110.4**	**79.4**	**109.4**	**107.4**	**105.4**	**103.4**	**95.2**	**60.9**	**115.6**	**115.6**	**115.6**	**115.6**	**115.6**	**115.6**	**114.6**	**112.6**	**110.6**	**108.6**	**100.4**	**88.9**
EXISTING THERMAL POWER	**MW**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.2**	**84.5**	**84.5**	**84.5**	**84.5**	**76.0**	**76.0**	**76.0**	**76.0**	**76.0**	**76.0**	**76.0**	**76.0**
CT Ambohimanambola	MW	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
CT Antsirabe	MW	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
CT Mandroseza	MW	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
IPP HFF Ambohimanambola	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Loc HYDELEC Ambohimanambola	MW	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	**MW**					**22.5**	**22.5**	**22.5**	**22.5**	**22.5**	**22.5**	**22.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**
CT Ambohimanambola 2	MW	New groups already programmed				22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
unité de 6, 25MW	MW	New groups to foresee											25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
TOTAL THERMAL POWER	**MW**	**84.2**	**84.2**	**84.2**	**84.2**	**106.7**	**106.7**	**106.7**	**106.7**	**106.7**	**106.7**	**106.7**	**131.7**	**132.0**	**132.0**	**132.0**	**132.0**	**123.5**	**123.5**	**123.5**	**123.5**	**123.5**	**123.5**	**123.5**	**123.5**
TOTAL AVAILABLE OUTPUT	**MW**	**194.6**	**194.6**	**194.6**	**194.6**	**217.1**	**186.1**	**216.1**	**214.1**	**212.1**	**210.1**	**201.9**	**192.6**	**247.6**	**247.6**	**247.6**	**247.6**	**239.1**	**239.1**	**238.1**	**236.1**	**234.1**	**232.1**	**223.9**	**212.4**
RATIO OF HYDROPOWER OUTPUT	**%**	**56.7%**	**56.7%**	**56.7%**	**56.7%**	**50.9%**	**42.7%**	**50.6%**	**50.2%**	**49.7%**	**49.2%**	**47.2%**	**31.6%**	**46.7%**	**46.7%**	**46.7%**	**46.7%**	**48.3%**	**48.3%**	**48.1%**	**47.7%**	**47.2%**	**46.8%**	**44.8%**	**41.9%**
Peak Demand	**MW**	**171.8**	**173.5**	**175.3**	**177.0**	**178.8**	**180.5**	**182.3**	**184.0**	**185.8**	**187.5**	**189.3**	**191.0**	**192.3**	**193.6**	**194.9**	**196.2**	**197.5**	**198.8**	**200.1**	**201.4**	**202.7**	**204.0**	**205.3**	**206.6**
MARGIN	**MW**	**22.9**	**21.1**	**19.4**	**17.6**	**38.4**	**5.6**	**33.9**	**30.1**	**26.4**	**22.6**	**12.7**	**1.6**	**55.3**	**54.0**	**52.7**	**51.4**	**41.6**	**40.3**	**38.0**	**34.7**	**31.4**	**28.1**	**18.6**	**5.8**

As of Oct, 2008

Source: Tables from JIRAMA

Table 16 Plan for Demand and Supply of Antananarivo Grid (continue)

Year		2011												2012											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	MW	110.4	110.4	110.4	110.4	110.4	110.4	109.4	107.4	105.4	103.4	95.2	88.9	110.4	110.4	110.4	110.4	110.4	110.4	109.4	107.4	105.4	103.4	95.2	85.9
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	21.0	21.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	24.0	21.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	MW	54.2	54.2	76.2	60.2	60.2	48.2	30.2	29.2	28.2	11.2	60.2	58.0	138.2	138.2	126.2	110.2	110.2	98.2	80.2	79.2	78.2	61.2	60.2	58.0
Lily	MW	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Tsiazompaniry	MW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0
Andekaleka G3	MW	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0
Andekaleka G4	MW			25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
Sahofika I	MW											50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mandraka II	MW																								
Antetezambato	MW																								
Ranomafana	MW																								
Sahofika II	MW																								
TOTAL HYDROPOWER	MW	164.6	164.6	186.6	170.6	170.6	158.6	139.6	136.6	133.6	114.6	155.4	146.9	248.6	248.6	236.6	220.6	220.6	208.6	189.6	186.6	183.6	164.6	155.4	143.9
EXISTING THERMAL POWER	MW	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0	74.0
CT Ambohimanambola	MW	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
CT Antsirabe	MW	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
CT Mandroseza	MW	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
IPP HFF Ambohimanambola	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Loc HYDELEC Ambohimanambola	MW																								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	MW	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5	47.5
CT Ambohimanambola 2	MW	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
unité de 6, 25MW	MW	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
TOTAL THERMAL POWER	MW	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5	121.5
TOTAL AVAILABLE OUTPUT	MW	286.1	286.1	308.1	292.1	292.1	280.1	261.1	258.1	255.1	236.1	276.9	268.4	370.1	370.1	358.1	342.1	342.1	330.1	311.1	308.1	305.1	286.1	276.9	265.4
RATIO OF HYDROPOWER OUTPUT	%	57.5%	57.5%	60.6%	58.4%	58.4%	56.6%	53.5%	52.9%	52.4%	48.5%	56.1%	54.7%	67.2%	67.2%	66.1%	64.5%	64.5%	63.2%	60.9%	60.6%	60.2%	57.5%	56.1%	54.2%
Peak Demand	MW	207.7	209.1	210.5	211.9	213.3	214.7	216.1	217.5	218.9	220.3	221.7	223.1	224.3	225.8	227.3	228.8	230.4	231.9	233.4	234.9	236.4	237.9	239.5	241.0
MARGIN	MW	78.4	77.0	97.6	80.2	78.8	65.4	45.0	40.6	36.2	15.8	55.2	45.3	145.8	144.3	130.8	113.3	111.7	98.2	77.7	73.2	68.7	48.2	37.4	24.4

As of Oct, 2008

Source: Tables from JIRAMA

Table 16 Plan for Demand and Supply of Antananarivo Grid (continue)

Year		2013												2014											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	**MW**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	**MW**	**188.2**	**188.2**	**176.2**	**160.2**	**160.2**	**148.2**	**130.2**	**129.2**	**128.2**	**111.2**	**110.2**	**108.0**	**188.2**	**188.2**	**176.2**	**160.2**	**160.2**	**148.2**	**130.2**	**129.2**	**128.2**	**111.2**	**110.2**	**108.0**
Lily	MW	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Tsiazompaniry	MW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0
Andekaleka G3	MW	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0
Andekaleka G4	MW	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
Sahofika I	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mandraka II	MW																								
Antetezambato	MW																								
Ranomafana	MW																								
Sahofika II	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
TOTAL HYDROPOWER	**MW**	**294.6**	**294.6**	**282.6**	**266.6**	**266.6**	**254.6**	**235.6**	**232.6**	**229.6**	**210.6**	**204.4**	**193.9**	**294.6**	**294.6**	**282.6**	**266.6**	**266.6**	**254.6**	**235.6**	**232.6**	**229.6**	**210.6**	**204.4**	**193.9**
EXISTING THERMAL POWER	**MW**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**	**57.0**
CT Ambohimanambola	MW																								
CT Antsirabe	MW																								
CT Mandroseza	MW	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0	37.0
IPP HFF Ambohimanambola	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Loc HYDELEC Ambohimanambola	MW																								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	**MW**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**
CT Ambohimanambola 2	MW	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
unité de 6, 25MW	MW	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
TOTAL THERMAL POWER	**MW**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**	**104.5**
TOTAL AVAILABLE OUTPUT	**MW**	**399.1**	**399.1**	**387.1**	**371.1**	**371.1**	**359.1**	**340.1**	**337.1**	**334.1**	**315.1**	**308.9**	**298.4**	**399.1**	**399.1**	**387.1**	**371.1**	**371.1**	**359.1**	**340.1**	**337.1**	**334.1**	**315.1**	**308.9**	**298.4**
RATIO OF HYDROPOWER OUTPUT	%	**73.8%**	**73.8%**	**73.0%**	**71.8%**	**71.8%**	**70.9%**	**69.3%**	**69.0%**	**68.7%**	**66.8%**	**66.2%**	**65.0%**	**73.8%**	**73.8%**	**73.0%**	**71.8%**	**71.8%**	**70.9%**	**69.3%**	**69.0%**	**68.7%**	**66.8%**	**66.2%**	**65.0%**
Peak Demand	**MW**	**242.2**	**243.9**	**245.5**	**247.2**	**248.8**	**250.4**	**252.1**	**253.7**	**255.3**	**257.0**	**258.6**	**260.3**	**261.6**	**263.4**	**265.2**	**266.9**	**268.7**	**270.5**	**272.2**	**274.0**	**275.8**	**277.5**	**279.3**	**281.1**
MARGIN	**MW**	**156.9**	**155.2**	**141.6**	**123.9**	**122.3**	**108.7**	**88.0**	**83.4**	**78.8**	**58.1**	**50.3**	**38.1**	**137.5**	**135.7**	**121.9**	**104.2**	**102.4**	**88.6**	**67.9**	**63.1**	**58.3**	**37.6**	**29.6**	**17.3**

As of Oct, 2008

Source: Tables from JIRAMA

Table 16 Plan for Demand and Supply of Antananarivo Grid (continue)

Year		2015												2016											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	**MW**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	**MW**	**188.2**	**188.2**	**176.2**	**160.2**	**160.2**	**148.2**	**187.8**	**186.8**	**185.8**	**168.8**	**267.8**	**265.6**	**395.8**	**395.8**	**383.8**	**367.8**	**367.8**	**355.8**	**337.8**	**336.8**	**335.8**	**268.8**	**267.8**	**265.6**
Lily	MW	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Tsiazompaniry	MW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0
Andekaleka G3	MW	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0
Andekaleka G4	MW	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
Sahofika I	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mandraka II	MW							57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6
Antetezambato	MW											100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ranomafana	MW																								
Sahofika II	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0
TOTAL HYDROPOWER	**MW**	**294.6**	**294.6**	**282.6**	**266.6**	**266.6**	**254.6**	**293.2**	**290.2**	**287.2**	**268.2**	**362.0**	**351.5**	**502.2**	**502.2**	**490.2**	**474.2**	**474.2**	**462.2**	**443.2**	**440.2**	**437.2**	**368.2**	**362.0**	**351.5**
EXISTING THERMAL POWER	**MW**																								
CT Ambohimanambola	MW																								
CT Antsirabe	MW																								
CT Mandroseza	MW																								
IPP HFF Ambohimanambola	MW																								
Loc HYDELEC Ambohimanambola	MW																								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	**MW**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**22.5**	**22.5**	**22.5**	**22.5**								
CT Ambohimanambola 2	MW	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5								
unité de 6, 25MW	MW	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0												
TOTAL THERMAL POWER	**MW**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**47.5**	**22.5**	**22.5**	**22.5**	**22.5**								
TOTAL AVAILABLE OUTPUT	**MW**	**342.1**	**342.1**	**330.1**	**314.1**	**314.1**	**302.1**	**340.7**	**337.7**	**334.7**	**315.7**	**409.5**	**399.0**	**524.7**	**524.7**	**512.7**	**496.7**	**474.2**	**462.2**	**443.2**	**440.2**	**437.2**	**368.2**	**362.0**	**351.5**
RATIO OF HYDROPOWER OUTPUT	**%**	**86.1%**	**86.1%**	**85.6%**	**84.9%**	**84.9%**	**84.3%**	**86.1%**	**85.9%**	**85.8%**	**85.0%**	**88.4%**	**88.1%**	**95.7%**	**95.7%**	**95.6%**	**95.5%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Peak Demand	**MW**	**282.6**	**284.5**	**286.4**	**288.3**	**290.2**	**292.1**	**294.0**	**295.9**	**297.8**	**299.7**	**301.7**	**303.6**	**305.2**	**307.2**	**309.3**	**311.3**	**313.4**	**315.5**	**317.5**	**319.6**	**321.7**	**323.7**	**325.8**	**327.8**
MARGIN	**MW**	**59.5**	**57.6**	**43.7**	**25.8**	**23.9**	**10.0**	**46.7**	**41.8**	**36.9**	**16.0**	**107.8**	**95.4**	**219.5**	**217.5**	**203.4**	**185.4**	**160.8**	**146.7**	**125.7**	**120.6**	**115.5**	**44.5**	**36.2**	**23.7**

As of Oct, 2008

Source: Tables from JIRAMA

Table 16 Plan for Demand and Supply of Antananarivo Grid (continue)

Year		2017												2018											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	**MW**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	**MW**	**395.8**	**395.8**	**383.8**	**367.8**	**367.8**	**355.8**	**337.8**	**336.8**	**335.8**	**318.8**	**317.8**	**315.6**	**445.8**	**445.8**	**433.8**	**417.8**	**417.8**	**405.8**	**387.8**	**386.8**	**385.8**	**318.8**	**317.8**	**315.6**
Lily	MW	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Tsiazompaniry	MW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0
Andekaleka G3	MW	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0
Andekaleka G4	MW	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
Sahofika I	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mandraka II	MW	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6
Antetezambato	MW	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
Ranomafana	MW																								
Sahofika II	MW	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0
TOTAL HYDROPOWER	**MW**	**502.2**	**502.2**	**490.2**	**474.2**	**474.2**	**462.2**	**443.2**	**440.2**	**437.2**	**418.2**	**412.0**	**401.5**	**552.2**	**552.2**	**540.2**	**524.2**	**524.2**	**512.2**	**493.2**	**490.2**	**487.2**	**418.2**	**412.0**	**401.5**
EXISTING THERMAL POWER	**MW**																								
CT Ambohimanambola	MW																								
CT Antsirabe	MW																								
CT Mandroseza	MW																								
IPP HFF Ambohimanambola	MW																								
Loc HYDELEC Ambohimanambola	MW																								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	**MW**																								
CT Ambohimanambola 2	MW																								
unité de 6, 25MW	MW																								
TOTAL THERMAL POWER	**MW**																								
TOTAL AVAILABLE OUTPUT	**MW**	**502.2**	**502.2**	**490.2**	**474.2**	**474.2**	**462.2**	**443.2**	**440.2**	**437.2**	**418.2**	**412.0**	**401.5**	**552.2**	**552.2**	**540.2**	**524.2**	**524.2**	**512.2**	**493.2**	**490.2**	**487.2**	**418.2**	**412.0**	**401.5**
RATIO OF HYDROPOWER OUTPUT	**%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Peak Demand	**MW**	**329.6**	**331.8**	**334.0**	**336.3**	**338.5**	**340.7**	**342.9**	**345.2**	**347.4**	**349.6**	**351.8**	**354.1**	**355.9**	**358.3**	**360.7**	**363.2**	**365.6**	**368.0**	**370.4**	**372.8**	**375.2**	**377.6**	**380.0**	**382.4**
MARGIN	**MW**	**172.6**	**170.4**	**156.2**	**137.9**	**135.7**	**121.5**	**100.3**	**95.0**	**89.8**	**68.6**	**60.2**	**47.4**	**196.3**	**193.9**	**179.5**	**161.0**	**158.6**	**144.2**	**122.8**	**117.4**	**112.0**	**40.6**	**32.0**	**19.1**

As of Oct, 2008

Source: Tables from JIRAMA

Table 16 Plan for Demand and Supply of Antananarivo Grid (continue)

Year		2019												2020											
Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
EXISTING HYDROPOWER	**MW**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**106.4**	**105.4**	**103.4**	**101.4**	**99.4**	**94.2**	**85.9**
Andekaleka G1 & G2	MW	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	60.0	56.0
Antelomita 1	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Antelomita 2	MW	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Manandona	MW	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	0.0	0.0
Mandraka	MW	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	18.0
Sahanivotry	MW	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7	15.0	15.0	15.0	15.0	15.0	15.0	14.0	12.0	10.0	8.0	6.0	3.7
HYDROPOWER PROJECT	**MW**	**445.8**	**445.8**	**433.8**	**417.8**	**417.8**	**405.8**	**387.8**	**386.8**	**385.8**	**318.8**	**367.8**	**365.6**	**495.8**	**495.8**	**483.8**	**467.8**	**467.8**	**455.8**	**437.8**	**436.8**	**435.8**	**391.8**	**390.8**	**388.6**
Lily	MW	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0	3.0	3.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	1.0	1.0	1.0
Tsiazompaniry	MW	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	3.0
Mahitsy	MW	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0	12.0	12.0	12.0	12.0	12.0	10.0	8.0	7.0	6.0	5.0	4.0	4.0
Andekaleka G3	MW	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0	34.0	34.0	31.0	20.0	20.0	15.0	15.0	15.0	15.0	0.0	0.0	0.0
Andekaleka G4	MW	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	34.0	34.0	25.0	20.0	20.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0
Sahofika I	MW	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mandraka II	MW	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6	57.6
Antetezambato	MW	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0	200.0
Ranomafana	MW																						23.0	23.0	23.0
Sahofika II	MW	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	50.0	50.0	50.0
TOTAL HYDROPOWER	**MW**	**552.2**	**552.2**	**540.2**	**524.2**	**524.2**	**512.2**	**493.2**	**490.2**	**487.2**	**418.2**	**462.0**	**451.5**	**602.2**	**602.2**	**590.2**	**574.2**	**574.2**	**562.2**	**543.2**	**540.2**	**537.2**	**491.2**	**485.0**	**474.5**
EXISTING THERMAL POWER	**MW**																								
CT Ambohimanambola	MW																								
CT Antsirabe	MW																								
CT Mandroseza	MW																								
IPP HFF Ambohimanambola	MW																								
Loc HYDELEC Ambohimanambola	MW																								
EDM	MW																								
Loc HFF Ambohimanambola	MW																								
THERMAL POWER PROJECT	**MW**																								
CT Ambohimanambola 2	MW																								
unité de 6, 25MW	MW																								
TOTAL THERMAL POWER	**MW**																								
TOTAL AVAILABLE OUTPUT	**MW**	**552.2**	**552.2**	**540.2**	**524.2**	**524.2**	**512.2**	**493.2**	**490.2**	**487.2**	**418.2**	**462.0**	**451.5**	**602.2**	**602.2**	**590.2**	**574.2**	**574.2**	**562.2**	**543.2**	**540.2**	**537.2**	**491.2**	**485.0**	**474.5**
RATIO OF HYDROPOWER OUTPUT	**%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Peak Demand	**MW**	**384.4**	**387.0**	**389.6**	**392.2**	**394.8**	**397.4**	**400.0**	**402.6**	**405.2**	**407.8**	**410.4**	**413.0**	**415.2**	**418.0**	**420.8**	**423.6**	**426.4**	**429.2**	**432.0**	**434.8**	**437.6**	**440.4**	**443.2**	**446.0**
MARGIN	**MW**	**167.8**	**165.2**	**150.6**	**132.0**	**129.4**	**114.8**	**93.2**	**87.6**	**82.0**	**10.4**	**51.6**	**38.5**	**187.0**	**184.2**	**169.4**	**150.6**	**147.8**	**133.0**	**111.2**	**105.4**	**99.6**	**50.8**	**41.8**	**28.5**

As of Oct, 2008

Source: Tables from JIRAMA

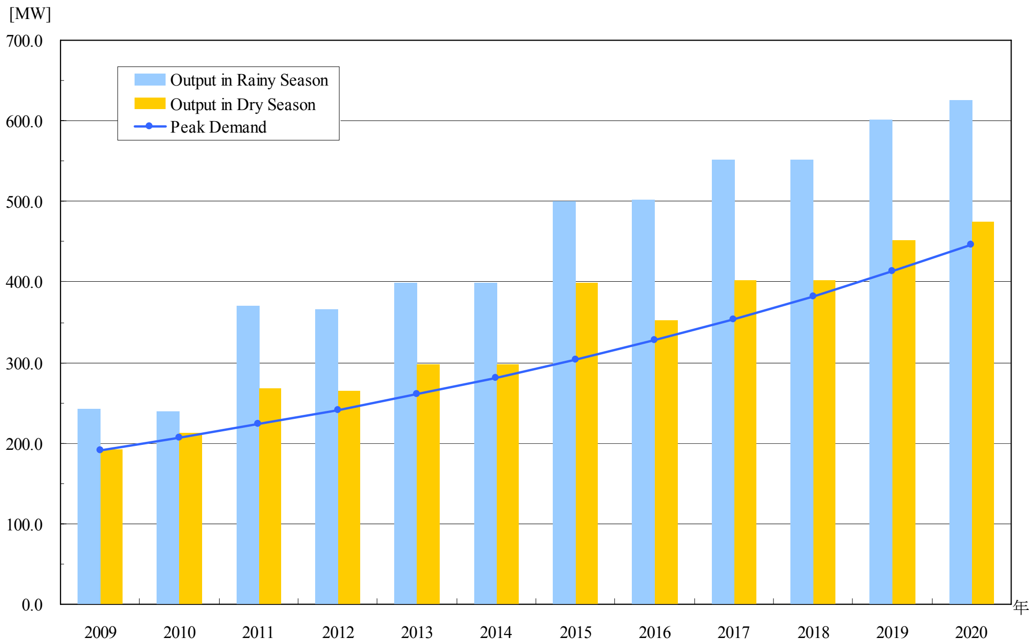


Figure 10 Peak Demand, Output in Rainy Season and Dry Season of Antananarivo Grid

There is no margin of output in the dry season for the demand forecast of almost of all years as shown in Figure 10. Therefore, in this demand forecast and supply plan, it is assumed that the stopped thermal power plants due to the introduction of a new hydropower plants are considered to be preserved as the backups without abandon.

