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ESMAP
Energy Sector Management Assistance Program

Small Hydro Resource Mapping in Madagascar

INCEPTION REPORT

[ENGLISH VERSION]

August 2014

This report was prepared by SHER Ingénieurs-Conseils s.a. in association with Mhylab, under contract to The World Bank.

It is one of several outputs from the small hydro resource mapping component of the activity '*Renewable Energy Resource Mapping and Geospatial Planning – Madagascar*' [Project ID: P145350]. This activity is funded and supported by the Energy Sector Management Assistance Program (ESMAP), a multi-donor trust fund administered by The World Bank, under a global initiative on Renewable Energy Resource Mapping. Further details on the initiative can be obtained from the ESMAP website.

This document is an **interim output** from the above-mentioned project. Users are strongly advised to exercise caution when utilizing the information and data contained, as this has not been subject to full peer review. The final, validated, peer reviewed output from this project will be a Madagascar Small Hydro Atlas, which will be published once the project is completed.

Phase 1 – Preliminary resource mapping
INCEPTION REPORT

Renewable Energy Resource Mapping: Small Hydro – Madagascar [P145350]
August 2014

English version

IN ASSOCIATION WITH

FINAL OUTPUT

Correspondence Table between the terms of reference and reporting and the ESMAP phases:

ESMAP General Phasing	Correspondence with ESMAP-Small Hydro Madagascar ToR
Phase 1 Preliminary resource mapping output based on satellite and site visits	**Activity 1** – Data collection and production of Hydro Atlas, review and validation of small hydro potential **Activity 2** – Small hydro electrification planning **Activity 3** – Small hydro prioritisation and workshop
Phase 2 Ground-based data collection	**Activity 4 -** Data collection and final validation (from the REVISED TERMS OF REFERENCES FOR THE ACTIVITY 4) : A – Review of previously studied small hydropower sites B – Data collection and final validation C – Pre-feasibility study of two priority sites for small hydropower development
Phase 3 Production of a validated resources atlas that combine satellite and ground-based data	D – Support to the Ministry of Energy to build capacity and take ownership of the created GIS database for hydropower E – Updated Small Hydropower Hydro Planning and Mapping Reports for Madagascar

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Abbreviations and acronyms

FEEMA / ADEME	French Environnement and Energy Management Agency /Agence de Maîtrise de l'Energie
ADER	Agence de Développement de l'Electrification Rurale (Development Agency for Rural Electrification)
AO	Appel d'Offre (Offers)
DDP	Detailed Draft Project
APIPA	Autorité pour la Protection contre les Inondations de la Plaine d'Antananarivo (Authority for Protection against Flooding on the Plain of Antananarivo)
PDS	Proposed Draft Summary
ADB	African Development Bank
BDHM	Banque de Données Hydro pluviométriques de Madagascar (Malagasy Data Bank of Rainfall)
EIB	European Investment Bank
WB	World Bank
BRGM	Bureau de Recherches Géologiques et Minières (Geological and Mining Research Bureau)
CIRAD	Centre International de Recherche pour l'Agriculture et Développement (International Research and Agricultural Development Centre)
DGE	Direction de l'Energie (Energy Division)
DGM	Direction Générale de la Météorologie (General Department of Meteorology)
DGRE	Direction de la Gestion des Ressources en Eau (Department of Water Ressources Managment)
EDM	Electricité de Madagascar (Malagasy Electricity)
RE	Renewable Energy
ERD	Decentralised Rural Electrification
ESF	Electriciens Sans Frontières
ESMAP	Energy Sector Management Assistance Program
EU	European Union
ADF	African Development Fund
FMO	Netherlands Development Finance Company
FONDEM	Fondation Energies pour le Monde
FTM	FOIBEN-TAOSARINTANIN'I MADAGASIKARA (Malagasy Cartography Centre)
FWC	Framework Contract
GEOSIM	Logiciel de planification de l'Electrification Rurale (Rural Electrification Planning Software)
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Society for International Cooperation)
GRDC	Global Runoff Data Centre
GRET	Groupe de Recherche et d'Echanges Technologiques (Group for Research and Technological Exchanges)
GTE	Groupe de Travail Energie (Energy Working Group)
GTZ/GIZ	Deutsche Gesellschaft für Technische / Internationale Zusammenarbeit GmbH (German Society for Technical / International Cooperation)
GVEP	Global Village Energy Partnership