Table 17 Power Source Installation Plan in Antananarivo Grid and Toamasina Grid on PEMC

Year	Unit	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Planning Hydropower Project	**MW**	**0.00**	**39.30**	**104.80**	**107.05**	**157.05**	**157.05**	**314.65**	**414.65**	**414.65**	**464.65**	**464.65**	**549.65**	**549.65**	**549.65**	**549.65**	**549.65**	**669.65**	**669.65**	**693.05**	**693.05**	**693.05**	**693.05**
PlanningHydropower Project more than 10MW																							
Mahitsy			12MW	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Andekaleka G3		34MW	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Mandraka II							57.6MW	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Talaviana												15MW	■	■	■	■	■	■	■	■	■	■	■
Tsinjoarivo																			21MW	■	■	■	■
Sahofika 1			50MW	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Antetezambato 1&2&3							100MW	■	+50MW ■	■	+50MW ■	■	■	■	■	■	■	■	■	■	■	■	■
Sahofika 2					50MW	■	■	■	+50MW ■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Ranomafana												70MW	■	■	■	■	■	■	■	■	■	■	■
Lohavanana																	120MW	■	■	■	■	■	■
Planning Thermal Power Project	**MW**	**63.72**	**70.92**	**70.92**	**78.12**	**63.72**	**63.72**	**63.72**	**38.72**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**16.22**	**66.98**	**134.66**	**219.26**
Planning Thermal Power Project more than 10MW																							
CT Ambohimanambola 2, Unité de 6.25MW / FO	22.5MW	■	■	■	■	■	■	■	■														
Unité de 6.25MW / FO	25MW	■	■	■	■	■	■	■															
Unité de 8.0MW / FO																				50.76MW	■	+67.68MW ■	+84.6MW ■
Tamatave IV, Unité de 6.4MW / FO	16.224MW	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Unité de 8.0MW / FO		7.2MW	■	■	+7.2MW ■																		

As of Dec, 2008

Source: Information from Plans de Developpement des Equipements de Production Electricite

Table 18 Power Source Installation Plan in Fianarantsoa Grid on PEMC

Year	Unit	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Planning Hydropower Project	MW	0.00	0.00	0.00	0.00	8.00	8.00	8.00	8.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Planning Hydropower Project more than 10MW																								
Namorona2					8MW					+4MW														
Planning Thermal Power Project	MW	0.00	1.35	2.25	4.50	2.52	2.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.22	5.22	20.97	20.97	20.97	24.12	27.27	30.42	33.57
Planning Thermal Power Project more than 10MW																								
RI Fianarantsoa / Unité de 3.5MW / FO																	15.75MW				+3.15MW	+3.15MW	+3.15MW	+3.15MW

As of Dec, 2008

Source: Information from Plans de Developpement des Equipements de Production Electricite

The installation plans of new power sources in three grids of JIRAMA on PEMC are shown in Table 17 and Table 18. Because the connection of Antananarivo Grid and Toamasina Grid will be implemented in the future, their plan of demand and supply is estimated in total on PEMC.

The information of plans and studies for the power source developments got by hearing at site are shown in Table 19.

Table 19 Project and Study of identified by hearing

Project	Area	Capacity	Startup	Sponsor or Planner
Planning Project				
Tsiazompanry Hydro	Antananarivo Grid	5.2MW?	Jan, 2010	Henlri Fraise
Andekaleka III Hydro	Antananarivo Grid	29MW	2011	Chino Hydro, China
Andekaleka IV Hydro	Antananarivo Grid	20MW	Not decided	Chino Hydro, China
Fuel Oil Thermal	Antananarivo Grid	25MW	May, 2009	Sherritt, Canada
Fuel Oil Thermal	Toamasina Grid	9.9MW	First qtr., 2009	ENELEC
Study				
Antetezambato Hydro	Antananarivo Grid	180MW	Pre-F/S ~ Feb, 2009	World Bank Sogreah, France
Locoho Hydro	Andapa / Antsiranana	6MW	Studying	EDF

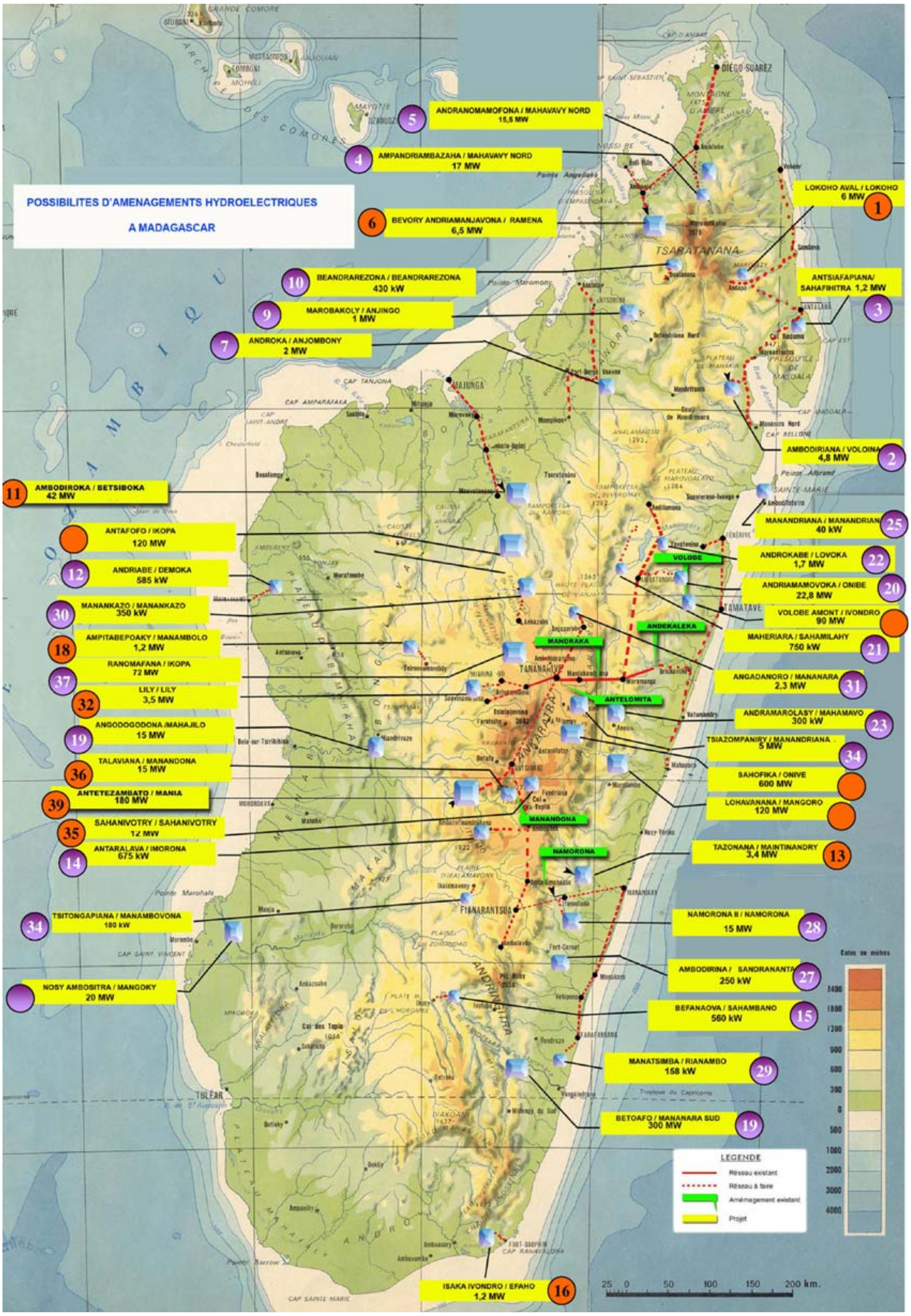
The locations of hydropower potential plans are shown in Table 20 and Figure 11. Sahanivotry hydropower shown by No.35 was already completed in October, 2008 and starts to supply the electric power to Antananarivo Grid in 2009.

Table 20 Project Potential of Hydropower Development

Station name / River name	Head [m]	Average Discharge [m^3/s]	Output Capacity [kW]	Annual Electricity [GWh]	No.
Lokoho Aval / Lokoho	53.0	15.0	5,963	48.10	1
Vodiriana / Voloina	92.0	7.0	4,830	37.31	2
Antsiafapiana / Sahafihatra	10.0	15.0	1,200	9.00	3
Ampandriambazaha / Mahavavy Nord	150.0	15.0	16,875	132.45	4
Andranomamofona / Mahavavy Nord	103.0	20.0	15,450	119.05	5
Bevory Andriamanjavona / Ramena	89.0	9.7	6,475	49.00	6
Androka / Anjobony	15.9	6.4	815	8.00	7
Andohariana / Bemarivo	22.3	15.0	2,509	19.00	8
Marobakoly / Anjingo	20.7	5.0	828	6.60	9
Beandrarezona / Beandrarezona	35.8	1.6	430	4.00	10
Ambodiroka / Betsiboka	70.0	78.0	40,950	329.00	11
Andriabe / Demoka	7.8	10.0	585	5.00	12
Tazonana Aval / Maintinandry	99.8	4.5	3,369	27.00	13
Antaralava / Imorona	30.0	3.0	675	6.00	14
Befanaova / Sahambano	15.0	5.0	563	4.65	15
Isaka Ivondro / Efaho	165.0	1.0	1,238	9.00	16
Tsitongapiana / Manambovona	24.7	1.0	186	2.04	17
Ampitabepoaky / Manambobo	20.2	8.5	1,288	11.00	18
Angodongodona / Mahajilo			15,000	118.00	19
Andriamamovoka / Onibe	152.0	20.0	22,800	172.00	20
Maheriara / Sahamilahy			750	6.00	21
Androkabe / Lovoka	75.0	3.0	1,688	13.00	22
Andramarolasy / Mahamavo	83.9	0.5	315	3.00	23
/ Nosivolo			750	6.00	24
Manandriana	26.8	0.2	40	0.30	25
Ambodiriana			190	1.50	26
Ambodiriana / Sandrananta			250	2.00	27
NamoronaII / Namorona	93.0	20.0	13,950	98.00	28
Rianambo / Manatsimba	10.5	2.0	158	1.51	29
Manankazo / Manankazo	46.5	1.0	349	2.58	30
Angadanoro / Mananara	43.3	7.0	2,274	17.00	31
Lily / Lily	74.9	6.0	3,371	24.00	32
Amboasary / Andromba	30.0	8.5	2,000	13.00	33
Tsiazompaniry / Manandriana	34.0	20.0	5,100	32.00	34
Sahanivotry / Sahanivotry	200.0	10.0	15,000	113.00	35
Talaviana / Manandona	121.5	15.0	14,580	145.00	36
Ranomafana / Ikopa	72.0	125.0	67,500	473.00	37
Mandraka Amont / Mandraka	233.0	10.0	17,475	132.00	38
Antetezambato / Mania	195.0	120.0	182,520	1,303.00	39
Total			**470,289**	**3,502.09**	

Data without description are calculated as estimated values. Source: MEM

4-34



Source: MEM

Figure 11 Hydropower Development Potential Map

3.6.2 Transmission Line Development Plan

There are no master plans for the development of transmission grid network. The information of development plans obtained through interview below.

- Antananarivo ~ Toamasina: Voltage of 138kV or 230kV
  Connection of Antananarivo Grid and Toamasina Grid
- Antsirabe ~ Ambositra: Voltage of 63kV
  Extension for the south of Antananarivo Grid
- Namorona ~ Mananjary & Manakana : Voltage of 63kV
  Extension for the east and southeast of Fianarantsoa Grid to transmit the electricity generated by the planned Namorona II hydropower plant

The Transmission Line development plan known through interview and assumed by the demand forecast procedure in "Plans de Developpement des Equipements de Production Electricite" is shown in Figure 12.

Original Source: WB Implementation Completion Report for an Energy Sector Development Project, Sep 27, 2006
Revised by the information from "Plans de Developpement des Equipements de Production Electricite"

Figure 12 Transmission Line Development Plan

3.7 Matters and Concerns

As mentioned earlier, JIRAMA is now making the plan for power demand and supply through PEMC. But there is little information for individual projects to achieve the plan.

JICA implemented the study on energy sector in southern region of Africa intended for Madagascar and Mozambique in 2006, and the necessity of the master plan for hydropower and transmission grid network in Madagascar is shown in the report.

In the hearing at MEM, the strong necessity of the justification tool for aid agencies and private investors, that is, hydropower master plan including the information of each hydropower site and priority list, and transmission grid network master plan based on the locations of hydropower sites to be developed, is appealed.

The request from Madagascar government to Japanese government is done through the Ministry of Foreign Affairs in Madagascar, and the prioritization of request is implemented by the Secretary General in Executive Office of the President that takes responsibility of Madagascar Action Plan (MAP). Although all fields are shown evenly in MAP, the opinion of the President might greatly influence about the development plan.

Chapter 4 Proposed Expansion of Manandona Hydroelectric Power Plant Project

4.1 Present Situation of Manandona Hydroelectric Power Plant

4.1.1 Outline of Manandona Hydroelectric Power Plant

Mananona Hydroelectric Power Plant (HEPP) is located around 10km south from Antsirabe city, which is about 170km south from Antananarivo city, the capital of Madagaskar.

Manandona HEPP was completed in 1934, which installed capacity was 1,000 kW (500 kW x 2 units). In 1960 a weir was heightened 2.5m and an additional generator of 600 kW was installed. Total installed capacity became 1,600 kW (500 kW x 2 units and 600kW x 1unit).

The location of Manandona HEPP is shown in Figure 16. The general layout of Manandona HEPP is shown in Figure 13. The height of the weir is 10.5m (including 2.5m heightening refer Figure 14) and crest length is 66m with over-flow portion of 25.9m. The drawdown of the poundage is 2.0m. The effective poundage volume is estimated to be 50,000m^3. The weir is made of wet masonry.

Whole portions of the waterway from the weir to the powerhouse are made of pressure steel pipes. Total length is about 495m and tunnel portion is about 140m. The inner diameter of the penstock is 1.0m. The penstock is riveted steel pipe.

There is a surge tank made of same steel pipes as penstock. The distance from the weir to the surge tank is about 298m.

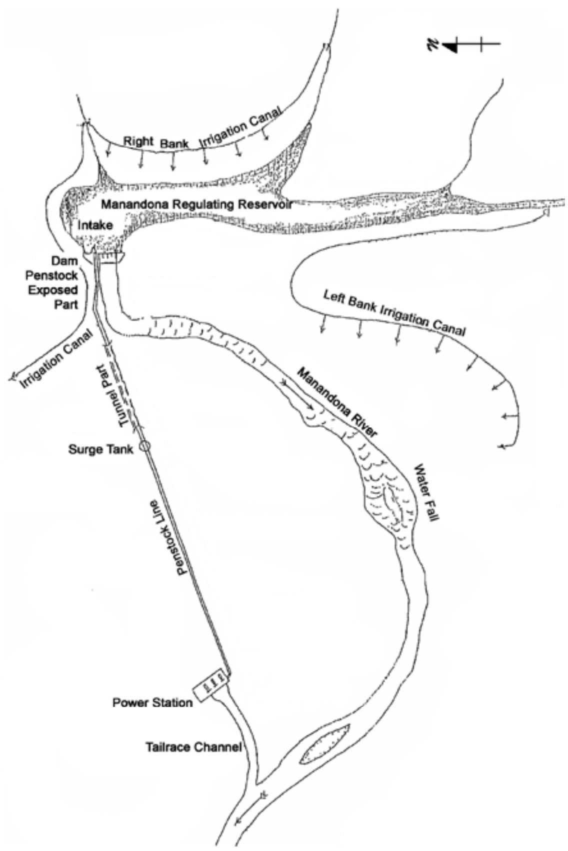


Figure 13 General Plan of Manandona HEPP

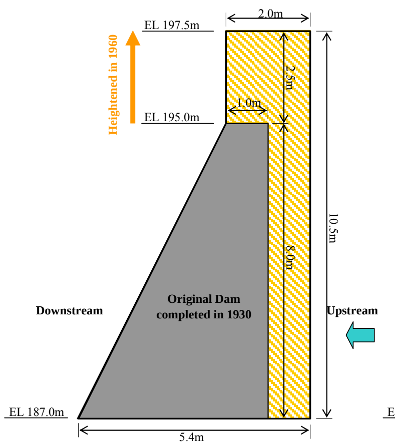
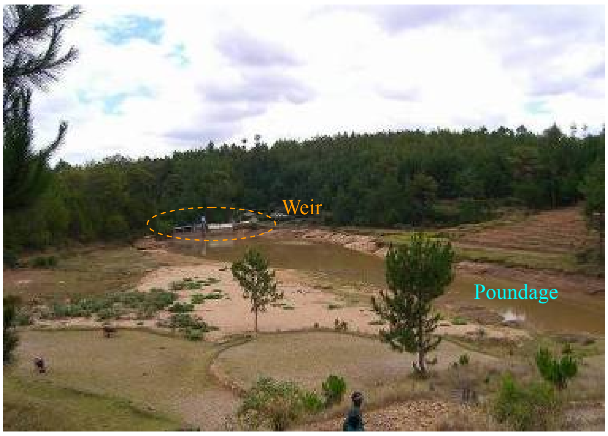


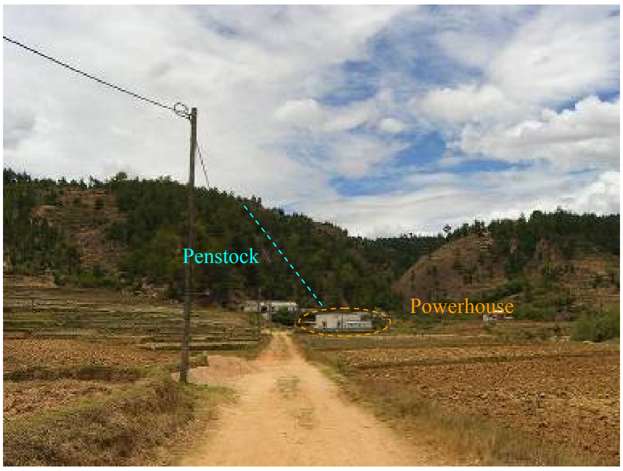
Figure 14 Typical Section of the Weir (Existing)

The Outline of existing Mananona Hydroelectric Power Plant is given in Table 21. Single diagram of Antananarivo Grid is shown in Figure 15.

Location map of Mananona HEPP is shown in Figure 16.



<u>Photo-1</u> Overall view from upstream



<u>Photo-2</u> Overall view of Powerhouse & Penstock

Table 21 Outline of Manandona Hydroelectric Power Plant (Existing)

Items	Unit	Value	Note
Maximum power output (under present condition)	kW	1,200*	Rated output: 1,600kW (500kW×2 + 600kW×1)
Annual Generation Energy	MWh/year	5,885.48	Actual record in 2007
Effective head	m	104.50	
Maximum turbine discharge	m^3/sec	2.20	
Catchment area	km^2	375	
Weir height	m	10.5	Original height: 8.0m (before 1960)
Weir crest length	m	66	
Effective storage	m^3	50,000	planning stage
Full water level	m	1,497.50	
Low-water level	m	1,495.50	
Draw down	m	2.00	available depth
Penstock length	m	495	Tunnel portion length 140m
Inner diameter of Penstock	m	1.0	
Transmission length	km	10.7	20 kV, 52.5mm Cu

* : Actual output is lower than rated one due to lower turbine efficiency.

4-2

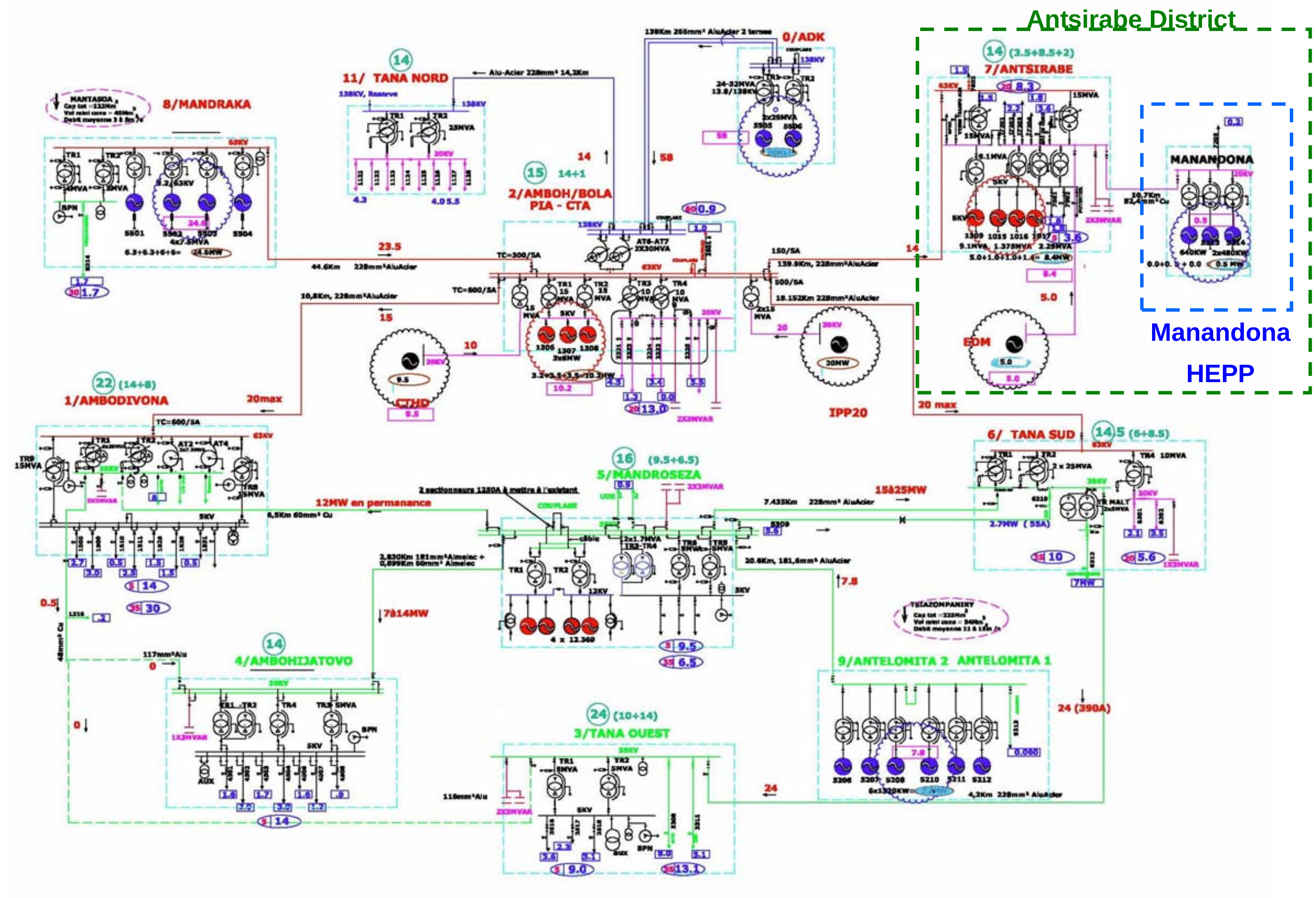


Figure 15 Single Diagram of Antananarivo Grid

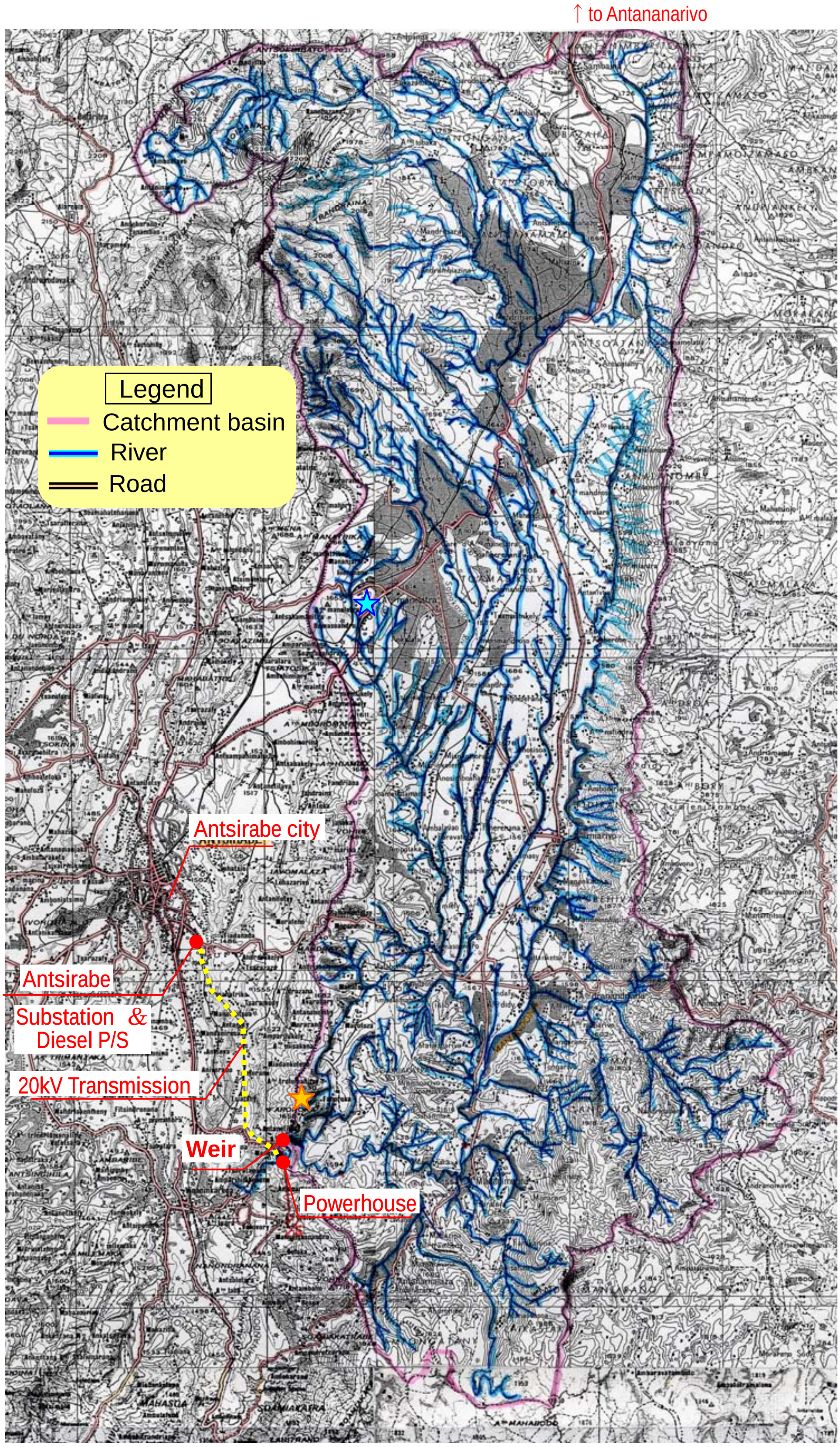


Figure 16 Location Map of Manandona HEPP

4.1.2 Site investigation of Manadona HEPP

The site reconnaissance of the Manandone HEPP was conducted by ECFA study team consist of 4 members on October 24 and 25 2008 accompanying Mr. François Xavier R, Director of Exploitation of Antananarivo Grid, JIRAMA. The schedule is given below;
The team visited JIRAMA Diesel Power Plant to collected river discharge data, operational records, drawings and so on as given in Appendix 3. As-built drawings and design calculating sheets of the power plant could not be obtained because of lack of management and budgets.

Date	Contact Agency	Activities
Oct-24 (Fri)	JIRAMA Antsirabe Regional Branch	Courtesy call to General Manager
	JIRAMA Antsirabe Diesel power plant	Collection of operational record, drawings etc.
	JIRAMA Manandona Hydropower plant	Site reconnaissance at weir, waterway, Powerhouse
Oct-25 (Sat)	JIRAMA Antsirabe Diesel power plant	Collection of operational record, drawings etc.
	JIRAMA Manandona Hydropower plant	Site reconnaissance at weir and upstream of poundage

Figure 17 Satellite Photograph of Manandona Hydroelectric Power Plant

Photo-3 **Upstream View of the Weir**

Photo-4 **Downstream View of the Weir**

Photo-5 **Overflow Portion of the Weir**

Photo-6 **Downstream View of the Weir**

Photo-7 **Downstream of the Weir**.

Photo-8 **Air pipe of Penstock**

<u>Photo-9</u> Upper Portion of Penstock

<u>Photo-10</u> Inclined Portion of Penstock

<u>Photo-11</u> Saddle of Penstock

<u>Photo-12</u> Tunnel Entrance of Penstock

<u>Photo-13</u> Tunnel Entrance Portion of Penstock

<u>Photo-14</u> Steel Surge Tank.

<u>Photo-15</u> Front View of Powerhouse

<u>Photo-16</u> Outlet and Tailrace Channel

<u>Photo-17</u> Control Panel

<u>Photo-18</u> Powerhouse

<u>Photo-19</u> Generator.(0.5MW)

<u>Photo-20</u> 3 Units of Generators
(0.5MW＋0.5MW＋0.6MW)

Photo-21 Antsirabe Sub-station

Photo-22 Antsirabe Sub-station

Photo-23 Antsirabe Diesel Power Plant

Photo-24 Antsirabe Diesel Power Plant

4.2 Necessity of Manandona Hydroelectric Power Plant

4.2.1 Load Demand in Antsirabe District

Manandona HEPP supplies electricity mainly to Antsirabe district, which is the second largest city in Madagascar. Antsirabe district is connected to Antananarivo Grid and located in the southern edge of Antananarivo. The daily load curve of Antsirabe district in September 2008, Grid is shown in Figure 18.

The peak demand of Antsirabe district is about 14MW on weekday and 10MW on weekend., power demand for daytime from 9:00AM to 5:00PM on weekday is about 10MW to 12MW and for midnight (from 0:00AM to 6:00AM) about 8MW. Since most of factories in Anstirabe district operate for 24hors, the minimum demand is not lowered so much.

Main electric sources to supply to Antsirabe district are Manandona HEPP (1.6MW), Antsirabe diesel power plant (14MW) and the source supplied by transmission line (63kV) from Antananarivo Grid. All power shortage is adjusted by electricity from Antananarivo Grid. The pattern of composition of electric sources varies due to available power discharge for Manandona HEPP by season. Due to steep rise of oil price, Antsirabe diesel power plant often stops. Typical pattern of load composition of Antsirabe district by season is shown in Figure 19.

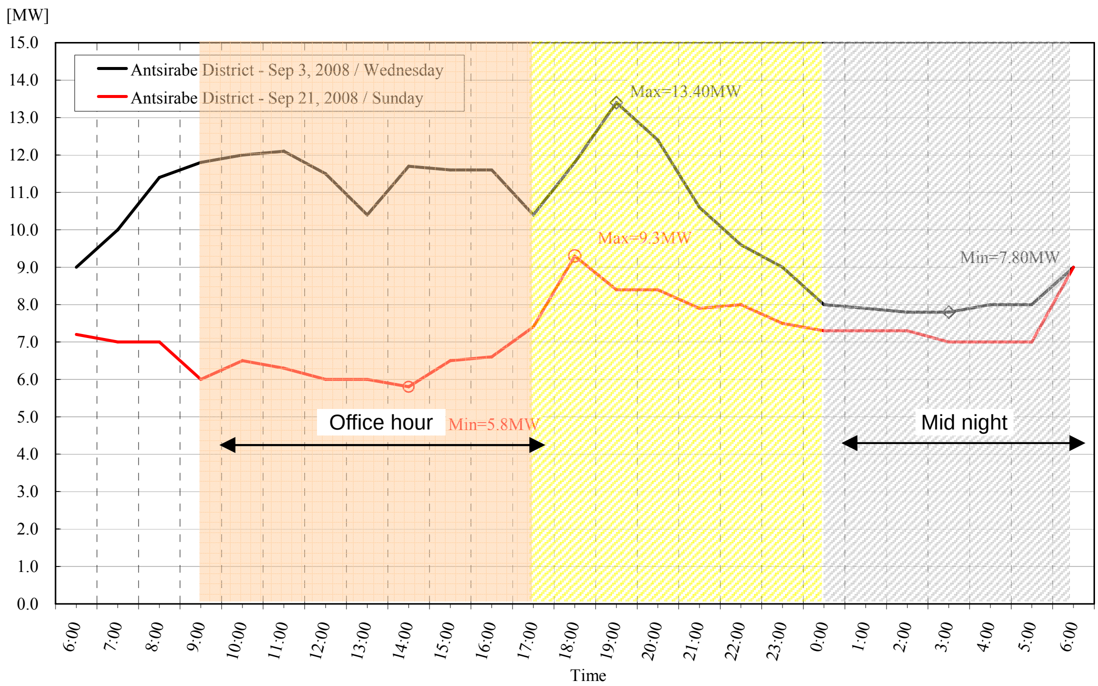


Figure 18 Daily Load Curve in Antsirabe District

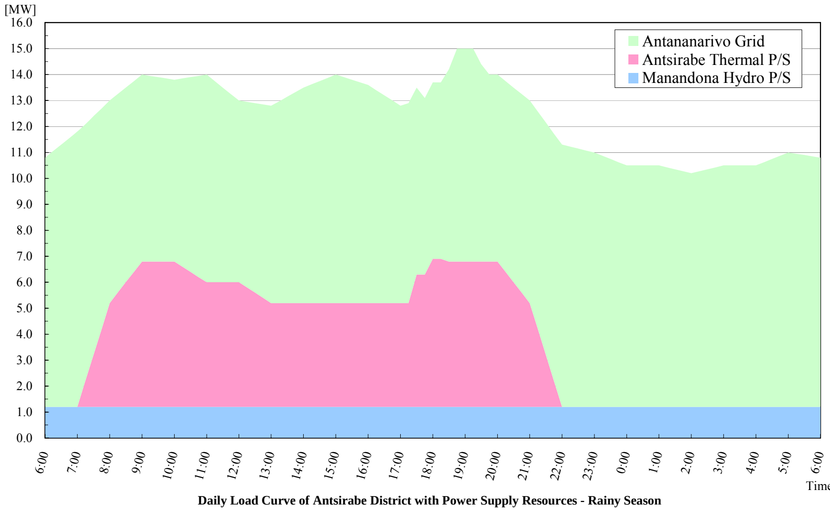
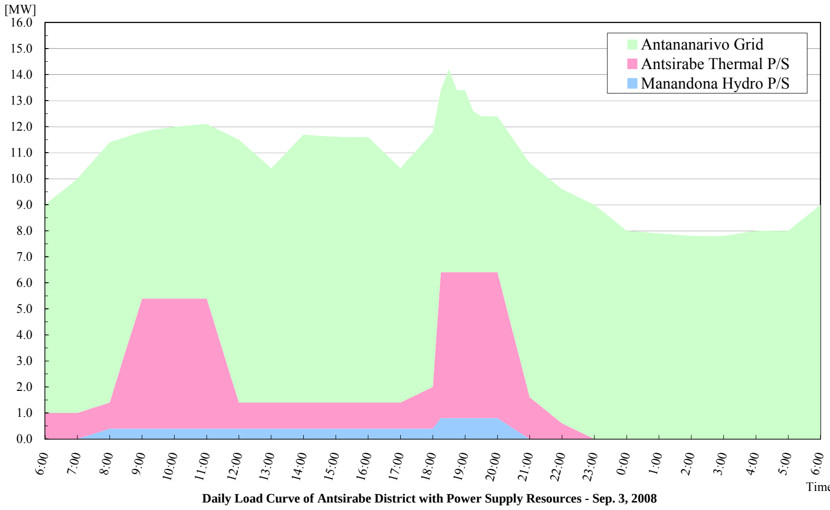
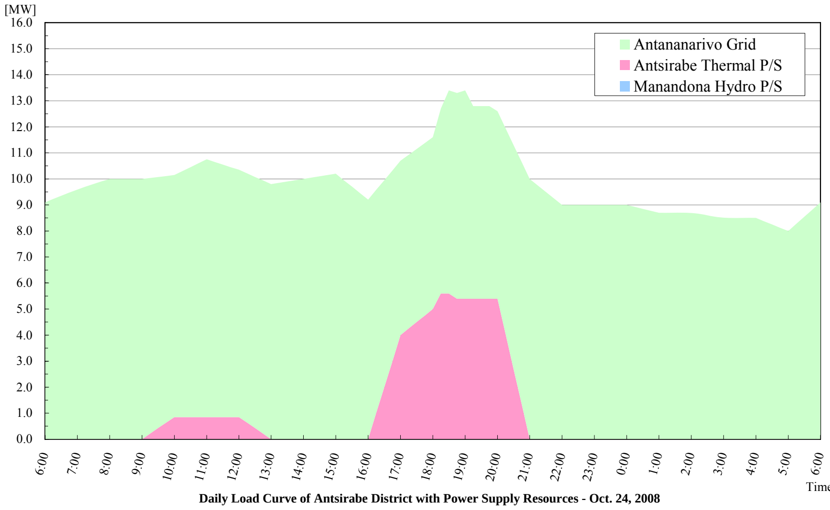
<table>
<tr><th>Season</th><th>Typical Load Curve of Antsirabe District</th><th>Explanation</th></tr>
<tr><td>Rainy</td><td>
</td><td>Amount of river flow is sufficient. Therefore, Manandona HEPP operates at the max. power for 24 hours.</td></tr>
<tr><td>Rainy
- Dry</td><td>
</td><td>Amount of river flow is not sufficient. Therefore, Manandona HEPP operates at lower power (some of units stop) for daytime and peak time at evening.
The operation is prioritized at peaking hour.</td></tr>
<tr><td>Dry</td><td>
</td><td>Amount of water is too small to operate Manandona HEPP.
Manandona HEPP stop operation.</td></tr>
</table>

Figure 19 Typical Pattern of Load Composition of Antsirabe District

4.2.2 Generation Energy of Manandona HEPP

Mean annual generation energy of Manandona HEPP from 2004 to 2007 is about 4,800MWh/year and flow utilization factor is about 46% as given in Table 22.

Flow utilization factor is calculated by using actual estimated output due to lower turbine efficiency, because the turbine wore out heavily and was repaired by the local manufacturer roughly.

Monthly generation energy varies as shown in Table 23 and Figure 21.

In the dry season from September to November, generation energy is decreasing very much. Only generation energy in these 3 months sums about 11% of annual generation energy.

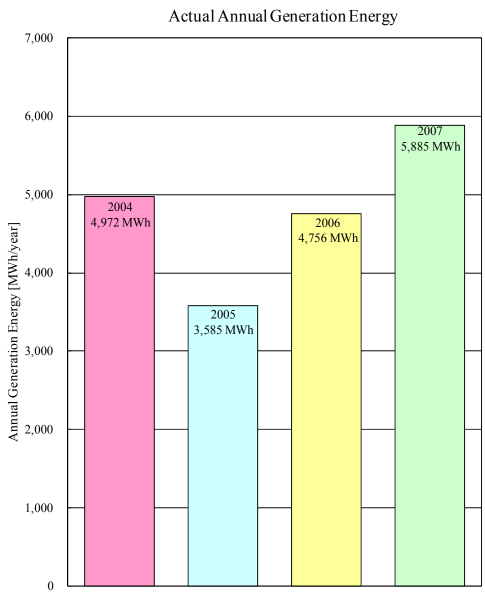


Figure 20 Annual Energy Generation

Table 22 Annual Generation Energy and Utilization Factor (2004 ~ 2007)

year	Maximum Output* [kW]	Annual Generation Energy [MWh/year]	Flow Utilization factor [%]
2004	1,600 (1,200)	4,972.450	47.3%
2005	1,600 (1,200)	3,584.620	34.2%
2006	1,600 (1,200)	4,756.420	45.3%
2007	1,600 (1,200)	5,885.480	56.0%
Mean of 2004--2007	1,600 (1,200)	4,799.743	45.7%

Note *: Rated installed capacity is 1,600kW, actual output is about 1,200kW due to lower turbine efficiency.

Table 23 Actual Monthly Generation Energy (4 years, 2004 ~ 2007)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	285.200	261.900	530.100	668.000	667.250	675.000	427.700	331.800	167.700	224.400	497.800	235.600	4,972.450
2005	259.750	271.040	267.235	259.080	437.335	394.185	389.510	348.135	182.240	111.530	119.820	544.760	3,584.620
2006	556.740	502.550	560.610	542.390	537.530	526.165	464.930	367.325	24.930	0.000	186.955	486.295	4,756.420
2007	499.025	460.345	430.100	515.430	865.380	860.385	754.845	474.700	215.010	116.615	383.105	310.540	5,885.480
Mean	400.179	373.959	447.011	496.225	626.874	613.934	509.246	380.490	147.470	113.136	296.920	394.299	4,799.743

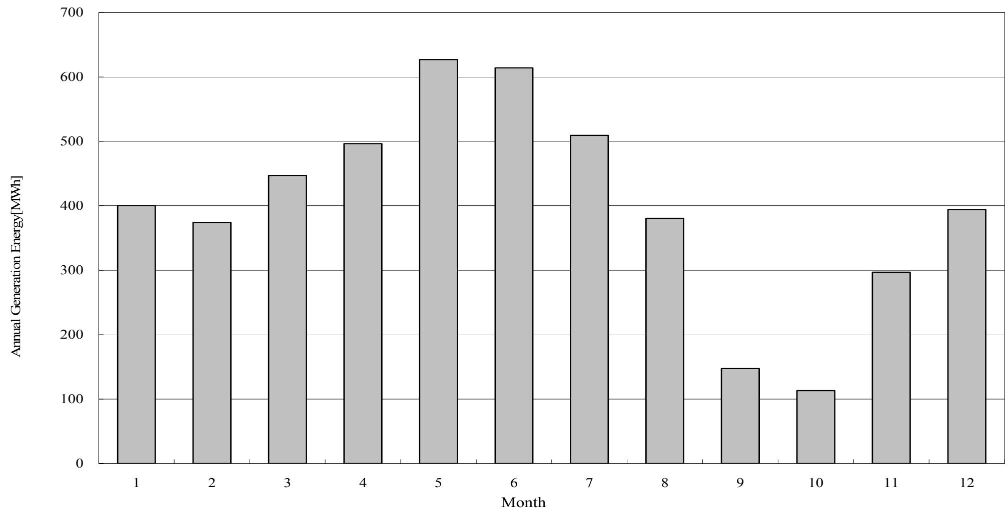


Figure 21 Actual Mean Monthly Generation Energy (4 years, 2004 ~ 2007)

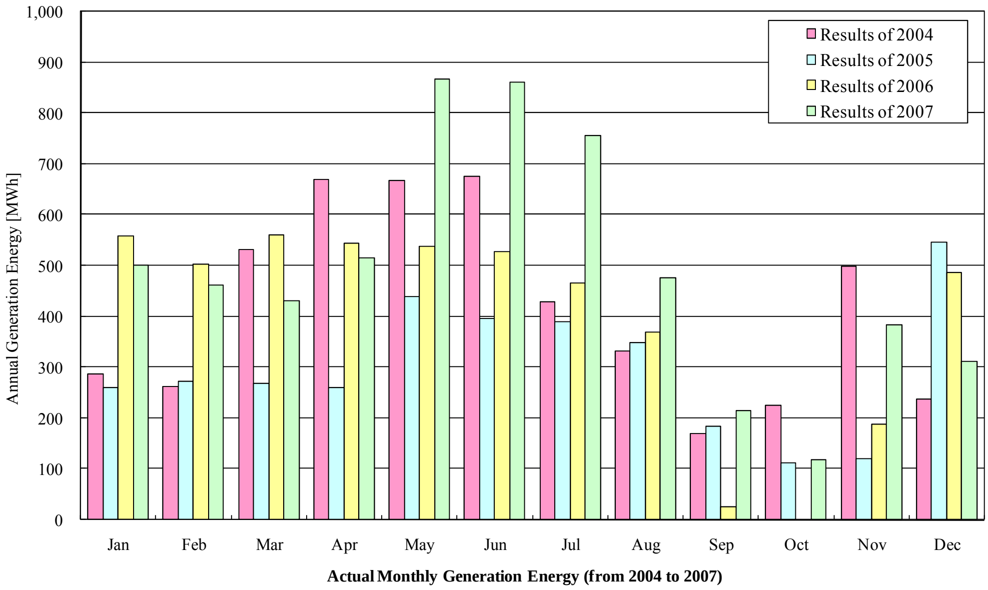


Figure 22 Actual Monthly Generation Energy (4 years, 2004 ~ 2007)

4.2.3 Meteorology and Hydrology

The annual mean rainfall of Manandona HEPP site is about 1,400mm/year as shown in Figure 23.

The rainfall records from 1971 to 2000 at Antananarivo are given in Table 24 and Figure 24

The dry season is from April to September.