GWh	Giga Watt hour, Billions of kWh or Millions of MWh
HFF	Henri Fraise & Fils (société) (Henri Fraise and Sons company)
IED	Innovation Energie Développement (Energy Development Innovation)
IEPF	Institut de l'Energie et de l'Environnement de la Francophonie (Institute of Energy and Francophone Environment)
INSTAT	Institut National de la Statistique (National Statistics Institute)
IPP's	Independent Power Producer's
IRENA	International Renewable Energy Agency
JICA	Japan International Cooperation Agency
JIRAMA	Jiro sy Rano Malagasy (Société d'électricité et d'eau de Madagascar) Malagasy Electricity and Water Board)
kW	kilo Watt
kWh	kilo Watt hour
LCOE	Levelised Cost Of Electricity
MAP	Madagascar Action Plan
MoE	Ministry of Energy
MDE	Maîtrise De l'Energie (Energy Control)
MGA	Malagasy Ariary
MIGA	Multilateral Investment Guarantee Agency
DEM	Digital Elevation Model
MW	Mega Watt
MWh	Mega Watt hour
NEPAD	NEw Partnership for Africa's Development
NOAA	National Oceanic and Atmospheric Administration
ONE	National Office of the Environment
NGO	Non-Governmental Organisation
OER	Office of Electricity Regulation
ORSTOM	Office de la Recherche Scientifique et Technique Outre-Mer (Overseas Office Of Scientific and Technical Research)
PADR	Plan d'Action pour le Développement Rural (Action Plan for Rural Development)
PIC	Projet Pôles Intégrés de Croissance (Integrated Poles Project of Growth)
UNDP	United Nations Development Programme
PPP	Public-Private Partnership
PV	Solar Photovoltaics
RFE	Rainfall estimates
RIAED	Réseau International d'Accès aux Energies Renouvelables (International Network for Access to Renewable Energy)
RTA	Rio Tinto Alcan
ES	Electrical System
IFC	International Finance Corporaion
GIS	Geographic Information System
SNAT	Stratégie Nationale d'Aménagement du Territoire (National Territorial Strategy Planning)
TWh	Tera Watt hour
WB	World Bank
WWF	World Wide Fund

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1 Introduction

1.1 General context of the ESMAP – FWC project

ESMAP (Energy Sector Management Assistance Program) is a program of technical assistance given by the World Bank and upheld by 11 bilateral donors. ESMAP launched, in January 2013, an initiative which upholds efforts directed by the countries to improve renewable energy resource understanding (RE), and puts in place institutional frameworks suitable for RE development, and supply free access to resources and geospatial data. This initiative will also strengthen the IRENA-Global Atlas program by improving data availability and quality viewable through an interactive Atlas.

This study "Renewable Energy Resource Mapping: Small Hydro Madagascar", is part of a technical assistance project, financed by ESMAP, implemented by the World Bank in Madagascar (the “Client”), which aims to sustain mapping resources and geospatial planning for small hydraulics. It is directed in close coordination with the Ministry of Energy, the Office of Electrical Regulation (OER), the Development Agency for Rural Electrification (ADER), and JIRAMA.

1.2 Context of the electrical sector in Madagascar

Madagascar has enormous energy resources, especially renewable ones (hydraulic, solar, wind, biomass), but the national energy consumption is still very low. This energy consumption is still outclassed by wood energy and its by-products. Either way, the country imports petrol products and energy costs are too high to effectively contribute to social and economic development of the country.