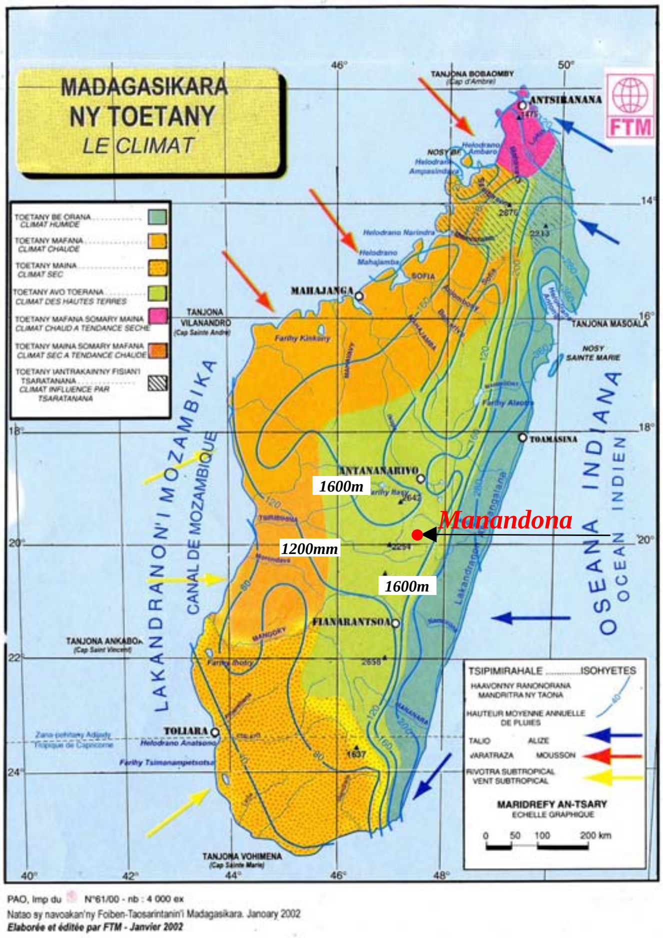


Figure 23 Isohyets graph in Madagascar

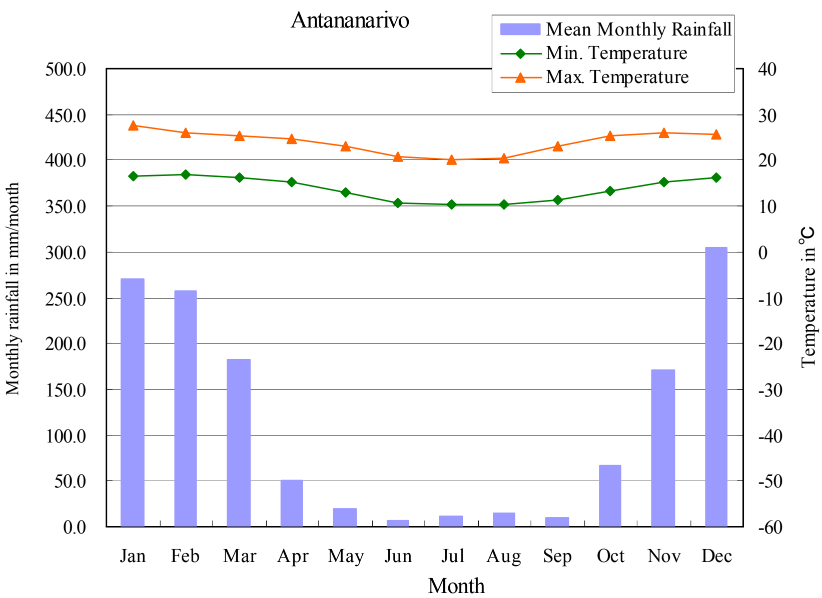


Figure 24 Mean Monthly Rainfall graph in Antananarivo

Table 24 Rainfall in Antananarivo Madagascar

Month	Mean Temperature		Mean Total Rainfall (mm)	Mean Number of Rain Days
	Daily Min.	Daily Maxi.		
Jan	16.6	27.7	270.4	18
Feb	16.9	25.9	256.9	17
Mar	16.3	25.4	183.1	17
Apr	15.2	24.8	50.5	9
May	12.9	22.9	20.1	6
Jun	10.8	20.9	7.2	6
Jul	10.3	20.2	11.1	8
Aug	10.3	20.6	15.0	9
Sep	11.3	23.0	9.5	4
Oct	13.4	25.2	66.6	8
Nov	15.1	26.0	170.8	14
Dec	16.3	25.8	304.1	20
			1,365.3	136 (37%)

Remarks:Climatological information is based on monthly averages for the 30-year period 1971-2000.

Run-off coefficient at Manandona weir site is 0.44 (CA=375km^2, Q_{mean}=7.27m^3/sec, Mean Annual Rainfall=1,400mm/year). Drainage basin of Manandona HEPP is mainly covered by cultivated fields, deforestation areas, resident areas and very few forests as shown in topographic map and photographs.

Figure 25 shows fluctuation of accumulated river flow from 1990 to 2007. From this figure, no definite sign of river flow decreasing is found. On the other hand, time-series number of flood occurrence every year (Q>50m^3/sec) is plotted on Figure 26, number of flood occurrence tends to increase under the same level of river flow.

It is judged that condition of river flow is not so much changed in recent 20 years, however, deforestation in the upstream might not be stopped,

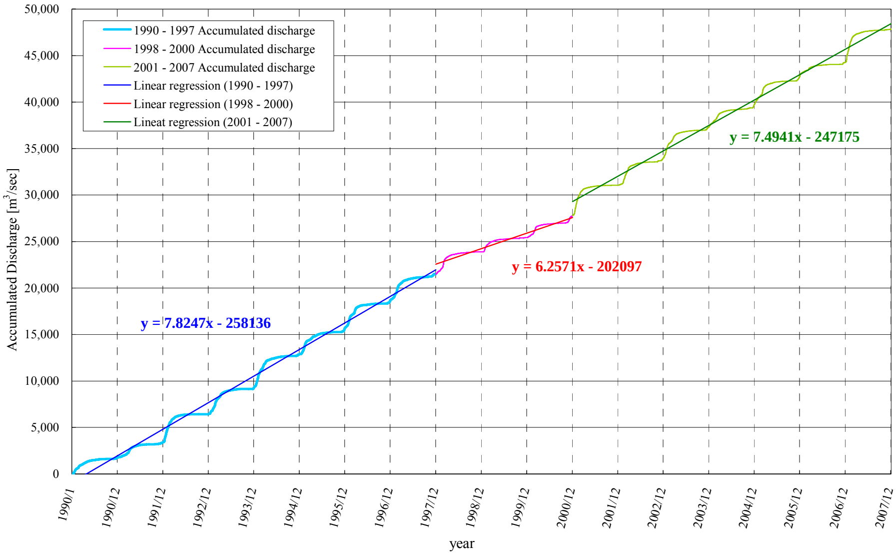


Figure 25 Fluctuation of Accumulated Discharge

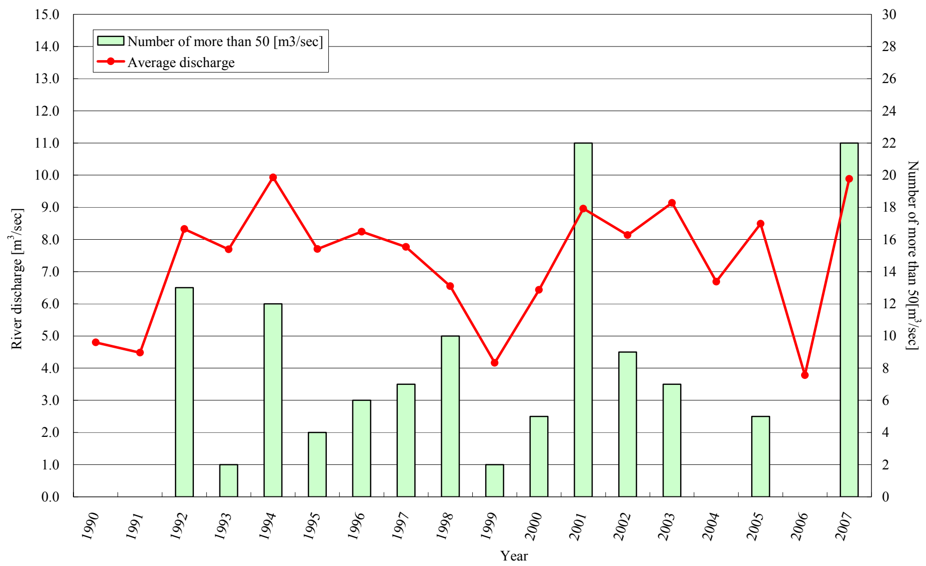


Figure 26 Mean Discharge and Number of Flood which is more than 50m3/sec (18years, 1990 ~ 2007)

<u>Photo-25</u> Upstream of the Weir

<u>Photo-26</u> Poundage

<u>Photo-27</u> Rice Field Upstream of the Weir

<u>Photo-28</u> Irrigation Channel Upstream of the Weir

☆ ☆ : locations are shown in Figure 16

4.2.4 Problems of Manandona HEPP

Manandona HEPP was completed in 1934, therefore the power plant has been operating for more than 75 years. However, the maintenance of the facilities is not sufficient and appropriate because of shortage of spare parts, budgets, skill technicians.

During site reconnaissance, the following problems / issues were found,

(1) Weir / Poundage

- A large amount of sediments are accumulated in the poundage. The sediments are used to be removed from both bottom outlets by manual every year just in front of the weir.
- The leakage occurs from gates of left and light bottom outlets. The amount of leakage depends on water level of the poundage.
- The right bank just upstream of the weir was flushed out completely due to attack of the cyclone occurred in 1977. Damaged river bank was repaired and strengthened by steel sheet piles and placement of gabions.
- The left bank just upstream of the weir was damaged due to attack of the cyclone occurred in 1977. Damaged river bank was repaired and strengthened by steel sheet piles.

(2) Penstock (Waterway)

- Damaged supports of the penstock just downstream of the weir due to attack of the cyclone occurred in 1977 were replaced by steel frames.
- Bending portion of the penstock and tunnel portion of the penstock were replaced in 2001.
- Most of the penstock was heavily rusted and corroded.
- Painting of most of the penstock is heavily deteriorated.

(3) Surge Tank

- Large gaps and cracks of wet masonry foundation of a steel surge tank were developed. Those gaps and cracks had been monitored and now are not monitored.
- During surging occurs, surging water overflows from the top of the tank. No facilities for overflowing water are provided.

(4) Electro-Mechanical Equipment

- No.3 unit of a turbine (600kW) was resembled and at present a damaged runner is being repaired and balanced at a local manufacture at Antananarivo city.
- Turbine runners heavily wore out and have been repaired often by local manufacturers so far.

<u>Photo-29</u> **Leakage from Bottom Outlet Gate**

<u>Photo-30</u> **Heavily Rusty Penstock**

<u>Photo-31</u> **Painting Deterioration of Penstock**

<u>Photo-32</u> **Replacement of Bending Portion of Penstock**

<u>Photo-33</u> **Reinforcement works in the Right bank (Sheet pile method & gabion placement)**

<u>Photo-34</u> **Reinforcement works in the Left bank (Sheet pile method)**

Photo-35 **Sedimentation near the Weir**

Photo-36 **Sedimentation Upstream of the Weir**

Photo-37 **Heavily Worn-out Runners**

Photo-38 **Resembling of Unit No.3 (Under repair)**

4.3 Preliminary Study of Expansion Plan of Manandona HEPP

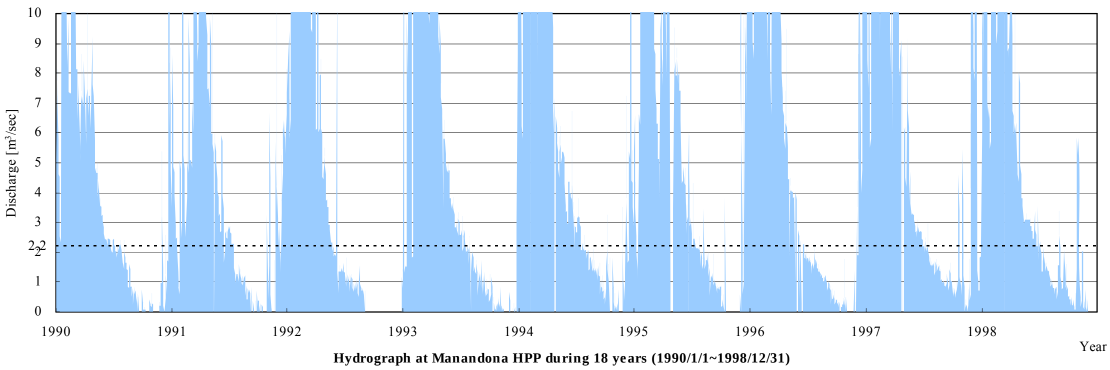
4.3.1 Hydrological Study

Released discharge, Overflow discharge and Power (Turbine) discharge are measured at 6 am every day by JIRAMA. Released discharge is one from bottom outlets. Overflow discharge is one from overflow portion of the weir crest. Daily river flow is calculated to sum those 3 measured discharges as shown in Figure 27 and Figure 28. Mean daily river flow for 18 years from 1990 to 2007 is 7.27 m^3/sec. The summary of various discharges is given in Table 25 and Figure 29. The Flow duration curve is shown in Figure 30. There is considerable difference in duration curve of each year and in the dry season, river discharge decreases appreciably. A mean discharge is corresponding to 30% flow.

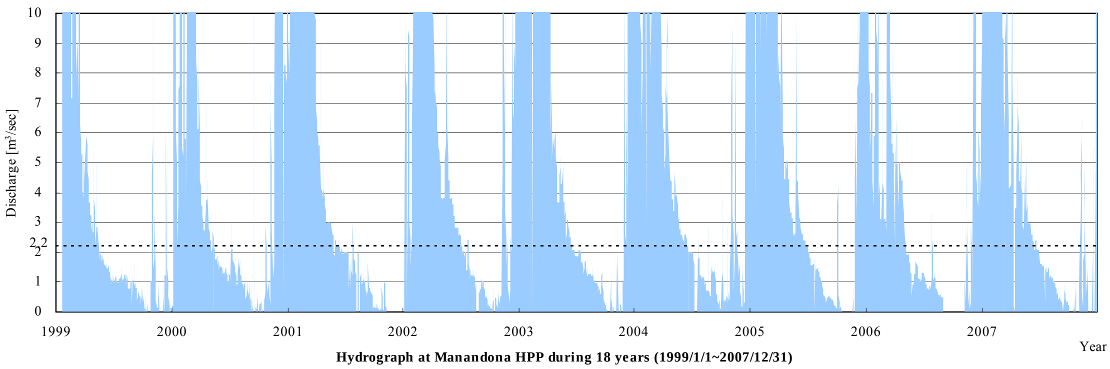
Table 25 Main River Discharge related to Hydropower Study

Item		unit	Mean	Min	Max
Mean discharge		m^3/sec	7.27	3.78	9.93
95-day discharge	26% flow	m^3/sec	8.14	3.66	12.59
185-day discharge	50% flow	m^3/sec	2.32	1.22	3.20
275-day discharge	75% flow	m^3/sec	0.75	0.00	1.31
355-day discharge	97% flow	m^3/sec	0.02	0.00	0.02

Note : calculated by mean daily river discharge from 1990 to 2007



Max. Power Discharge $2.2m^3$/sec



Max. Power Discharge $2.2m^3$/sec

Figure 27 River Discharge (18 years, 1990 ~ 2007)

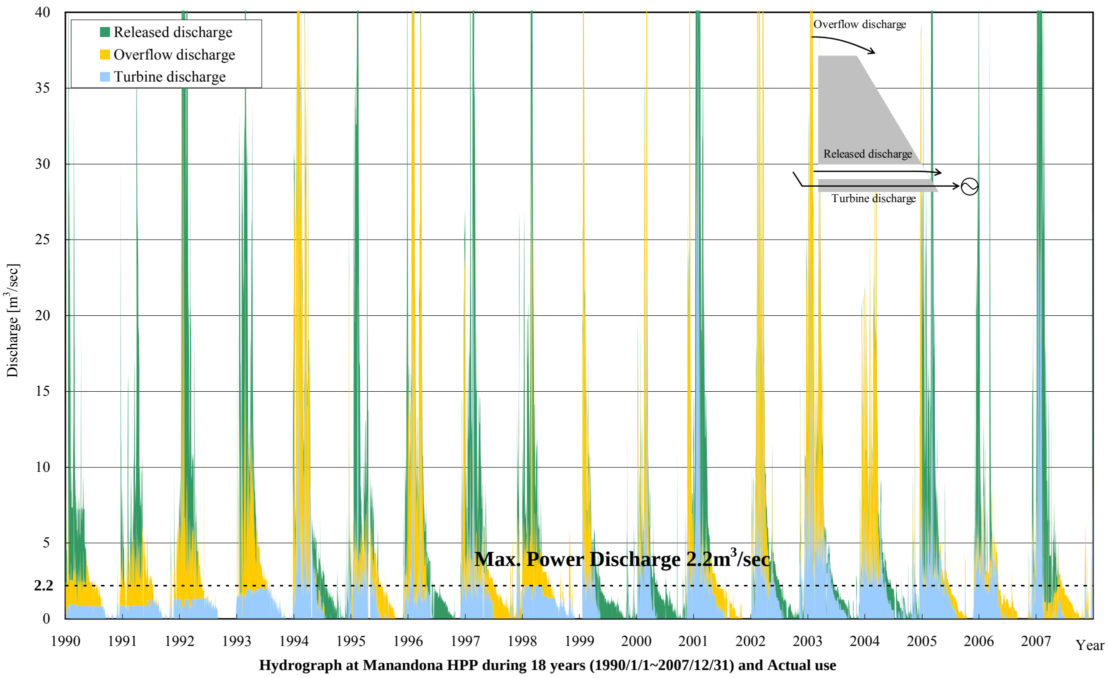


Figure 28 Power Discharge, Outflow discharge and Released Discharge (18 years, 1990~2007)

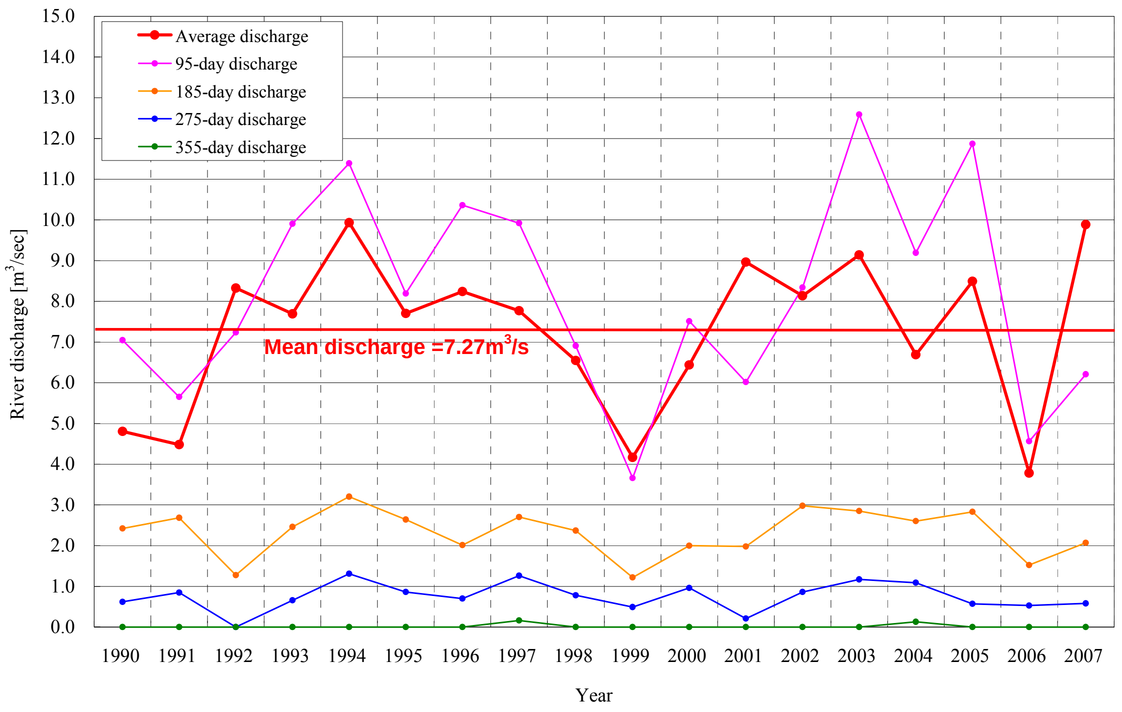


Figure 29 Time –history Various River Discharge (18 years, 1990 ~ 2007)

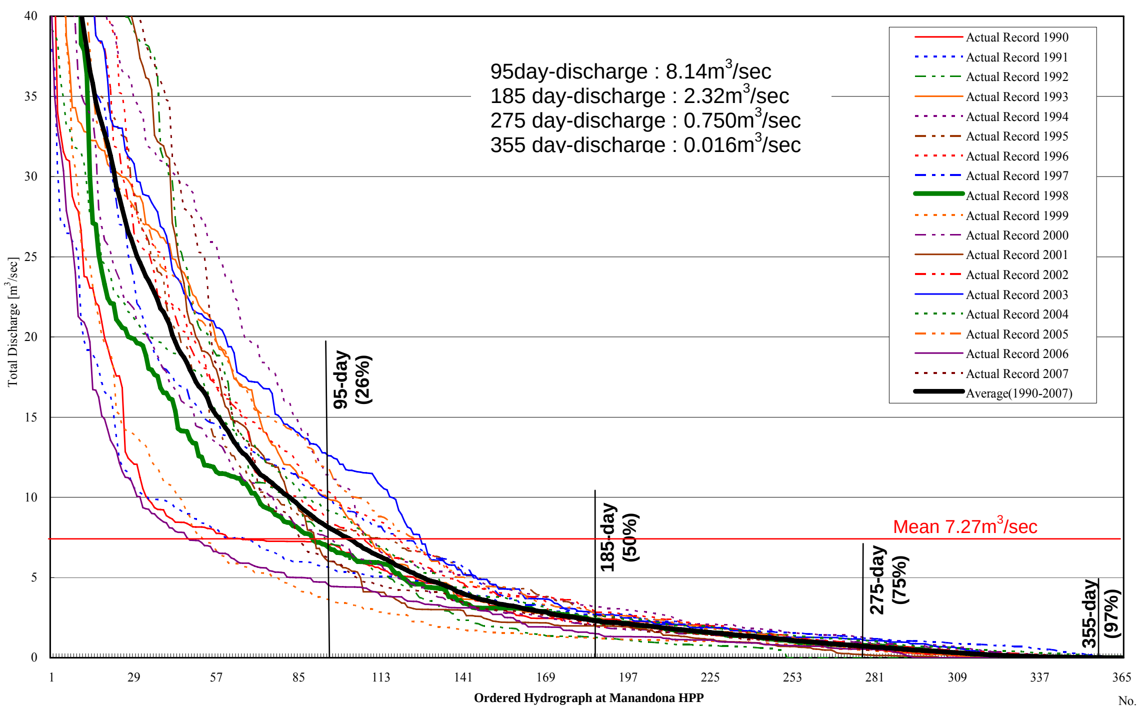


Figure 30 Flow Duration Curve (18 years, 1990 ~ 2007)

4.3.2 Optimization of Manandona HEPP

The generation energy is calculated by using dairy river discharge for 18 years from 1990 to 2007. The following formula is applied for both of existing P/S and expansion P/S

$$P_i = 9.8 \times Q_i \times H_e \times \eta$$

$$E = \frac{\sum_{i=1}^{365} P_i \times H_e \times 24 \times 60 \times 60}{1{,}000} = \frac{9.8 \times \sum_{i=1}^{365} Q_i \times H_e \times \eta \times 24 \times 60 \times 60}{1{,}000}$$

Where:

P_i: Output on i-day (kW)

E: Annual Generation Energy (MWh/year)

He: Effective Head (m) (=104.50m)

Q_i: Power discharge on i-day (m^3/sec)

η: Turbine - generator composition efficiency

(assumed, Existing P/S: 0.71, Expansion P/S: 0.8)

The Flow Utilization Factor (UT) is calculated as follows;

$$P_{rated} = 9.8 \times Q_{max} \times H_e \times \eta$$

$$E_f = \frac{P_{rated} \times 365 \times 86{,}700}{1{,}000} = \frac{9.8 \times Q_{max} \times H_e \times \eta \times 365 \times 24 \times 60 \times 60}{1{,}000}$$

$$UT = E \;\; / E_f$$

Where:

P_{rated}: Rated Output (kW) (Existing P/S: 1,600kW)

Q_{max}: Maximum power discharge on i-day (m^3/sec) (Existing P/S: 2.2m^3/sec)

E_f: Annual Generation energy in case full-time operation with rated output (MWh/year)

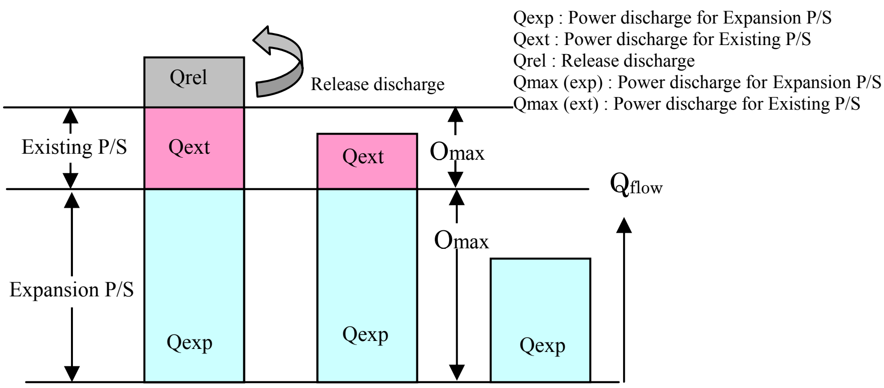


Figure 31 Discharge distribution for Expansion P/S and Existing P/S

Power discharge for Expansion P/S is allocated at first, then remaining discharge is utilized for Existing P/S. Typical discharge distribution for Expansion P/S and Existing P/S is shown in Figure 31. In this simulation, due to poundage daily regulating function, generation is assumed to be possible for any amount small of daily river flow.

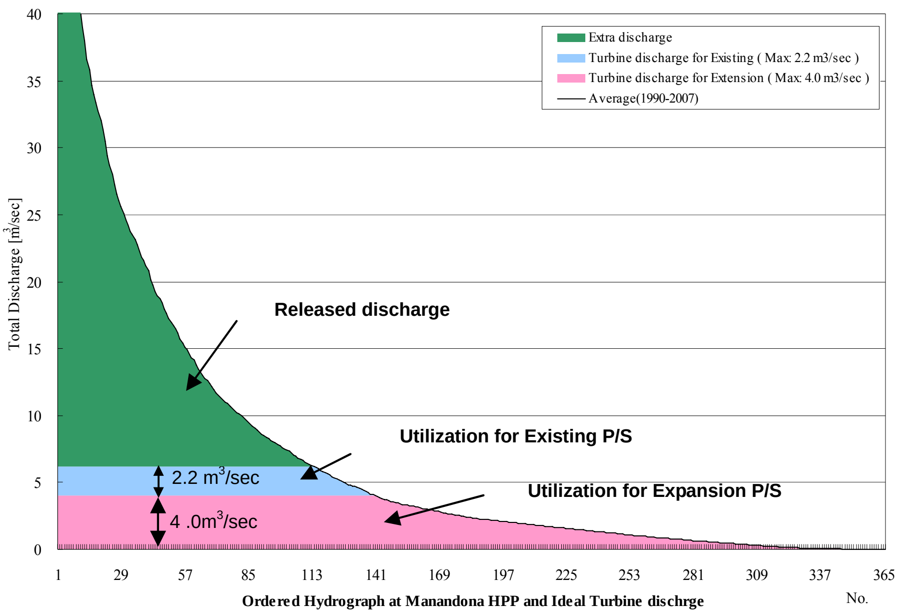


Figure 32 Flow Distribution on Flow Duration Curve

For run-off-river type hydropower, in general the optimum flow utilization factor is obtained at the scale of 45% to 60% in case of grid connection. The power discharge of the expansion plant, which fulfill the above condition is 4 to 8 m^3/sec based on Figure 33. In addition, as shown in Figure 34 the inflexion point of annual generation energy curve of the expansion plant is found to be approximately 6 m^3/sec of power discharge. Therefore, for this preliminary study stage, 6m^3/sec is selected for the maximum power discharge, which is corresponding to 116-day flow, i.e. 32% flow. As a simulation result by using annual flow duration curve obtained by daily river flow for 18 years, annual generation energy is about 21,500 MWh/year, flow utilization factor is about 50% and max power output is 4,900 kW.

(In case that the existing power plant operates by using 2.2 m^3/sec, the maximum power discharge of the expansion power plant becomes 4.0 m^3/sec, then total power discharge is 6.2 m^3/sec.)

The expansion power plant will generate about 2.2 times larger annual energy than one of the existing plant with 3 times bigger power output than the existing one. The generation energy of the existing power plant is calculated to be 9,679 MWh/year and the flow utilization factor is about 71% based on a simulation result.

The generation energy and flow utilization factor of both power plants for various maximum power discharges of expansion P/S are summarized in Figure 36 shows water utilization of both the existing and expansion power plants for various maximum power discharge projected in hydrograph in 1998. No generation energy is increasing during the dry season from June to November even though power discharge of the expansion plant increases. Calculated annual and mean monthly generation energy of both existing P/S and expansion P/S in case of 6.0 m^3/sec of maximum power discharge is shown in Figure 37. From this figure, the existing power plant might stop during the dry season from July to October based on the simulation result.

No.	Max Power discharge for Expansion [m^3/sec]	Annual Generation Energy			Flow Utilization Factor		
		Existing* [MWh/year]	Expansion [MWh/year]	Total [MWh/year]	Existing* [%]	Expansion [%]	Total [%]
1	1.00	7,584	5,739	13,323	54.9%	80.9%	63.0%
2	2.00	6,187	10,166	16,353	44.6%	71.8%	57.5%
3	3.00	5,304	13,665	18,969	38.5%	64.3%	53.4%
4	4.00	4,689	16,595	21,284	34.6%	58.5%	50.0%
5	5.00	4,196	19,164	23,360	31.4%	54.1%	47.2%
6	6.00	3,784	21,452	25,236	28.6%	50.6%	44.7%
7	7.00	3,444	23,502	26,946	26.1%	47.7%	42.6%
8	8.00	3,154	25,365	28,519	23.9%	45.2%	40.6%
9	9.00	2,907	27,060	29,967	22.1%	43.0%	38.9%
10	10.00	2,686	28,622	31,308	20.3%	41.0%	37.3%
	0.00	9,679				71.0%	

Note : *: Rated output of 1,600kW is applied to values for existing P/S.

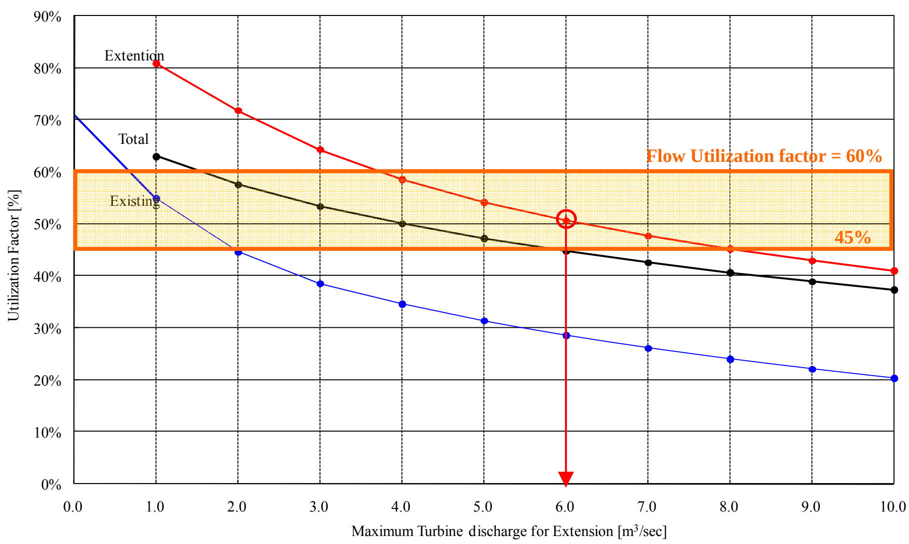


Figure 33 Power Discharge for Expansion P/S vs Flow Utilization Factor

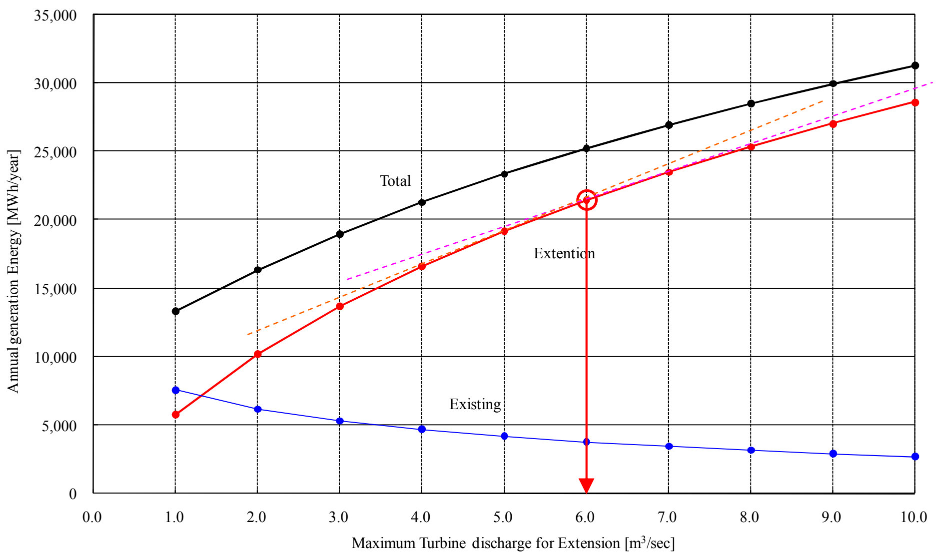


Figure 34 Power Discharge for Expansion P/S vs. Annual Generation Energy

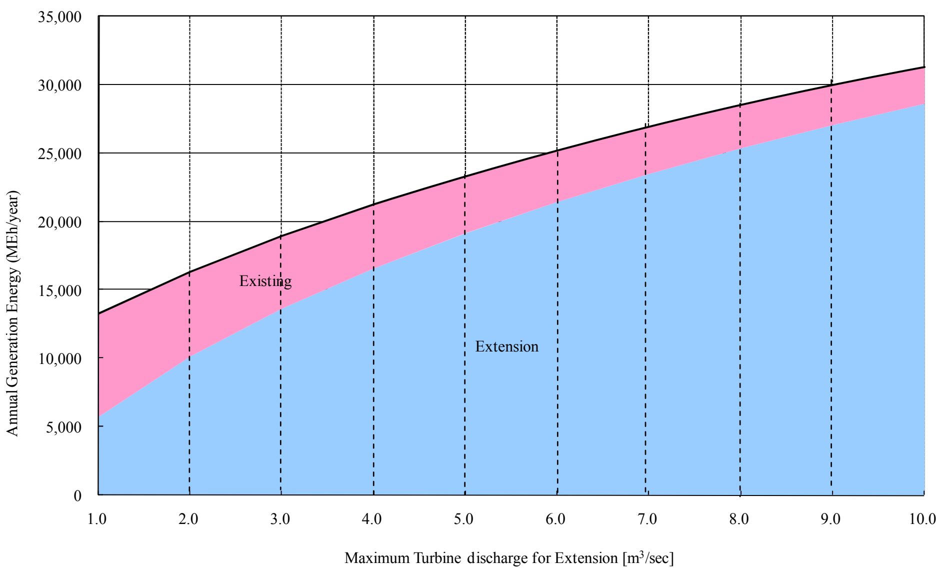


Figure 35 Power Discharge for Expansion P/S vs. Annual Total Generation Energy

No.	Max Power discharge for Expansion [m^3/sec]	Annual Generation Energy			Flow Utilization Factor		
		Existing* [MWh/year]	Expansion [MWh/year]	Total [MWh/year]	Existing* [%]	Expansion [%]	Total [%]
1	1.00	7,584	5,739	13,323	54.9%	80.9%	63.0%
2	2.00	6,187	10,166	16,353	44.6%	71.8%	57.5%
3	3.00	5,304	13,665	18,969	38.5%	64.3%	53.4%
4	4.00	4,689	16,595	21,284	34.6%	58.5%	50.0%

5	5.00	4,196	19,164	23,360	31.4%	54.1%	47.2%
6	6.00	3,784	21,452	25,236	28.6%	50.6%	44.7%
7	7.00	3,444	23,502	26,946	26.1%	47.7%	42.6%
8	8.00	3,154	25,365	28,519	23.9%	45.2%	40.6%
9	9.00	2,907	27,060	29,967	22.1%	43.0%	38.9%
10	10.00	2,686	28,622	31,308	20.3%	41.0%	37.3%
	0.00	9,679				71.0%	

Note : *: Rated output of 1,600kW is applied to values for existing P/S.

Table 26 Generation Energy and Utilization Factor for Power Discharge

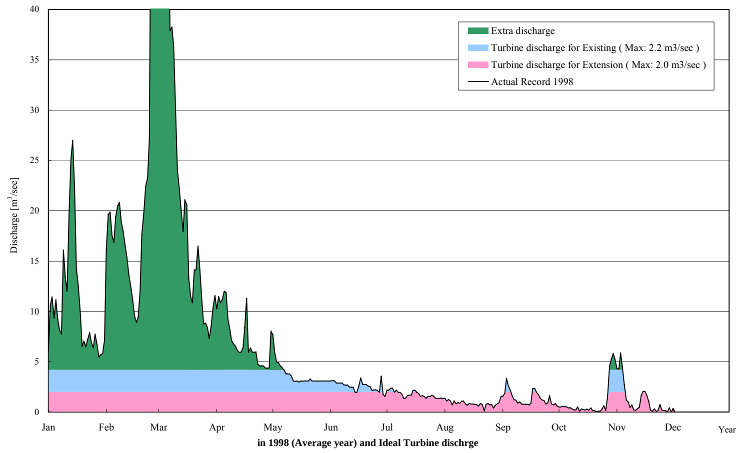
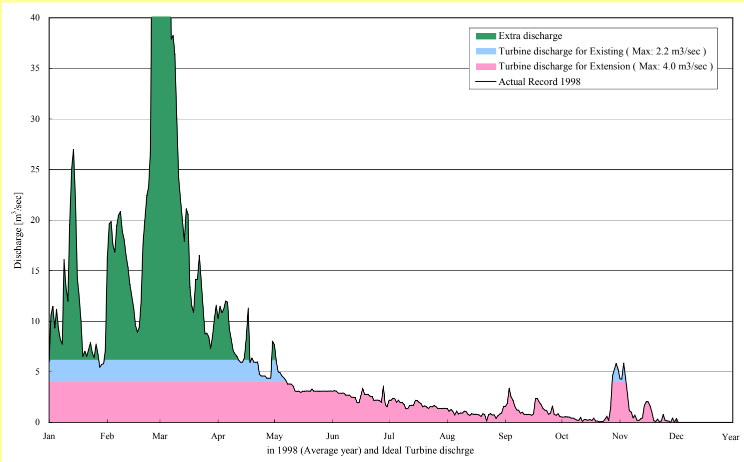
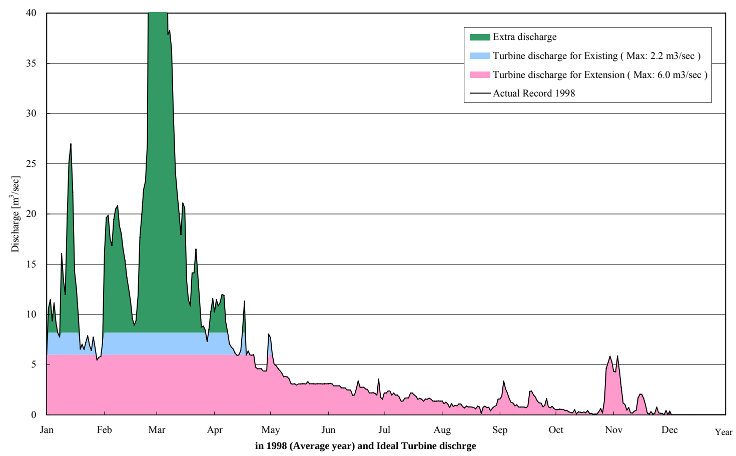
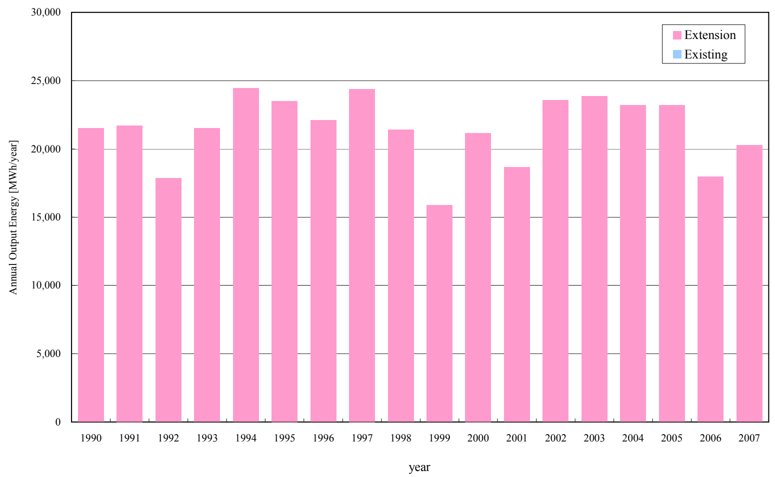
Expansion P/S	Existing P/S	Water Utilization Pattern
$2.0m^3/s$ Total	$2.2m^3/s$ $4.2m^3/s$	
$4.0m^3/s$ Total	$2.2m^3/s$ $6.2m^3/s$	
$6.0m^3/s$ Total	$2.2m^3/s$ $8.2m^3/s$	

Figure 36 Hydrographs which show Water Utilization for Various Power Discharge of Expansion P/S in 1998

<table>
<tr><th>Expansion P/S</th><th>Existing P/S</th><th>Calculated Annual Generation Energy (1990 ~ 2007)</th><th>Calculated Mean Monthly Generation Energy (1990 ~ 2007)</th></tr>
<tr><td>6 0m^3/s</td><td>-</td><td>


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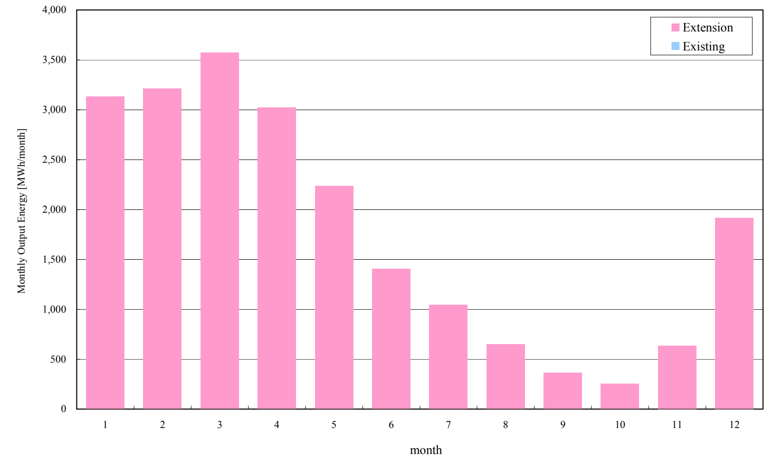

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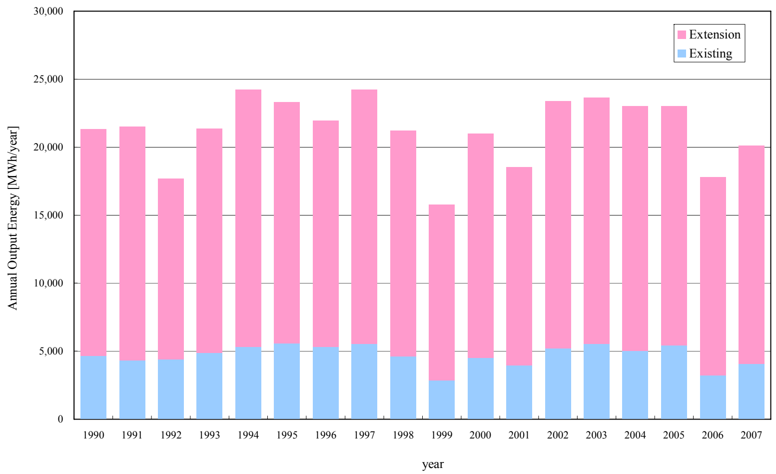
<tr><td>4.0m^3/s

Total</td><td>2.2m^3/s

6.2m^3/s</td><td>


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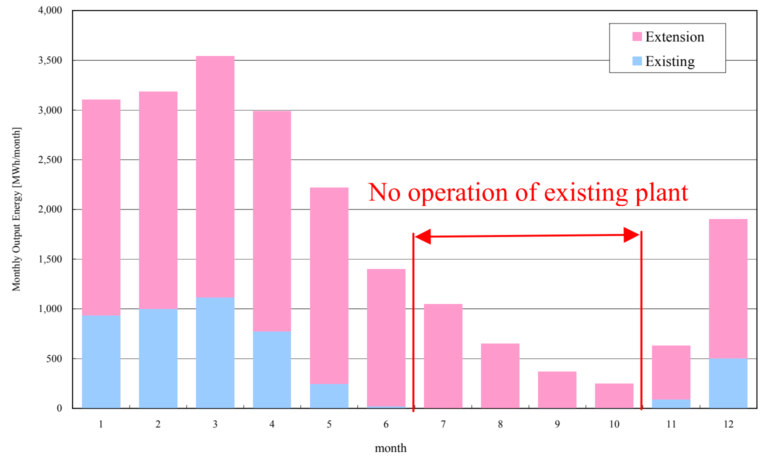

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Figure 37 Calculated Annual Generation Energy and Mean Monthly Generation Energy of Existing P/S & Expansion P/S

4.3.3 Preliminary Study on Expansion of Manandona HEPP

(1) Previous Study

Previous (Original) plan is to heighten about 2m of the existing weir by using a rubber dam in order to increase poundage capacity to produce more peak energy. However, during the dry season river flow becomes very small, and it was judged that heightening of the existing weir is limited as a result of site reconnaissance, so additional poundage volume is not so large amount. This previous plan was cancelled by the following findings based on results of site reconnaissance.