Today, very few people in Madagascar have access to modern energy sources, and this slows down development significantly. Furthermore, people who don’t have access need to use lesser quality and ineffective energy sources, often polluting, for which they spend much more than the few who have privilege of access. Households which are not connected to the electrical network spend on average between 2 and 10 times more for less lighting than those who are connected.

For electricity, the infrastructures are insufficient and a large part of production and distribution facilities in existence are outdated and are unable to satisfy present growing demands. Some production facilities are saturated and are very exposed to the bad weather despite the riches in renewable energy resources that are less exploited in the country. This situation constitutes a handicap to the country’s development and a blockage to competitivity of exporting industries. In farming, the electrical energy demand (electrical pump station) is still negligible.

The objectives of the energy sector of the Malagasy Government are to pursue the committed global economic reform program aiming to reach an increased economic growth under the momentum and initiative of private investments. The lack of fundamental economic infrastructures harms performance improvement in terms of economic growth and poverty reduction. To compensate this lack, particularly in the energy domain, government actions need to accelerate the increase population access to energy by a policy centralised around beneficiary community participation to the private sector and focused on development of renewable energy sources. This should translate by a cost reduction and productivity increase.

Because of issues and objectives for the energy sector in Madagascar and also integration in the fight for environmental protection on the international scale, we must absolutely succeed in conciliating the pursuit of an upheld energetic policy and the reduction of its negative impacts on the environment and health.

Amongst others these efforts consist of:

- promoting modern use of energy with efficient equipment on the energy plan,
- encouraging the use of renewable energy to progressively replace traditional types of energy.

We need to underline that wood is the main energy source used by the larger part of Malagasy households for their daily needs (lighting, cooking …) which encourages deforestation which harms the environment

It is necessary to accelerate the replacement of wood energy and access to electricity by thermal production and by other sources such as butane gas, biomass (biofuel), solar power, wind power and hydropower.

With the freedom of the electricity sector in 1999, the government has introduced a large number of structural reforms, with the creation of the OER, ADER and FNE and development programs like the project PIC (Growth Integrated Poles), which deserves certain improvement to privilege private investments or public-private partnerships.

1.2.1 The stakeholders of the electricity sector

JIRAMA

The Malagasy electricity sector is dominated by JIRAMA (national water and electricity company in Madagascar), founded on 17 October 1975 which is a public company whose capital is entirely kept by the State, while being governed by the limited companies laws. JIRAMA is in charge of almost all production, of transport and electricity distribution in Madagascar, meanwhile insuring the safe and industrial water supply across the country. But since 1999 et the liberalisation of the electricity sector, JIRAMA is not the only one in electricity production and distribution. It nevertheless keeps transport monopoly in HT and stays the relay of the Malagasy State in the installation of electrical infrastructures of the country.

The law N° 98-032 of 20 January 1999 introduced a new national energy policy. Dedicated to the reform of the electricity sector, this law aims to allow new operators to act in this sector to, on one side, replace the Malagasy government in the funding of the electric infrastructure and, on the other hand, promote efficiency and quality of the service offered to users by the rule of competition.

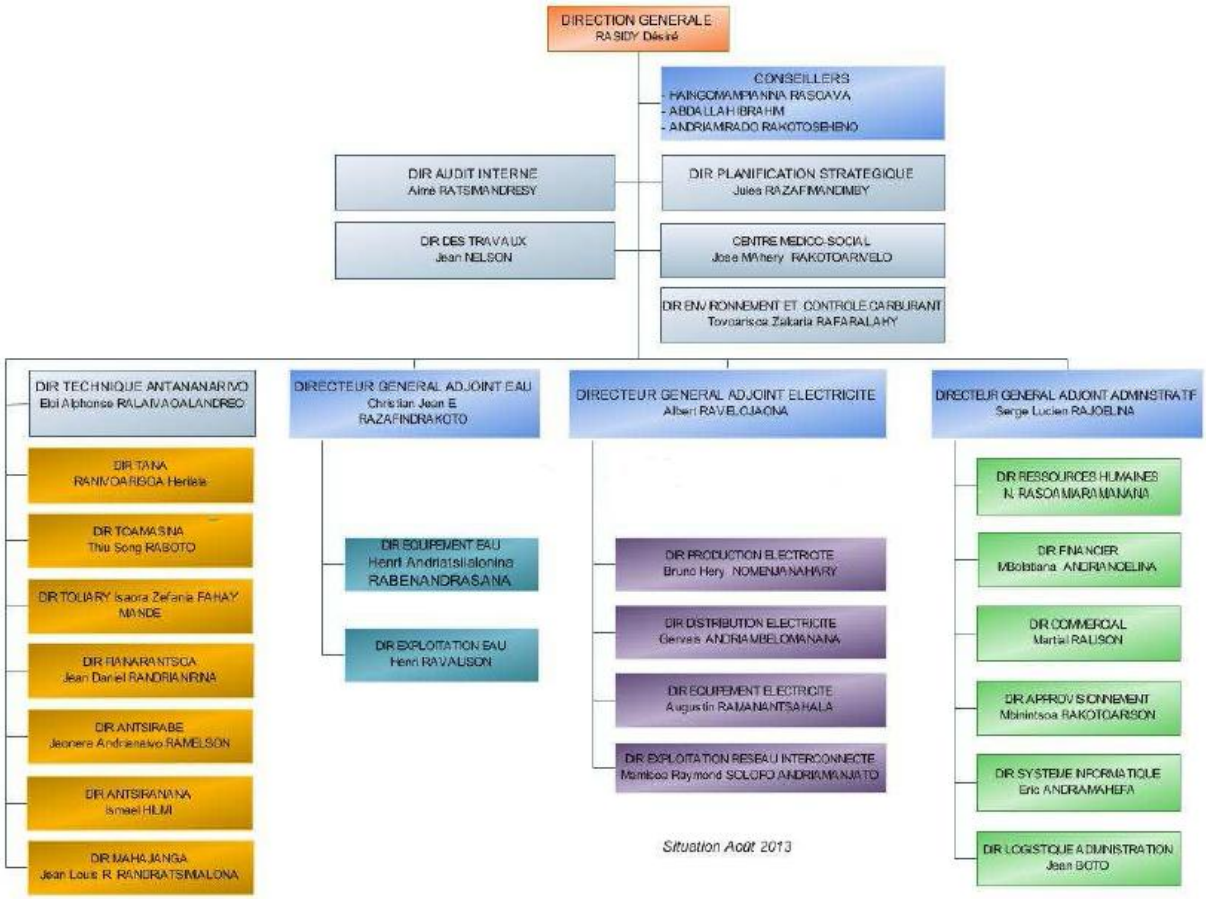


Chart 1 JIRAMA organisation

JIRAMA is made up of 114 operations centres, 100 of which are powered by diesel thermal generators (GO or HFO), while the others are powered by hydropower plants.

The Malagasy electricity system only comprises of 3 Interconnected Grids (IG) in HV: Antananarivo-Antsirabe (IGA), Toamasina (IGT) and Fianarantsoa (IGF). JIRAMA only gives its services to urban and suburban areas.

In 2013, the distribution of production was 45% for thermal energy and 55% for water power.

A small minority of the Malagasy population has access to electricity; yielded to the country's population, approximately 22.5 million inhabitants, there is around one subscriber per 48 inhabitants. The national access rate to electricity is still very low an dis estimated at 15.25% in 2013, 4.7% of which are in rural areas (source MoE).

For many years, the balance sheet of the company remains tense with halted payments because of financial difficulties. The constant annual increase of combustible consumption and the relatively low tariff level hasn't given to JIRAMA the ability to engage in new investments, especially the realisation of new hydropower projects allowing a reduction in national diesel and Heavy Fuel Oil consumption.