- Since reinforcement and repair works were carried out by using steel sheet piles and gabions near both abutments of the weir, higher water level might cause slopes unstable.
- Approximate 1m heightening of the existing weir is critical in order to avoid inundation of access bridge, control house, gate control board etc. In this condition, it is not expected to increase sufficient poundage volume.
- Installation of a rubber dam requires various works including removal of access bridge, piers, enlargement of overflow portion, widening of weir crest and so on. Those works are not easy.
- In 1960, 2m heightening of the weir was carried out, therefore detailed investigation and study of the foundation, existing structures etc. is required to heighten the weir further.

(2) Preliminary Study on Alternative Expansion Plans

Manandona HEPP has been operating for more than 70 years since 1934 and is listed on Power Development Plan for further years. However, based on site reconnaissance aging power facilities, Electro-mechanical equipment etc. are severely deteriorated and it is judged that if additional appropriate maintenance and rehabilitation would not be done, the power plant might stop operation in near future. Taking into above-mentioned present condition of the power plant, the following three 3 alternative plans are conducted below.

<u>(i) Alternative Plan 1</u>

The existing P/S is to be left as it is and the new expansion P/S is to be constructed. No rehabilitation for the existing P/S is to be conducted. Operation of the expansion P/S is to be prioritized. General layout of the expansion P/S plan is shown in Figure 38. The new intake is to be constructed in the left bank of the upstream of the existing weir. The waterway consists of tunnel portion, buried pipe portion (river crossing) and open pipe portion. The tunnel runs from the intake to the downstream of the weir in the left bank, then buried pipes cross the river, and again the tunnel runs to the left side of the existing penstock route. The open pipes run in parallel to the existing penstock route. The new powerhouse is to be constructed on the left side of the existing one. The new tailrace is to be connected to the existing one.

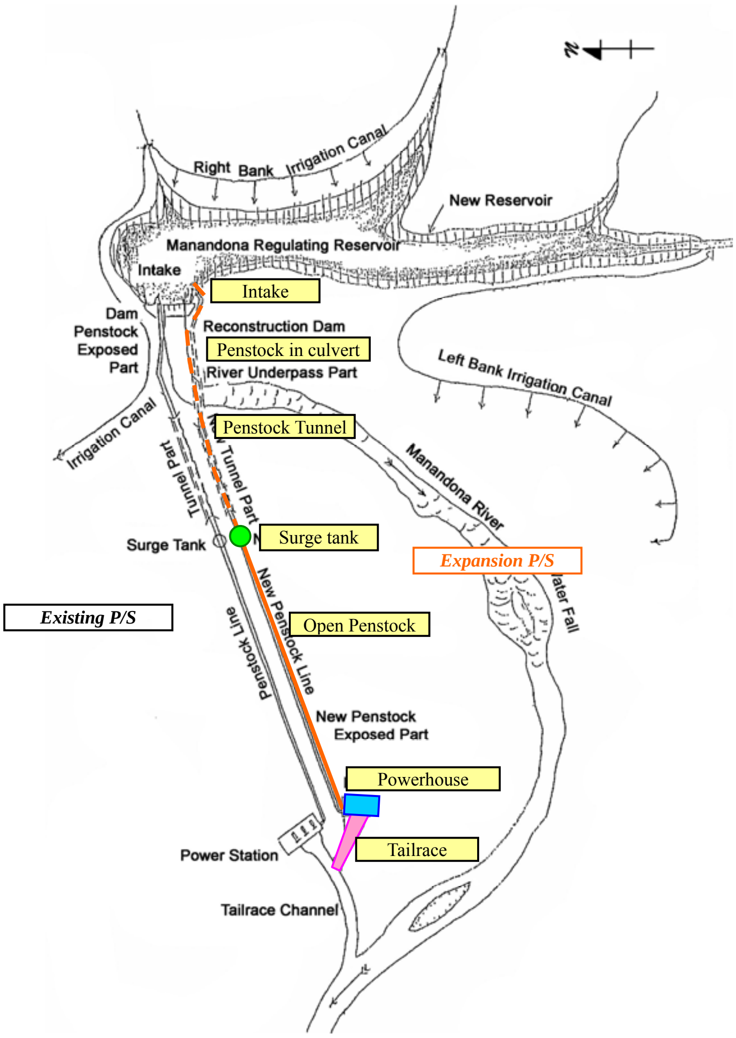

Figure 38 New Expansion P/S Plan of Alternatives 2 and 3

<u>(ii) Alternative Plan-2</u>

Existing P/S is to be rehabilitated and the original output is to be recovered and in addition,. the expansion P/S is to be constructed. The optimum scale is to be studied under condition of combined operation of both existing and expansion power plants. Therefore, the scale of the expansion P/S is the smallest among 3 alternatives. The layout of expansion P/S plan is as same as that of Alternative Plan-1.

(iii) Alternative Plan-3

All penstock pipes of the existing P/S is to be removed and new pipes is to be constructed along the existing waterway route. Therefore, volume of civil works is the smallest among 3 alternatives. Civil works are not so difficult and construction period could be shortened. The new powerhouse is to be constructed on the left side of existing one and the new tailrace is to be connected to the existing one.

The comparison of 3 alternatives is summarized in Table 27 as a result of comprehensive evaluation taking construction cost, construction period, easiness of construction and so on, Alternative Plan-3 is recommended in this preliminary study.

As-built drawing and design documents of Manandona HEPP were not found in JIRAMA office, the layout plan of the waterway and cross section and plan of the weir is reproduced based on collected sketches and drawings and shown in Table 28 and Table 29 respectively.

Table 27 Summary of Alternatives for Expansion Plan of Manandona HEPP

Alt	Existing P/S	Expansion P/S	Merit	Demerit
(i)	Existing condition	New construction (New waterway separately with the existing one)	Existing power plant can be operative even during construction period of the new one.	Construction cost becomes more expensive. Construction period will be longer compared to Alt. 3 which utilizes the existing penstock route.
(ii)	Implementation of Rehabilitation	New construction (New waterway separately with the existing one)	Scale of new plant is the smallest among the 3 alternatives. If the simultaneous construction were not done, there is no outage of power plant but the construction period would be longer.	Total construction cost of Rehabilitation of existing P/S and expansion P/S works becomes most expensive among 3 alternatives. Detailed survey and study on replacement, reinforcement of penstock, E/M equipment for rehabilitation is necessary.
(iii)	Disposal	New construction (New waterway after disposal of existing penstock)	As the existing penstock route is utilized, the civil work cost is the cheapest among 3 alternatives, and construction is also easier, construction period is shorter.	During the time of construction of new plant, the existing plant is stopped.

Table 28 Required Works for Each Alternative of Expansion Plan of Manandona HEPP

Alt	Existing P/S						Expansion P/S					
	Civil Works				E/M works	T/L works	Civil Works				E/M works	T/L works
	Weir	Intake	Water way	P/H Tailrace			Weir	Intake	Water way	P/H Tailrace		
(i)	×	×	×	×	×	×	×	○	○	○	○	Δ
(ii)	×	○	○	×	○	×	×	○	○	○	○	Δ
(iii)	×	×	×	×	×	×	×	Δ	Δ	○	○	Δ

Notes : ○ : Major construction works are needed, Δ : Minor construction works are needed

× : No construction works are needed

Table 29 Comparison of Each Alternative of Expansion Plan of Manandona HEPP

Alt.	Construction Cost	Construction Schedule	Constrains of construction	Power Cut period	O&M	Overall Evaluation
(i)	Δ	Δ	Δ	○	×	2
(ii)	×	×	Δ	○	○	3
(iii)	○	○	○	×	○	1

Notes : ○ : Advantage, Δ : Neither Advantage nor Disadvantage, × : Disadvantage

(3) Preliminary Study of Selected Expansion Plan of Manandona HEPP

Weir works need to replace gates of bottom outlets in both sides and widen the inlet structure. After removal of all existing penstock pipes, Fiberglass Reinforced Plastic Mortar (FRPM) Pipes are to be installed along the same route after necessary foundation works for FRPM pipes. Necessity of a surge tank is to be studied in further stage. New power house is to be constructed on the left side of the existing powerhouse and the new tailrace will connect to the exiting one. General parameters of selected Expansion Plan of Manandona HEPP, i.e. Alternative plan-3, are given in Table 30.

Table 30 General Parameters of Selected Expansion Plan of Manandona HEPP

Parameters	unit	Values	Remarks
Max. Power Output	kW	4,900	
Annual Generation Energy	MWh	21,500	Flow Utilization Factor = 50%
Max. Power Discharge	m^3/s	6.00	116-day flow = 32% flow
Effective Head	m	104.50	
Draw down	m	2.00	
Effective Poundage Volume	m^3	50,000	During planning stage, assumed
Weir Height	m	10.5	Existing weir
Weir Crest Length		66	Existing weir
Length/Line Num. of Pressure Pipe	m	495 / 1line	Tunnel portion 140m
Inner Diameter of Pressure Pipe	m	1.50	Fiberglass Reinforced Plastic Mortar (FRPM) Pipe
Powerhouse Type		Reinforced concrete, Surface	
Inlet Valve Type/Inner Diameter		Butterfly / 900mm	
Turbine Type/Max. Power/ Unit		Horizontal Fransis, 2,700kW X 2 units	
Generator Type/Capacity/Unit		3phase synchronous, 3,000kW X 2units	
T/L Capacity / Distance		20 kV / 10.7km	

(4) Ideas concerning Reduction of Construction cost and shortening of construction schedule

Instead of steel pressure pipes, Fiberglass Reinforced Plastic Mortar (FRPM) pipes are recommended to be used because of the following advantages;

- FRPM pipes are lighter than steel pipes, therefore transportation is easier and installation works are easier and simple.
- No particular installation methods such as welding are required for installation, so workability is quite good.
- Maintenance is also easy and simple because it is not necessary to paint pipes periodically. No deterioration such as rust of steel pipes occurs.
- Reduction of construction cost and shortening of construction period is expected due to the above-mentioned advantages

Photo-39 FRPM Pipe (Open portion)

Photo-40 FRPM Pipe (Embedded Portion)

(5) Socio-Environmental Impacts on Expansion Plan of Manandona HEPP

Since construction works of the Expansion Plan is related to the existing facilities and a new weir / dam construction and enlargement of the poundage area are not to be executed, also the heightening of the existing weir is not to be conducted, Socio-Environmental Impacts are foreseen to be minor.

Impacts against the selected expansion plan are as follows,

1) During Construction Stage including Preparatory Work Stage

- Environmental pollution due to heavy construction equipment and transportation vehicles (exhaust gas, dust, noise, traffic accident etc.).
- Nature destruction such as cutting tree,
- Environmental impacts due to development of spoil area, quarry sites, borrow pits etc
- Environmental impacts due to waste disposals from labor accommodations, temporary facilities etc.

- Environmental impacts due to removed materials (concrete, steel pipes etc.), equipment etc.

2) Post Construction Stage

No resettlement of the residents occurs, no inundation of cultivated lands and residential houses and no expropriation of land exist.

- Recession section of the river is less than 1km and no water utilization exists in this recession area.
- Little affection to the downstream residents exists because river water level rise due to increasing of power discharge are small.

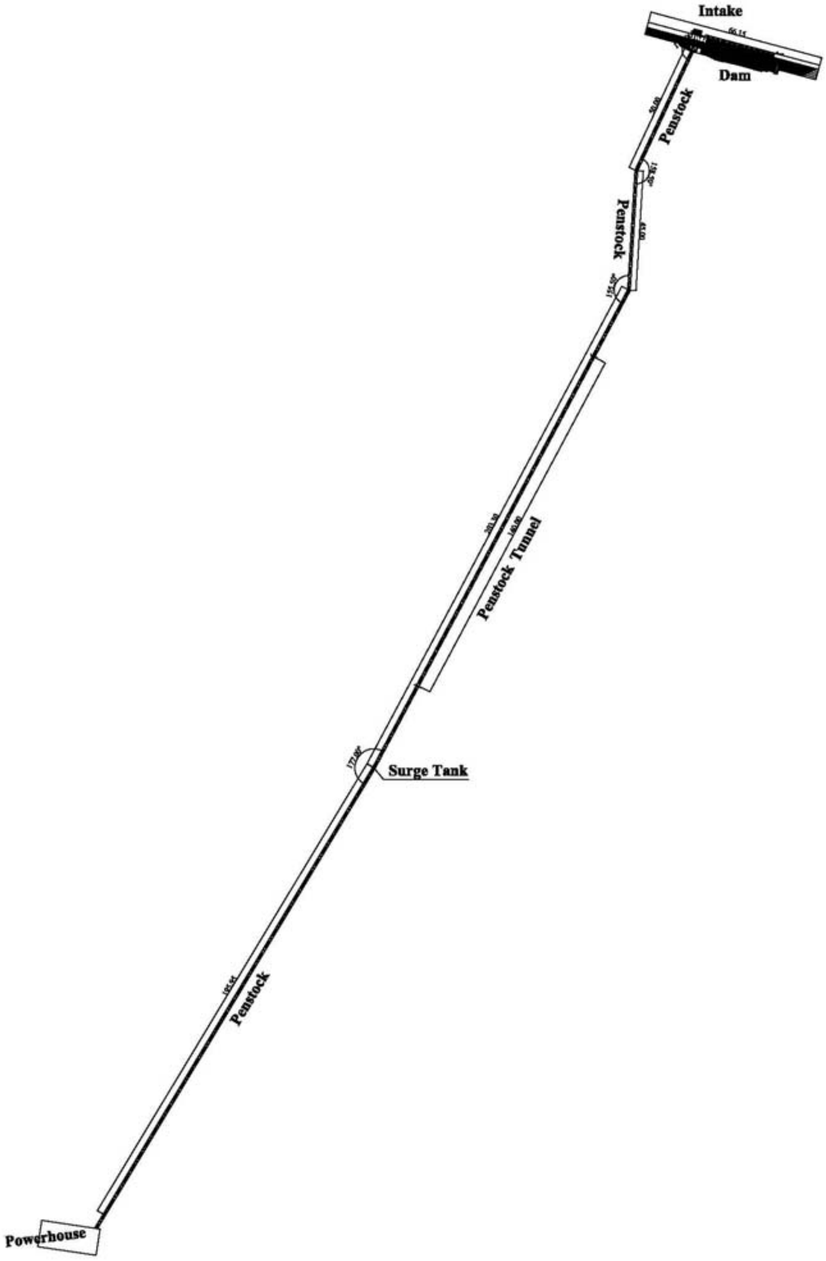

Figure 39 Layout Plan of Waterway (Existing)

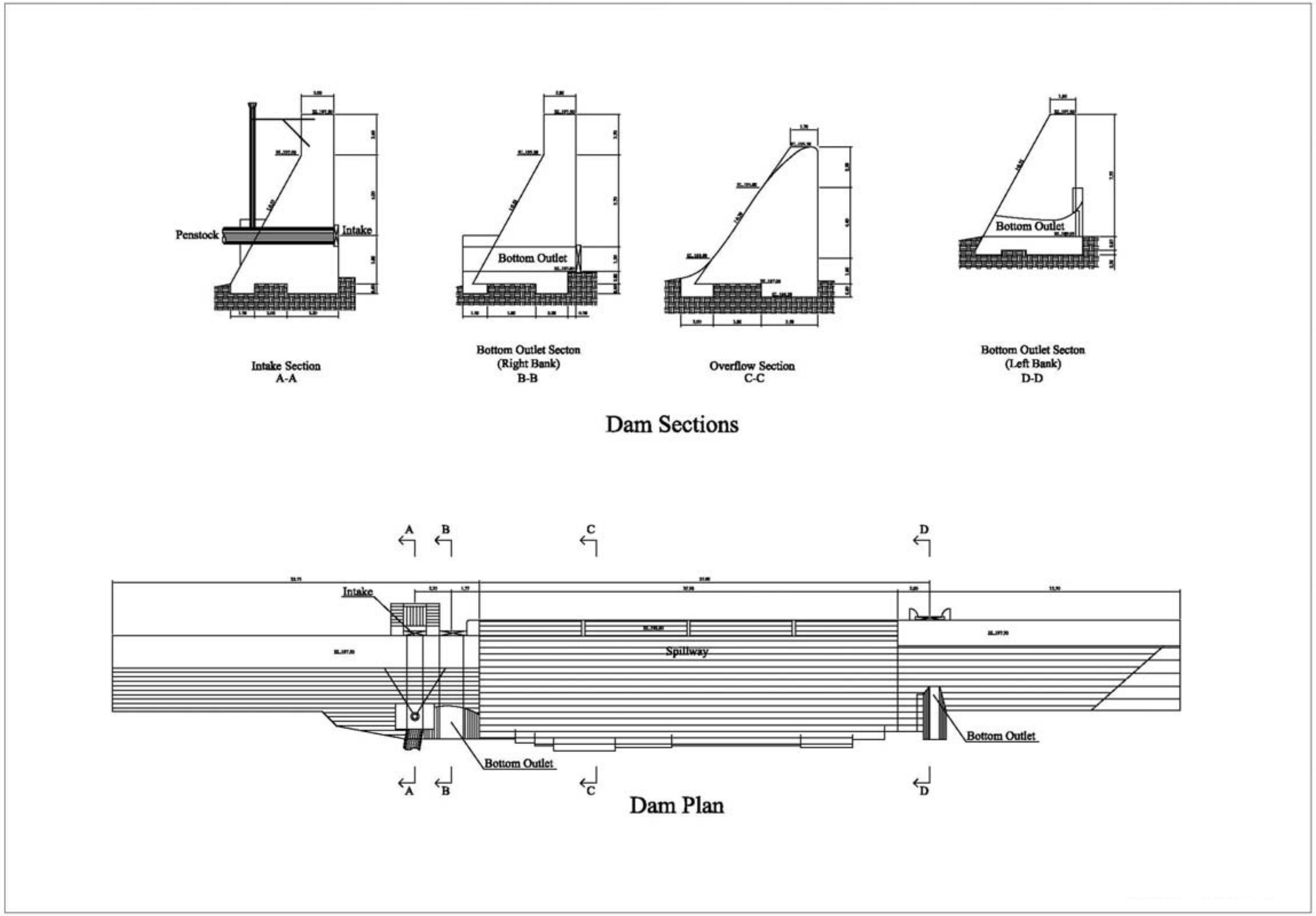

Figure 40 Cross Sections and Plan of the Weir (Existing)

Chapter 5　Capacity Development and Project Organization

5.1　Current Problems

After 1999, the private entry into the electric utility became possible. However, the investment into the power sector has not been processing. The vulnerability of the management bases caused by unsound financial condition and the drop of confidence of JIRAMA are assumed as one of the major causes of above-mentioned issue.

To improve this situation, the privatization and management restructuring of JIRAMA were implemented from 1997 to 2001 with the financial assistance from the World Bank. However, the privatization plan of JIRAMA was mothballed in 2002 by the decision of the new administration then. After that, the management contract was made for two years between German consultant and Madagascar government from April, 2005 by using the fund from the World Bank, aiming at the management improvement of JIRAMA. And the two experts of the Consultant involved in the management improvement from April, 2005 have been employed by the Madagascar government as Director General concurrently with Director General of Water and as Director General of Administration for two years from April, 2007. At present the improvement of JIRAMA's management capacity is in progress through the management contract. The problems extracted in the management of JIRAMA are shown in Table 31.

Table 31 Particular problems of JIRAMA

Items	Particular problems
Power generation	- Decrease in power generation because of lack of maintenance; - Increasingly significant share of the thermal production in the whole of the electricity production; - Increased and expensive recourse to external services, suppliers of energy and renting of groups to Diesel.
Financial	- Insufficient current returns to cover the loads; - Fragile financial situation.
Commercial and management	- Absence of a reliable and effective information system (piloting to view) and of clear procedures; - Gap in customer management and weak performance on collection of rates; - Very heavy and ineffective organizational structure.
External causes	- Vulnerability to the evolution of the exchange rate due to an asymmetry; - Increasing of fuel price: more than 300% on the period 2005-2007.
Internal causes	- Insufficient of investments: Net receding of generated production in hydropower compared to that in thermal power since 1997; - Insufficiency of piloting control by panel; - Gap in management and absence of planning in the definition of the investment programs of short term, middle term and long term.

Source: Lettre de Politique Sectorielle Eau et Electricité à Madagascar, Ministère de l'Energie et des Mines

Unpaid amount of the charge at the end of September, 2008 is shown in Table 32. The unpaid amount in Administrations is large as well as amount in Households.

Table 32 Situation of unpaid

Currency unit: MGA

Big customers	38,021,517,299.54
Administrations	42,042,138,660.30
Households	52,289,120,244.61
Middle size factories	12,836,152,346.13
Total	**145,188,928,550.58**

At the end of September, 2008 Source of origin: JIRAMA

5.2 Organization for Power Projects and their Capacity

(1) Organisation and Functions

As mentioned in Chapter 3.2, there are four organizations for power sector in Madagascar; Ministry of Energy and Mines (MEM), Electricity Sector Regulator (ORE), Agency for Rural Electrification (ADER), and Jiro sy Rano Malagasy (JIRAMA). MEM is responsible for establishing the electricity development strategy which includes aid requests to foreign donors. JIRAMA takes charge of technical part in power sector development, operation and maintenance of power plants, transmission lines and distribution lines

(2) Assistance to Power Sector

The management contract between a German consultant, Lahmeyer International, and Madagascar government was concluded for two years from April, 2005 with the fund of the World Bank. And after April, 2007, two consultants involved in the management improvement have been employed by the Madagascar government for two years from April, 2007.

After March, 2009, a new management contract of about five years is scheduled to be concluded as mid/long-term reform assistance.
Besides, a technological adviser and transaction advisor are employed in parallel by the fund of World Bank.

Though the privatization (shifting to joint-stock company) of JIRAMA combining with management rebuilding through the World Bank project had been tried from 1997 to 2001, it was not achieved, and JIRAMA has been decided not to be privatized by the new government that started in 2002.