The short-term and long-term issues for JIRAMA are mainly and respectively:

- The reduction of its diesel and HFO consumption in isolated production plants through developing renewable energy depending on their availability,
- Strengthening the HV/ LV distribution grid with, in particular for 2020, for the grid project for greater Tana, the commissioning of the 4th group (33MW) of Andekaleka and the Fempona control dam (100hm3) including a plant central (50MW), and the realisation of the interconnection (IGATA) of the 3 grids of IGA, IGT and Ambositra once a great development such as Antetezambato (180MW) is operational,
- Commissioning as early as possible a scaled hydropower development for the country allowing grid interconnections and extensions, the choice of which is between these: Antetezambato, Mahavola, Sahofika, Antafofo, Lohavanana, et Volobe.

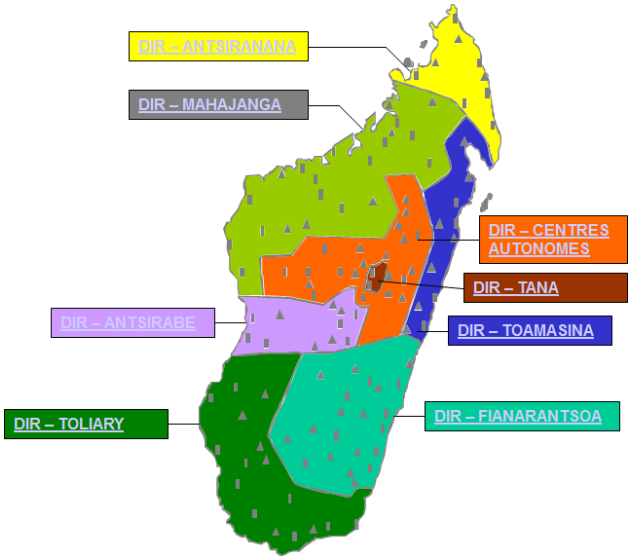


Chart 2 Division of the 8 JIRAMA regional offices

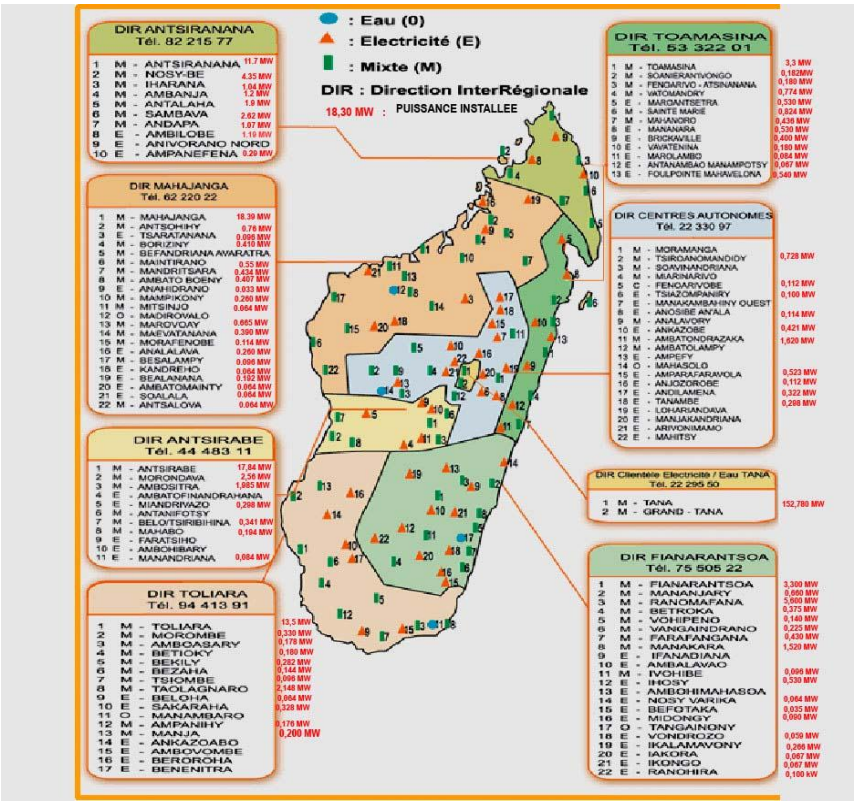


Chart 3 Division of the centres of production

Other Operators and Distributors

The main new operators infusing on the transport network of JIRAMA are in production: Cy HFF (Henri Fraise and Sons Company) and Hydelec Madagascar Ltd. For rural electrification, 23 private companies operate presently in the sector, such as CASIELEC, JIRAFI, SM3E, etc.

The Ministry of Energy

The Ministry of Energy (MoE) is the ministry in charge of the electricity sector. It has recently been reorganised by the new minister Richard Fienena. The organisation of the MoE is as follows:

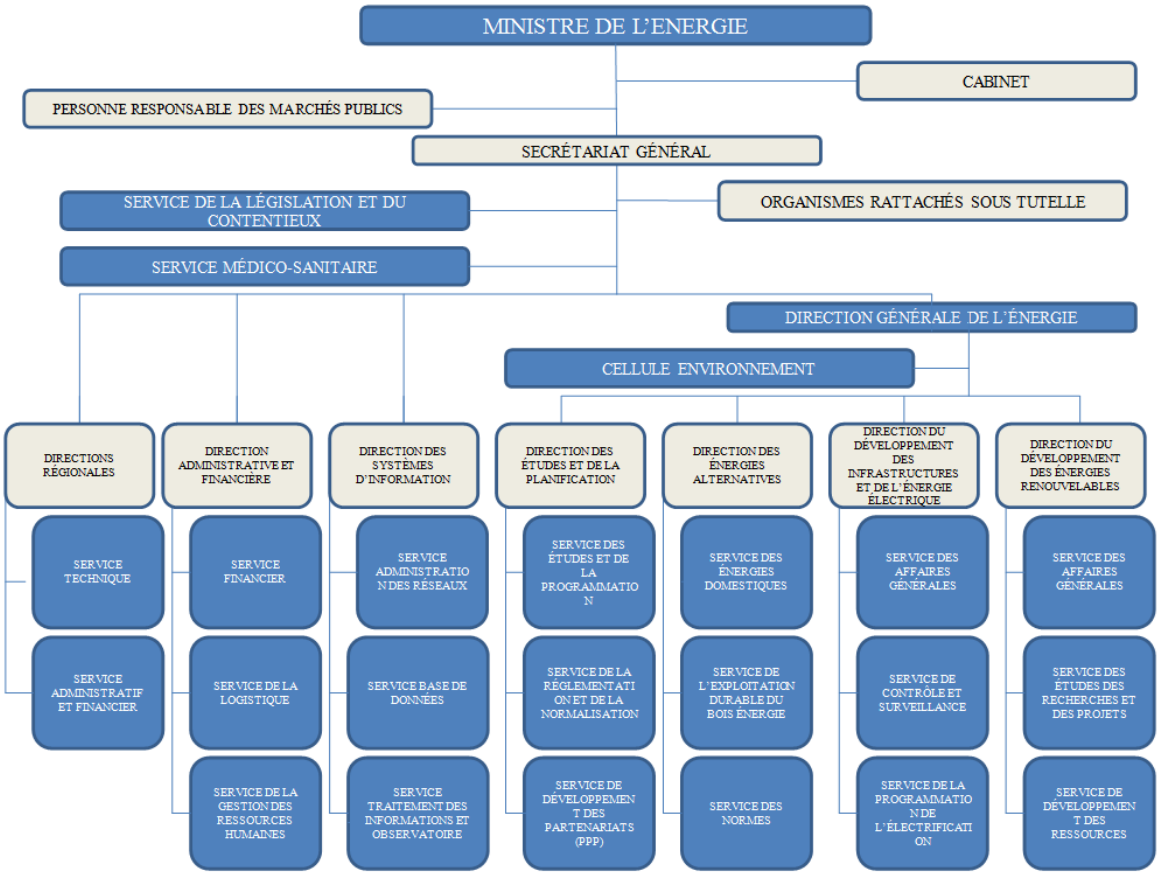


Chart 4 Organisation of the Ministry of Energy

The principal mission of the MoE is to establish a long-term planning of the electricity sector at the least cost to the electrical system (ES), coherent to the government's priorities which favour development of production means in PPP. It will specially be charged with the urgent task of selecting and quickly beginning the future project among the 6 competing hydropower projects of the blueprint at the lowest price. The MoE will be helped by the OER whose mission is to put forward a indicative planning. JIRAMA also develops a planning for its operations.

The MoE also has to check concessions granted for many years and to propose adapted regulations for the new ones.

Another mission is to constitute a centralised database including the hydropower heritage of the country and viewable on its site.

The Office of Electricity Sector Regulation

In the context of liberalisation of the Electricity sector in Madagascar, the act n°98-032 of 20 January 1999 established the creation and implementation of a regulatory organ, the OER, charged with the regulation of activities in the electricity sector. The OER is a public institution with an administrative nature. It is placed under the technical management of the Ministry of Energy. The necessary budget to accomplish its missions is fed solely through the reception of taxes from operators in the electricity sector

Its organisation and its function are outlined by the decree n°2001-803.

The main missions of the OER consist of:

- publish and supervise the prices of electricity and decide on the top price of the electricity;
- control and regulate a safe competition;
- watch over the norms of service quality.