The World Bank funded project "Power/Water Sector Recovery and Restructuring Project" includes the following components as follows.

1) Rehabilitation of power facilities
2) Reduction of transmission and distribution loss
3) Management improvement of JIRAMA, and modernization of information systems
4) Capacity development of MEM, Preparation for future electricity development projects, etc.

The period of the Project is from September, 2006 to April, 2009. Though it seems the JIRAMA's management had been improving (one of components of 3)), there were no data or information available about other components.

Present condition which could be found at field study about these components above mentioned is shown as follows with respect to the capacity development.

1) Rehabilitation of power facilities

- Through the interview at Manandona Hydroelectric Power Plant, the maintenance is conducted just only as follow-up measures. However, workmanship of operators at the power plant was not so low.
- Daily record of power discharges and the generation energy are reported to Director of Antananarivo Grid every day. Thus, it seems that basic reporting structure is established.
- Drawings and design documents of existing facilities and equipment, which are necessary for rehabilitation, maintenance or repairs, are not properly stored.
- Though the numbers of hydropower plants are not so much at present, the numbers will increase according to the future government policies. Therefore, the succession of skills at the existing hydropower plants will be important.

2) Reduction of transmission and distribution loss

- Though it is said that transmission loss is around 4.5-5.0% in Antananarivo Grid, it is not clear whether it includes distribution loss or not. If this 4.5-5.0% means net loss which is displayed in difference of electric power generation and electric power consumption, the loss volume is almost as the same as the loss in Japan. However, considering from the present condition of collection of electricity tariff, it is hard to say that electric power consumption is recognized accurately. Therefore this 4.5-5.0% seems to indicate only the loss of transmission lines between the electric power plants and the substations.

- It seems that there is no detailed load dispatching coordination between Antananarivo and Antsirabe, because of the problem of communication systems.
- A deficiency of electricity of Antsirabe is supplied from Antananarivo without condition. Then the shortage of electricity is offset by rotational brownout in Antananarivo. (There is no system in Antananarivo Grid which enables to respond in real time for adjustment in Antsirabe.)
- Power generating at Antsirabe thermal power station is completely stopped during night time. Then demand of electricity during night time is completely supplied by transmitted electricity from Antananarivo. It is because of vulnerability of power supply system.
- Therefore, it is necessary to promote system equipment which can distribute electricity effectively and respond in real time according to the electricity demand. Additionally, it is also necessary to promote the capacity development of human resource.

3) Management improvement of JIRAMA, and modernization of information systems

- The administrative improvement project funded by the World Bank has been executed as expressed in Chapter 3. As the result, the management of JIRAMA is improving, and is getting out of the red in 2007 as shown in Table 4 and Table 5 in Chapter 3.3.3.
- It means that, though it is not possible for investment for development by JIRAMA's own resource, it is possible for the development with the loan from foreign donor.
- Judging from the situation of 2006 – 2007 year; i.e., electricity sales increased 7.7% while the power production increased 4.8%, the percentage of collecting electricity charge seems to be improving. However, unpaid amount of the charge at the end of September, 2008 is almost the half of annual electricity sales. Therefore, it is desired to strengthen the collection system of the electricity charge.
- As mentioned in 2) above, the electricity distribution system is vulnerable. Considering Grid integration in the future, it is important to strengthen the capacity and the system for electricity distribution.

4) Preparation for the power development projects in the future

- The master plan prepared by Hydro Quebec Inc. in 2006 is mainly described about thermal power generation. For the sake of improving JIRAMA's financial status, the master plan for hydropower development is requested.
- The hydropower potential master plan prepared by Hydro Quebec has not enough information as this preliminary study was done at the level of desk study. It is the present common recognition among the people related to power sector in Madagascar that there is no sufficient hydropower potential master plan. Besides, there is no master plan for

transmission grid network.

- The Madagascar side wants the execution of the more reliable master plan for hydropower and transmission grid network. And, it is necessary for developing capacity by On the Job Trainings through technical cooperation.

Chapter 6 Environmental Consideration

6.1 Environmental Policy and Strategy

(1) Environmental Policy in Madagascar

The Government of Madagascar announces officially the president's national vision "Madagascar Naturelement" as the highest development mission, and mid and long term development strategy "Madagascar Action Plan(MAP)".

The MAP consists of 8 COMITTMENT -1)Responsible Governance, 2)Connected Infrastructure, 3)Educational Transformation, 4)Rural Development and a Green Revolution, 5)Health, Family, Planning and the Fight Against HIV/AIDS, 6)High Growth Economy, 7)Cherish the Environment, 8)National Solidarity.

As one of the COMITTMENT, there is a "COMITTMENT-7: Cherish the Environment". In this COMITTMENT-7, there are 4 challenges.

CHALLENGE-1: Increase the Protected Areas for the Conservation of Land, Lake, Marine and Coastal Biodiversity

CHALLENGE-2: Reduce the Natural Resource Degradation Process

CHALLENGE-3: Develop the Environmental Reflex at All Levels

CHALLENGE-4: Strengthen the Effectiveness of Forest Management

(2) Strategies for Environmental Consideration

As CHALLENGE-3: **Develop the Environmental Reflex at All Levels** in COMITTMENT-7, there are 5 strategies as below.

[Strategies]

1. Explore ways that the government (national, regional and local) with the help of the private sector can assist in environmental protection and ensure that the highest global standards are met.
2. Strengthen the framework for preventing environmental damage (including pollution) caused by businesses, miners, farmers, fishermen, and tourism.
3. Contribute to the protection of sensitive zones through comprehensive environmental assessment.
4. Internalize the environmental stake into sector, regional, and communal policies.
5. Implement the Education Policy Relative to the Environment [Politique de l'Education Relative à l'Environnement (PERE)].

There are 16 preferential projects and activities, and they are evaluated by 4 indicators as below.

Table 33 Preferential Projects and Activities

PRIORITY PROJECTS AND ACTIVITIES
1. Ensure the implementation of international conventions relative to the Environment which are ratified by Madagascar, such as the Kyoto Accords
2. Develop the Code of the Environment
3. Develop a policy for mining companies and logging companies for biodiversity offsets and other mechanisms and incentives for environmental protection
4. Reduce pollution in industrial zones located in urban, rural, and port areas
5. Develop the value chains in potential business sectors to ensure that biodiversity is linked to the economy, and that economic pursuits are done in accord with environmental commitments.
6. Establish an Eco-tourism policy, charter, code that states the vision, the commitment, the values and the approach for the promotion and implementation of eco tourism throughout the country
7. Establish "wilderness zones" for eco-tourism
8. Promote and create investment standards to maintain quality
9. Develop, coordinate, share and promote important environmental information. This will include conducting information and dialogue sessions on environmental concerns for the diverse stakeholders (pupils, academics, environmental teams, farmers associations, communes, regions, mining companies and other businesses)
10. Promote the compatibility of investment with the environment [compatibilité des investissements avec l'environnement (MECIE)] and the environmental management system [système de management environnemental (SME)] in the sectors of mining, transportation, fishery, agriculture, tourism, industry…
11. Promote strategic environmental assessment [évaluation environnementale stratégique (EES)]
12. Assist communes in developing and controlling PCDs
13. Support the formulation and implementation of Urban Development Plans [plans de développement urbain (PDU)] and Regional Development Plans [Plan Régional de Développement (PRD)] which mainstream the environmental dimension with all aspects of development

Table 34 Indicators for evaluating Projects and Activities

	INDICATORS	2005	2012
1	Rate of processed complaint files	75%	95%
2	Rate of MECIE subject investment:	30%	70%
3	Number of regional plans mainstreaming the environmental prescriptions	9	22
4	Environmental Curriculum in primary, secondary, tertiary schools, and vocational schools: adopted	5%	90%

6.2 Environmental Law and Institution

(1)Environmental Institution

1) ONE: Office National pour l'Environnement

ONE was established in 1995 as an external organizational unit of the Ministry of Environment, Water, Forests and Tourism (MEEFT). The major responsibilities include environmental impact assessment and environmental monitoring. Other responsibilities include dissemination of environmental information, communication and environmental education.

ONE consists of four directions whose roles are; 1) personnel and financial management and planning,. 2) improve service and private partnerships and promote responsible for the quality of communications, 3) EIA(Environmental Impact Assessment) and environmental monitoring, 4) dissemination of environmental information. EIA mainly concerns the Environmental Assessment Unit and Pollution Monitoring Unit of Direction of Environmental Evaluation (DEE).

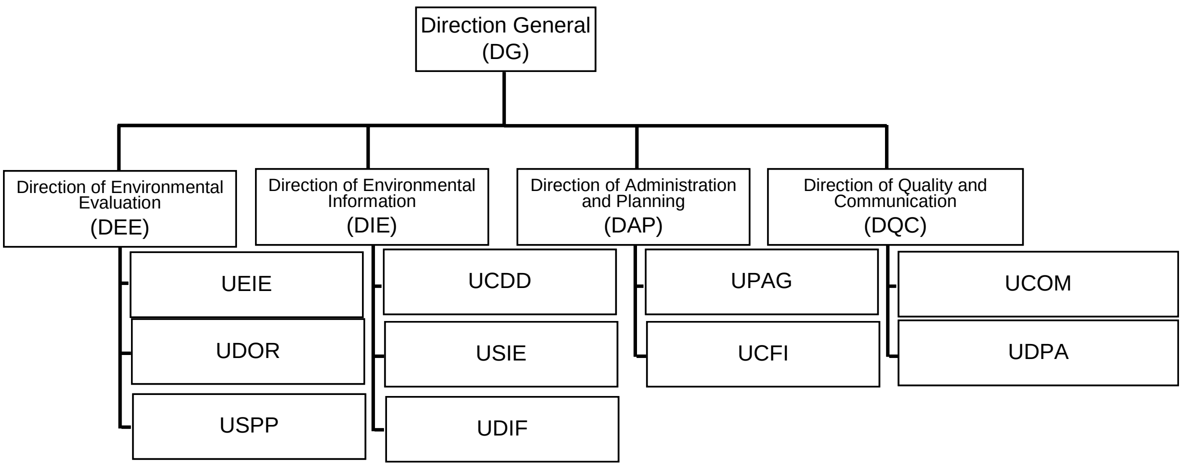

Figure 41 Organizational Structure of National Office for Environment (ONE)

Source: National Office for Environment (ONE)

(Source) Study on the Urgent Necessity of the Expansion Project for Madagascar Ivato International Airport in the Republic of Madagascar / Commissioned by the Ministry of Economy, Trade and Industry ; Japan External Trade Organization (JETRO) , 2008.3

2) MEEFT : Ministère de l'Environnement, des Forêts et du Tourisme

In February, 2003, Ministry of Water and Forests and Ministry of Environment were integrated as the Ministry of Environment, Water and Forests. In October, 2007, the organization was integrated with the Ministry of Tourism to be Ministry of Environment, Water, Forests and Tourism (MEEFT).

Among departments in the ministry, Directorate General of Water and Forests has a major role in EIA implementation. For those projects in the local areas, 22 regional offices have local responsibilities.

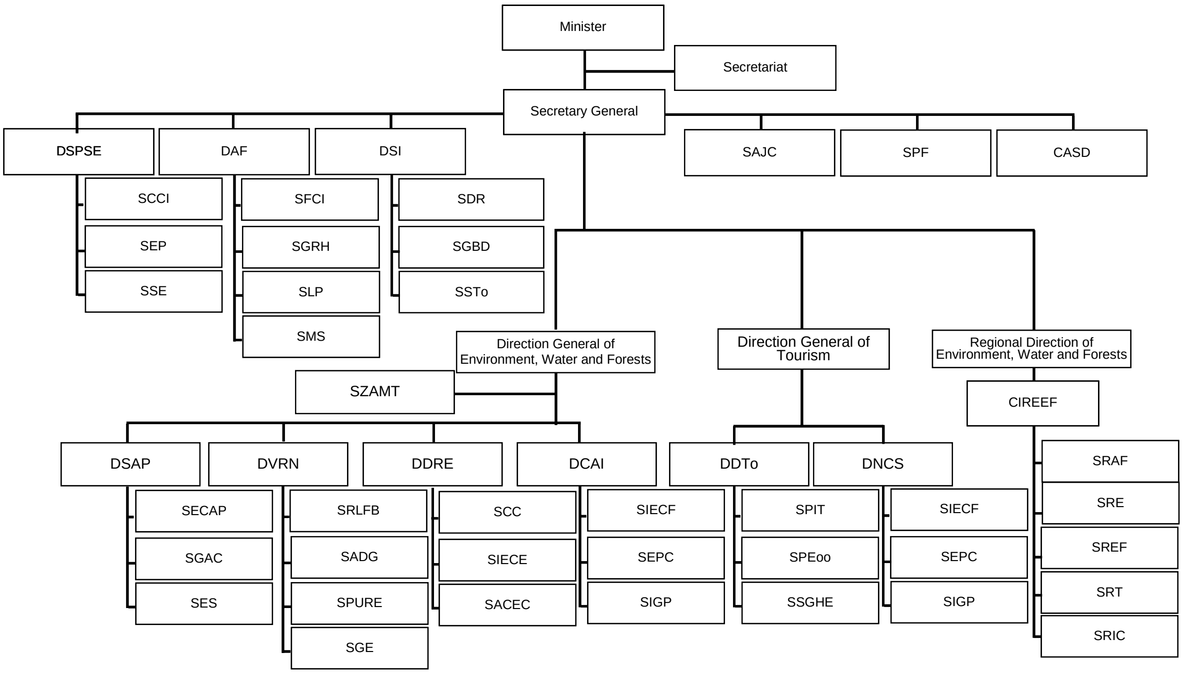

Figure 42 Organizational Structure of Ministry of Environment, Water, Forests and Tourism

(Source) Study on the Urgent Necessity of the Expansion Project for Madagascar Ivato International Airport in the Republic of Madagascar / Commissioned by the Ministry of Economy, Trade and Industry ; Japan External Trade Organization (JETRO) , 2008.3

3) Ministère des Travaux Publics et de la Météorologie(MTPM) Direction of Social and Environmental Impacts（DISE）

DISE was established in 2002. There are nine staff members as of February, 2008. DISE takes charge of making EIA report (work is entrusted to a consultant in part) for the project which requires EIA in the ministry and applying for environmental permit to DEE-ONE. It has authority over reviewing the project which requires IEE.

(2) Related Laws and Regulations

The following are major laws and regulations which may concern the environmental impact assessment.

1) Malagacy Charter of the Environment (Loi N° 90-033 du 21 Décembre 1990 modifiée

par la loi n° 97-012 du 06 juillet 1997 portant Charte de l'Environnement)

2) Relating to the implementation of Investment Compatibility with with the Environment Decree (MECIE : Decret N° 99-954 du 15 décembre 1999 modifié par le décret n° 2004 -167 du 03 février 2004 relatif à la mise en compatibilité des investissements avec l'environnement)
3) Definition and Delimitation of Sensitive Areas (Arrêté N° 4355/97 du 13 mai 1997: Arrêté sur les zones sensibles)
4) Relating to the arbitration of environmental conflict Decree (Décret N°2000-028 du 13-01-00: Médiateurs environnementaux)
5) Relating to the security of Real Estate Decree (Décret N°98 610 du 13-08-98: Sécurisation foncière relative)
6) Fixing the Procedures and the Modalities of Public Participation in Environmental Assessment (Arrêté N° 6830/2001 du 28-06-01 fixant les modalités et les participations du public à l'évaluation environnementale)
7) Water Code (Loi N°98-029 du 20 janvier 1999 portant Code de l'Eau)

6.2.2 REQUIREMENTS BY LAWS AND REGULATIONS

(1) Implementation of EIA Procedures

MECIE defines the procedure of Environment Impact Assessment. MECIE sets up the Project's organization to establish "Etude d'Impact Environnemental" (EIE) or "Programme d'Engagement Environnemental" (PREE) according to the project's type, scale, and site location. Projects requiring EIE are prescribed in the Attached Table 1 of Article.5, and projects requiring PREE are prescribed in the Attached Table 2 of Article 5. The contents related to hydroelectric projects are extracted as follows.

Project obligatorily subjected to EIE	Investment obligatorily subjected to a PREE
• Any storage of any liquid beyond 50,000m^3 • Any hydroelectric installation of over 150 MW • Any power station of over 50MW capacity • Any installation of power lines of a tension higher than or equal to 138 kV • Any hydro electric dam with a catchment area of over 500 ha • Any development of the inland waterways (including dredging) of over 5 km • Any taking of water (surface water or ground water) exceeding 30m^3/h	• Any hydroelectric installation of a power ranging between 50 and 150 MW • Any power station ranging from 25 to 50MW. • Any hydroelectric dam with a catchment area ranging between 200 and 500 ha

In this Project, if heightening of the weir is not selected, EIA is not obligated.
However, in the first option (heightening of the weir) is selected, this project obligatory subjected to EIA. (“Any storage of any liquid beyond 50,000m^3”, “Any hydro electric dam with a catchment area of over 500 ha”)

1) EIA Implementation

The first step as envisaged in the first phase of the EIA is consultation about screening with officials of ONE. ONE requires the proponent preparing a report which describes major items to be investigated on the EIA. The report format is not fixed, and the report is considered as a material to share understanding of the basic status of the project with ONE.

Through the discussions with ONE, requirement and process of EIA are clarified. Subsequently, the proponent talks to the relevant ministries, local governments and others to draft a scoping table. At the same time, the project should clarify the requirements for environmental standards by confirming the relevant ministries.

Prior to the commencement of the project, the proponent is required to implement EIA. In many cases, private consultants will implement actual investigation on EIA and prepare an EIA report under the supervision of the proponent. EIA implementation takes 3-6 months; however, it depends on the requirements which are defined through the discussion with authorities concerned. The required contents of the report are shown in MECIE and related guidelines. The summary of the report should be written in both French and Malagasy to be widely explained to the public.

2) EIA report examination

EIA should be implemented as a part of the project, and related expenses should be allocated by the project budget. EIA is the preliminary analysis of the foreseeable potential impacts of the project on the environment. Hence, it should be implemented before the commencement of the project. Therefore, the proponent is expected to consider the budget allocation schedule in long term to make sure the construction can be implemented in appropriate timing.

The EIA report is examined by ONE on the acceptability of the level and the mitigation measures to ensure the compatibility with the environment. For the examination, the Technical Evaluation Committee (CTE) will be formed. Whole EIA report evaluation procedure takes about 6 months. Proponents are expected to contribute the expenses for EIA review. The expense is expected to be deposited in advance in the project account created by ONE. Once the EIA report is approved, an Environmental Permit (PE) will be granted. In case PE is not granted, the project may go to the procedures of reexamination.

(month)	1	2	3	4	5	6	7	8	9	10	11	12
EIA implementation (3-6 months)	▒	▒	▒	▒	▒	▒						
EIA Reports Evaluation by ONE (6months)							▒	▒	▒	▒	▒	▒

Figure 43 EIA Procedures Before the Commencement of the Project

(Source) Study on the Urgent Necessity of the Expansion Project for Madagascar Ivato International Airport in the Republic of Madagascar / Commissioned by the Ministry of Economy, Trade and Industry ; Japan External Trade Organization (JETRO) , 2008.3

(2) EIA procedures (MECIE)

The procedures for the EIA stipulated in MECIE are summarized as follows and the flowchart is shown in Figure shown in below.

1) The proponent shall prepare a document describing the summary of the project, and submit it to ONE to commence the EIA procedure.
2) ONE shall accept the project summary, and CTE (Comintè Technique d'Evaluation ; an ad hoc committee in ONE) shall evaluate the submitted document from the viewpoint of environmental impact.
3) CTE shall conduct screening through preliminary environmental evaluation (PREE : Programme d'Engagement Environnemental) which in some cases includes on-site inspection with the proponent. If the CTE judges that the impact is small at this point, environmental permit is issued to the proponent.
4) If the CTE judges that the project has potential for major impact, CTE shall conduct scoping, and shall prepare Terms of Reference (TOR). ONE must undertake screening and scoping within 60 days.
5) The proponent, at its own expense, shall conduct the EIA in accordance with the TDR.
6) The proponent shall submit the EIA report to ONE for reviewing together with the expense for viewing.
7) The participation of the public in the review is made either on-site consultation of the documents, or by public survey, or by public hearings. ONE shall decide on the form of public participation.
8) ONE shall give advice on the Project Environmental Management Plan (PGEP : Plan de

Gestion Environnemental du Project). The proponent shall modify accordingly, and prepare the final EIA report.

9) Upon acceptance of the final EIA report, ONE issues the environmental permit of the project.

An EIA report shall include the following contents according to MECIE;

1) Summary
2) Introduction
3) Background and validity of the project
4) Environmental conditions
5) Contents of the project
6) Alternatives and environmental impact analysis
7) Risk and disaster assessment
8) Environmental comprehensivization of the project
9) Conclusion

(3) Compliance with Madagascan Environmental Standards and Introduction of International Standards

For the implementation of the project, it is expected to strictly comply with the environmental laws, regulations and standards, which were established by the Madagascar Government. In case the project determines that the legislative framework of Madagascar is not adequate for the management of certain emissions, it is expected to introduce appropriate environmental guidelines or standards with reference to Japanese or international standards, especially for noise and odor, for which the legislative framework in not yet available.

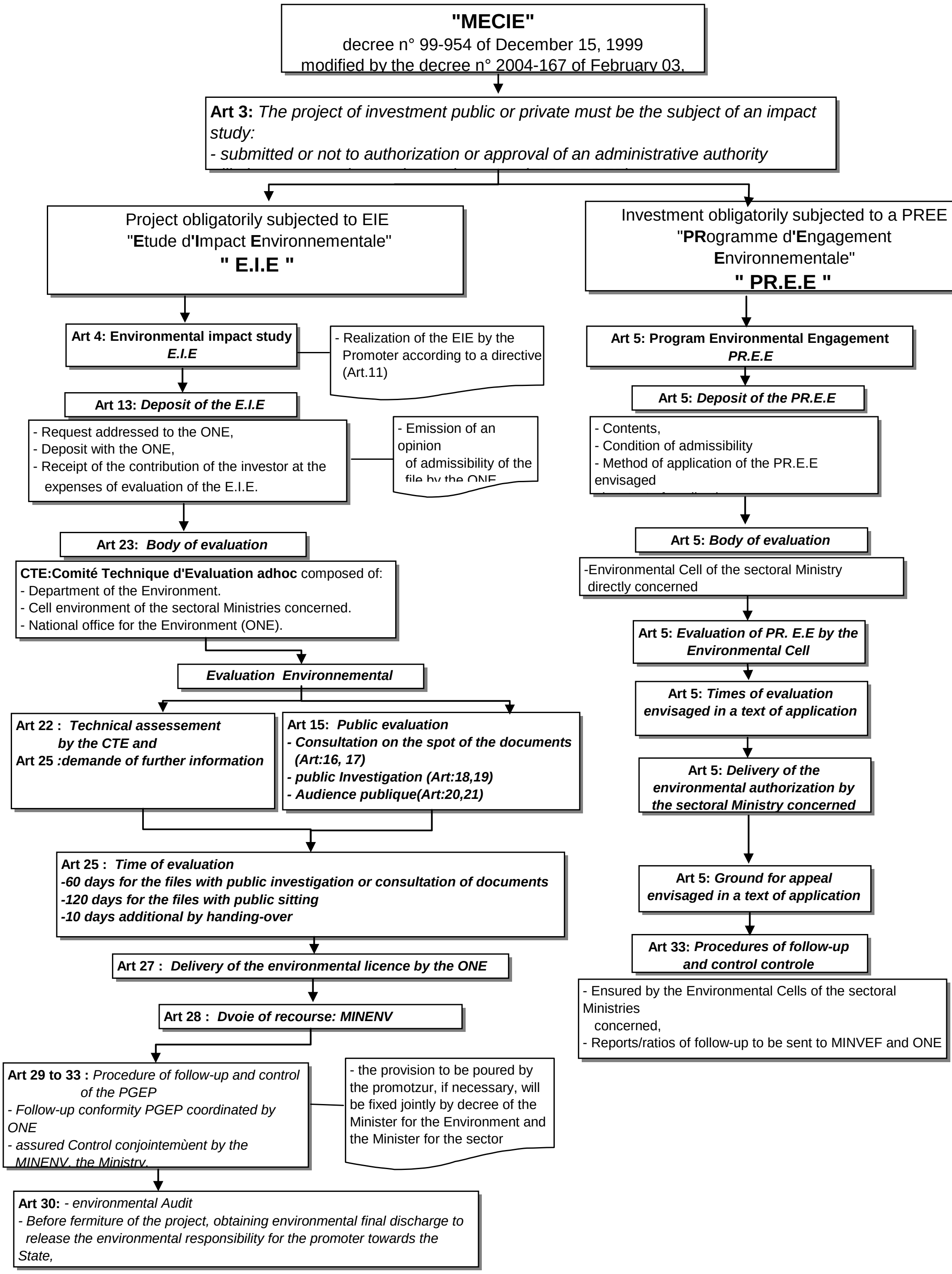

Figure 44 EIA Procedures (MECIE)

(Source) JIRAMA

Chapter 7 Conclusions and Recommendations

There are abundant renewable energy resources such as hydro and solar power potentials in Madagascar, and rare metals like nickel and cobalt are also abundant. However, the development of those resources and energy has just been started. In the rural villages, the people are still using firewood and/or charcoal as fuel sources. Because of this the deforestation is progressed and the health conditions of the resident are endangered. To improve the situation, Madagascar government sets up the national energy policy to convert from the traditional fuel source to modern fuel source, and to utilize the efficient energy resource as political measures. In the Madagascar Action Plan (MAP)(2007 to 2011), which is the mid-term development plan, acceleration of hydropower development and promotion of rural electrification are defined as the target. At present, the situation of Antananarivo, the capital city of Madagascar, is very severe and facing to the power shortage, causing rotational power cut for years. On the other hand, the electrification ratio per capita in the whole country is only about 16%.

After Year 2003, with the stabilization of domestic administration, the economy in the country is improved by self-help effort by the Madagascar government. Through formulation of MAP, the government sets up the value target of the economy and plans to activate the economy and to realize the affluence of the country. Japanese government has been contributing mainly to the acceleration of trade investment and agricultural development through Asia-Africa Cooperation Scheme. Recently, as the public-private-project, the development on infrastructures of Toamasina Port in relation to the Nickel Mining Development is progressing.

(1) Problems in the Power Sector of Madagascar

In Madagascar, there are a large potential of renewable energy resources such as hydropower, however, the development of such resources is so limited and the power supply capacity to cope with the power demand has not yet been developed. Such being the situation, the existing power plants and transmission and distribution systems have been deteriorated, and it becomes a big issue as the power demand is increasing in these days. Recently, the proportion of thermal power plant occupies more than a half of all the generation plants, and the soaring of fuel price gives a severe impact on the generation cost.

Though the power business has been opened to the private sector after Year 1999, because of the weakness and derogation of credibility of JIRAMA's financial status, the investment to power sector has not yet been increased. Due to the lack of construction of new power plants during a period between 2005 and 2007, JIRAMA limited the numbers of power connection to the new customers in the Antananarivo Grid considering the limited supply capacity of the whole grid.

As mentioned above, the power sector situation in Madagascar is in critical. Therefore, it is considered indispensable:

- that the power source to cope with the increase of power demand in the capital region shall be urgently developed as short-term solutions, and
- the power development master plan in the whole country considering hydro power as the main source and its related transmission system development plan for the main three transmission grid systems shall be prepared as mid/long-term solutions.

Two solutions schemes are explained below.

(2) Mid/Long-Term Solutions in the Power Sector

Power demand is forecasted to be increasing at the rate of about 8% per year and it is estimated that the generation capacity should be double of the present capacity in the next 10 years. About 70% of which are able to connect to the Antananarivo Grid. After this, to develop hydro power resources which are abundant in Madagascar is the first and foremost issue.

JICA recommended the necessity of review of hydropower development plan and the implementation of transmission line master plan study as solutions needs in the sector study entitled "Energy Sector Study in the Southern Africa Region (2006)".

In the course of discussion with the Ministry of Energy and Mines for the Study, Madagascar government requested to conduct the hydropower development master plan and related transmission line development master plan which will be a basis for the judgment of the private investors or financial institutions.

As it is difficult to develop the power plants by the fund of Madagascar government or JIRAMA, assistance in human resources to JIRAMA and in project finance from various countries and private investment are inevitable.

To improve the financial status of JIRAMA and the derogation of credibility which become a large burden to receive the financial assistance from various donors and investment by private developers, the World Bank has provided technical assistance for improvement of business performance of JIRAMA. Thereafter, JIRAMA concluded the management contract with the international consultant and now the financial status of JIRAMA seems to be recovering. At present the dependency on the generation plant firing oil is rather high, therefore, the soaring of oil price gives a large impact on the management of JIRAMA as the generation cost is increased. However, by developing the hydro power potentials, the soundness of financial situation of JIRAMA is expected to be improved further.

(3) Short-Term Solutions in the Power Sector

At present the rotational load shedding is implemented in the Antananarivo Grid, especially in the dry season when the power output by hydropower plants will be decreased. Further, due to the delay in the development of the new power plants, the extraordinary situation is occurred that JIRAMA limits the connection to the new customers. To cope with the issue, it becomes urgent to develop the power source in the Antananarivo Grid. In early 2008, Mandroseza Thermal Power Plant (37MW) has been introduced to the Antananarivo Grid. As the result, it is said that the numbers of brown out in Antananarivo City were temporarily decreased. However, the reserved surplus of the generation capacity is still not enough. Development plan for the next promising power source is still uncertain, therefore, it can not be said that the issue on the power crisis has been dissolved. In the present circumstances, the implementation for development of middle to large scale power source for the Antananarivo Grid as urgent measures is difficult from the view points of financial arrangement and construction period. As the urgent power source, the conventional type of diesel power plant will be effective in view of short-term measure. However it may create another issue for sustainable operation and maintenance due to the hike of fuel price. Compared to these, the expansion plan for the existing power plant is to reduce the construction cost by utilizing the existing facilities, the construction period and there is no necessity of fuel cost, and the operation and maintenance cost can be minimized.

Expansion plan of Manandona Hydropower Plant, which is the objective of the Study, is not only to satisfy the above-mentioned conditions, but also to be considered as the efficient project as it is connected to the Antananarivo Grid and it eases the power situation in the capital region though it is rather small.

(4) Expansion Plan of Manandona Hydroelectric Power Plant

Manandona Hydropower Plant supplies power mainly to Antsirabe City which is the southern end of the Antananarivo Grid. The power plant was constructed in 1934 and thereafter the plant has been operating for over 70 years. However, the generation facilities, turbine/generator, etc. were deteriorated year by year, and it is no wonder that the plant becomes inoperative as the budget for maintenance is not enough. Manandona Hydropower Plant has been contributing for long years in supplying the power to Antsirabe City. However, its role becomes smaller every year as the power demand is increasing due to the industrial development in the region. In case the optimum expansion plan is implemented based on the result of this study, it is estimated that the power output and the annual generation will be 3 and 2. times larger than that of the existing plant respectively. By keeping up the Manandona Hydropower Plant, the plant contributes as the stable power supplier to Antsirabe region as one of the main power source, and the operation hours of thermal power plant are reduced. As the result, it is expected to reduce the CO_2 emission from the thermal plant and it is worth to be renewed as the CDM project.

In this study, the calculation and study have been made on the following three alternative cases. As the result,

Table 35 Alternative Plan for Expansion of Manandona Hydropower Plant

Alt	Existing P/S	Expansion P/S	Merit	Demerit
(i)	Existing condition	New construction (New waterway separately with the existing one)	Existing power plant can be operative even during construction period of the new one.	Construction cost becomes more expensive. Construction period will be longer compared to Alt. 3 which utilizes the existing penstock route.
(ii)	Implementation of Rehabilitation	New construction (New waterway separately with the existing one)	Scale of new plant is the smallest among the 3 alternatives. If the simultaneous construction were not done, there is no outage of power plant but the construction period would be longer.	Total construction cost of Rehabilitation of existing P/S and expansion P/S works becomes most expensive among 3 alternatives. Detailed survey and study on replacement, reinforcement of penstock, E/M equipment for rehabilitation is necessary.
(iii)	Disposal	New construction (New waterway after disposal of existing penstock)	As the existing penstock route is utilized, the civil work cost is the cheapest among 3 alternatives, and construction is also easier, construction period is shorter.	During the time of construction of new plant, the existing plant is stopped.

Alternative Plan 3, which is to dispose the deteriorated existing steel penstock pipes and to install the new pipes of Fiberglass Reinforced Plastic Mortar (FRPM) Pipe, is recommended from the view points of economical efficiency (construction cost), reduction of construction period, easiness of construction method, view points of maintenance and management, etc. In this expansion works, augment of weir height is not implemented. Therefore, there is no issue on the relocation of the resident, the expropriation of land, cultivated area to be submerged, and further almost no impact is expected on the water rise due to increase maximum power discharge to the downstream.

APPENDIX

Appendix 1 Schedule for Field Investigation

Date	Schedule	Stay
Oct-17 (Fri)	[Mr. KIMURA] - Tokyo -> Bangkok [Mr. HAYASHI & Mr. SARUHASHI] - Osaka -> Bangkok	Flying overnight
Oct-18 (Sat)	- Bangkok -> Antananarivo	Antananarivo
Oct-19 (Sun)		Antananarivo
Oct-20 (Mon)	FTM, INSTAT, MTPM (Collection of data and map etc.) [Mr. SANO] - Osaka -> Bangkok	Antananarivo
Oct-21 (Tue)	[Mr. SANO] - Bangkok -> Antananarivo MTPM (Collection of meteorological information etc.)	Antananarivo
Oct-22 (Wed)	JIRAMA: Mr. Dieudonné Raoelijaona, Director General for Electricity BNGRC: Ms. Dia Styvanley Soa, Responsible of Communication Embassy of JAPAN: Mr. KOYANO Junichi, Second Secretary JICA: Mr. ASANO Atsushi, First Deputy Resident Representative, and Mr. HIGA Isaya, Deputy of Resident Representative JIRAMA: Mr Bernhard P. Romahn, Director General	Antananarivo
Oct-23 (Thu)	World Bank: Mr. Vonjy M.Rakotondramanana, Energy Specialist MEM: Mr. Germain Rakotoasimanana, Director of Electricity and Renewable Energy JIRAMA: Mr. François Xavier Rakotozafy, Director of Exploitation of Antananarivo Grid	Antananarivo
Oct-24 (Fri)	Site journey with Mr. François Xavier Rakotozafy, Director of Exploitation of Antananarivo Grid (Oct-24~25) - Antananarivo -> Antsirabe JIRAMA Antsirabe Regional Branch JIRAMA Antsirabe Thermal power plant JIRAMA Manandona Hydropower plant (Site inspection at weir, penstock, surge tank and power station)	Antsirabe
Oct-25 (Sat)	JIRAMA Antsirabe Thermal power plant (Collection of operational record and drawings) JIRAMA Manandona Hydropower plant (Site inspection at weir and upstream of reservoir) - Antsirabe -> Antananarivo	Antananarivo
Oct-26 (Sun)	Data processing and meeting	Antananarivo
Oct-27 (Mon)	JIRAMA: Mr. Jules Razafimandimby, Director of Strategic Planning and Tariff Management MTPM (Collection of meteorological data)	Antananarivo
Oct-28 (Tue)	MEM: Mr Rodolphe Ramanantsoa, Director General JIRAMA: Mr. François Xavier Rakotozafy, Director of Exploitation of Antananarivo Grid	Antananarivo
Oct-29 (Wed)	MTPM (Collection of meteorological data)	Antananarivo

Oct-30 (Thu)	JIRAMA: Mr. Jules Razafimandimby, Director of Strategic Planning and Tariff Management JIRAMA: Mr. Ndalana Nestor, Director of Production of Electricity APIPA: Ms. Nbola, Director of Technique	Antananarivo
Oct-31 (Fri)	Travel Agency (Payment) JIRAMA: Mr. Jules Razafimandimby, Director of Strategic Planning and Tariff Management - Antananarivo -> Bangkok	Flying overnight
Nov-1 (Sat)	[Mr. KIMURA] - Bangkok -> Tokyo [Mr. SANO, Mr. HAYASHI & M. SARUHASHI] - Bangkok -> Osaka	-

Appendix 2 Interviewed Persons List

Embassy of JAPAN

Mr. KOYANO Junichi, Second Secretary

JICA (Japan International Cooperation Agency)

Mr. ASANO Atsushi, First Deputy Resident Representative

Mr. HIGA Isaya, Deputy of Resident Representative

MEM (Ministry of Energy and Mines)

Mr Rodolphe Ramanantsoa, Director General

Mr. Germain Rakotoasimanana, Director of Electricity and Renewable Energy

JIRAMA (Jiro sy Rano Malagasy)

Mr. Bernhard P. Romahn, Director General

Mr. Dieudonné Raoelijaona, Director General for Electricity

Mr. Jules Razafimandimby, Director of Strategic Planning and Tariff Management

Mr. Ndalana Nestor, Director of Production of Electricity

Mr. François Xavier Rakotozafy, Director of Exploitation of Antananarivo Grid

MTPM (Ministry of Public Work and Meteorology)

Mr Leonguy, In charge of Cyclone

Mr Antoine, In charge of Wind

Mr Ndriana, In charge of Discharge

BNGRC (National office of Risk and Catastrophe Management)

Ms. Dia Styvanley Soa, Responsible of Communication

APIPA (Authority for Protection against the Floods of the Plain of Antananarivo)

Ms. Nbola, Director of Technique

World Bank, Madagascar Country Office

Mr. Vonjy M.Rakotondramanana, Energy Specialist

DAIHO Cooperation, Madagascar Office

Mr. HARADA Shinzi, Representative

SUMITOMO Cooperation, Antananarivo Office

Mr. ARIYAMA Nobuyuki, Director General

Appendix 3 Collected Data List

No.	Name of Document or Information	Collected from	Format	Note
1	New POP RIA.xls	JIRAMA	MS Excel	Power generation facilities plan (2008-2020)
2	Prév_RIANTANANARIVO.xls (PREVISION DE LA DEMANDE DE RIANTANANARIVO)	JIRAMA	MS Excel	Demand forcast of Antananarivo grid
3	The World Bank "Project Appraisal Document on a Project credit In the Amount of SDR 6.8 million(US$10million Equivalent) to the Pepublic of Madagascar for a Power/Water Sectors Recovery and Restructuring Project" June 14, 2006	World BankLibrary	Hard copy	
4	Reseau Tana avec 40MW.dwg	JIRAMA	Auto CAD	Single Diagram of Antananarivo grid
5	HYDROLOGIE MANANDONA.xls (Turbine Discharge etc. 1990-2008)	JIRAMA	MS Excel	Discharge record of Manandona hydropower plant
6	Puissance mensuelle 2009 à 2010 (Sept 2008).xls	JIRAMA	MS Excel	Power generation facilities plan (2009-2010)
7	PUISSANCE MENSUELLE 2008 Réelle et Prévision (fichier déf).xls	JIRAMA	MS Excel	Generated output(2008)
8	REEL PROD CONS SEPTEMBRE 2008 1.xls	JIRAMA	MS Excel	Output capacity[MW], Generation energy[kWh](2004-2008)
9	RELEVES DE PUISSANCE RI 42e S.xls	JIRAMA	MS Excel	Daily load (2008.10.13-19)
10	1:200,000 & 1:175,000 Administrative map(REGION VAKINANKARATRA and AMORON'IMANIA, 2 sheets)	FTM	Hard copy Map	Region including Antananarivo, Antsirabe and Manandona
11	Fetite Manandona Situee a Ambohimanga Caton de Manandona District d' Antsirabe, Region de Tananarivo, 1936/7/30	JIRAMA, Antsirabe	Hard copy Map	Manandona HPP, JIRAMA territory map
12	Zone D'Antsirabe (Barrage Manandona) Plan D'Ensemble Vue En Plan, 1977/11/15	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Dam and reservoir plan
13	Zone D'Antsirabe Barrage Sur La Manandona Plan Cote De La Retenue, 1952/1/18	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Reservoir plan
14	Reseau D'Antsirabe Sureleva Du Barrage De La Manandona Et Installation D'Une Vanne De Decharge R.G., 1960/2/16	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Dam (Heightening in 1960)
15	Chutes De La Manandona Usine De Antsirabe Barrage	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Dam (before heightening in 1960)
16	Zone D'Antsirabe Renforcement De La Berge Rive Gauche En Amont Du Barrage De La Manandona Vue En Plan & Situation Des Profils, 1966/11/14	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Reinforcement of left bank of dam
17	Zone D'Antsirabe Travaux De Refction Du Barrage De Manandona, 1992/11/9	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Reinforcement of right bank of dam
18	Amenagement De Manandona Coupes Types Degradation Du Pied De Parement Aval	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Reinforcement of downstream edge of dam
19	Barrage Et Prise D'Eau Plans Grilles A Debris Et Details, 1989/6/7	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Trashrack at intake
20	Chutes De La Manandona Projet De Mise En Valeue Plan D'ensemble, 1929/9/12	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Penstock route
21	Zone D'Antsirabe Centrale Hydraulique Vue En Plan Generale	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, Power station plan
22	Antsirabe Ligne De Transport D'Energie 20.000V, 1955/10/26	JIRAMA, Antsirabe	Hard copy Drawing	Manandona HPP, 20kV transmission line route
23	Antsirabe Substation Releve De Charge En Production (KW), 2008/9/3, 2008/9/4, 2008/10/24	JIRAMA, Antsirabe	Hard copy	Power transmission to Antsirabe substation
24	Antsirabe Substation Releves Charges Des Departs (KW), 2008/9/3, 2008/9/4, 2008/10/24	JIRAMA, Antsirabe	Hard copy	Power distribution from Antsirabe substation
25	Antsirabe Substation Input and Ooutput of Electricity , A certain day of 2008	JIRAMA, Antsirabe	Hard copy	Input and output of power at Antsirabe substation

Appendix 3 Collected Data List (continue)

No.	Name of Document or Information	Collected from	Format	Note
26	Antsirabe Substation Statistique Generale - Antsirabe, 2004, 2005, 2006, 2007	JIRAMA, Antsirabe	Hard copy	Annual electricity power at Antsirabe substation
27	Antsirabe Substation Courbes De Charges, 2008/9/18:Max, 2008/9/21:Min	JIRAMA, Antsirabe	Hard copy	Maximum and minimum daily load curve in September, 2008 at Antsirabe substation
28	Antsirabe Substation Sce Production Elec Dir Antsirabe, 2005/4	JIRAMA, Antsirabe	Hard copy	Monthly cost etc. at Antsirabe substation
29	Rapport PLANIFICATION.pdf (PLANS DE DEVELOPPEMENT DES EQUIPEMENTS DE PRODUCTION ELECTRICITE)	JIRAMA	PDF	Power operational plan
30	plan***.xls (Power operations plan:POP[MW] and [GWh], Expectation of annual fuel purchase, 86 files)	JIRAMA	MS Excel	Power operational plan at each district (attachment of No.30)
31	Dossier NEWJEC Japon.ppt (2008/8)	MEM	MS PPT	Instruction PPT of power sector in Madagascar
32	Loi 98-032 portant reforme du secteur de l'Electricité.doc (1999/1/20)	MEM	MS Word	Law No.98-032, Carrying to the reform of the Electricity Sector(Power Law)
33	Décret 2001-173 (application de la Loi 98-032).doc (2001/2/28)	MEM	MS Word	Decree No.2001 - 173 Fixing the conditions and modalities application of the law n°98-032 bearing in 20 January 1999 in electricity sector reforms
34	Lettre de politique sectorielle eau et electricité_151207.doc (2007/12/15)	MEM	MS Word	Letter of Sectoral Policy Water and Electricity in Madagascar
35	Bilan_an_05_06_07.xls	JIRAMA	MS Excel	JIRAMA Financial statements (2005-2007)
36	IMPAYES A FIN SEPT 2008.xls	JIRAMA	MS Excel	JIRAMA Situation of unpayment (at the end of 2008.9)
37	Tarif Elec.xls	JIRAMA	MS Excel	JIRAMA Electricity tariff
38	TAUX D'ACCES.xls	JIRAMA	MS Excel	Rate of access to electricity and water service (2005-2007)
39	CARACTERISTIQUES DES LIGNES DE TRANSPORT RI-FIANARANTSOA, TOAMASINA, TANA	JIRAMA	Hard copy	Features of transmission lines of Antananarivo, Fianarantsoa and Toamasina grids
40	RESEAU INTERCONNECTE DE FIANARANTSOA (2006/7)	JIRAMA	Hard copy	Single Diagram of Fianarantsoa grid
41	RESEAU INTERCONNECTE DE TOAMASINA (2006/6)	JIRAMA	Hard copy	Single Diagram of Toamasina grid
42	MESURES D'URGENCE VOLOBE RESTANT A REALISER	JIRAMA	Hard copy	Rehabilitation records of Volobe hydropower plant