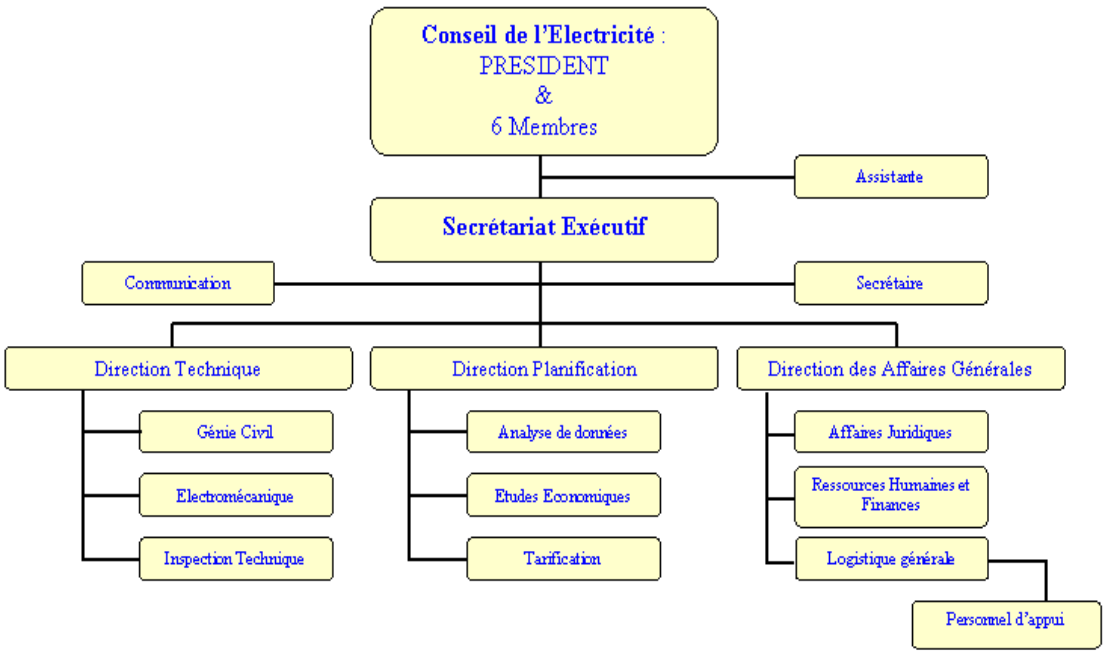


Chart 5 OER organisation

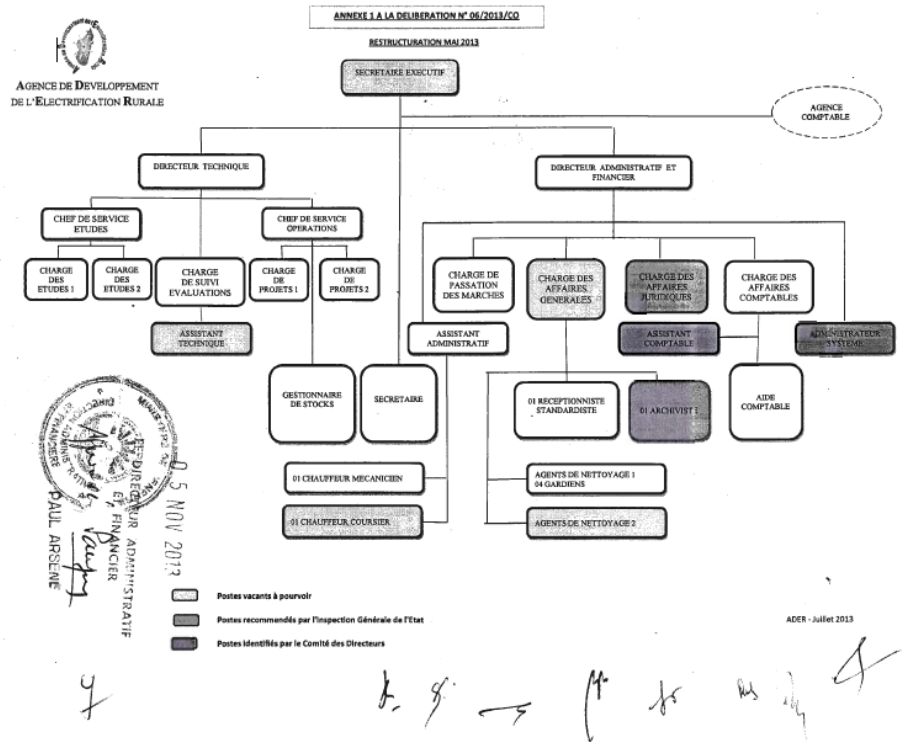
The new article 3 of the decree n°2003-194 defined the attributions of the OER:

In accordance with the dispositions of the article 35 of the Law, the OER insures regulation, controle and follow-up of the activities relating to the electricity sector. As such, the OER is charged, amongst others, with:

- Elaborate indicative plans for development of the electricity sector in conformity with the national electricity policy,

- Promote participation of the private sector in terms of production, and of electrical energy distribution in objective, transparent and non-discriminatory conditions;
- Define and put in place tariffs, respecting the methods and procedures set by the Act and provisions made for its application,
- Ensure consumers interest and insure the protection of their rights about equipment, service quality and electricity price,
- Ensure respect of the principle of equal treatment of users for every customer in the electricity sector,
- Follow the application of technical standards and norms by the operators of the electricity sector,
- Ensure compliance of the electricity sector, the conditions of implementation of concession contracts, and authorisation by operators.
- Apply sanctions under the Act and provisions adopted for its implementation.

The Development Agency for Rural Electrification



The Development Agency for Rural Electrification (ADER) is an organisation set up by the state during the reform of the act of the electricity sector in 1999. Its role is to help with electrification of rural and sub-urban isolated villages of the interconnected grid; that means:

- Promote the emergence and development of electrical plants en rural areas, notably through the attribution of equipment grants, taken from the national Funds for electricity (FNE) foreseen by the first article of the act N°2002-001 of 7 October 2002 to reduce the tariff given to consumers;
- Insure conditions of technical, economic and financial viability of users in rural areas.
- Ensure, in coordination with the ERO, the preservation of the interests of end users in rural areas and strengthen the protection of their rights;
- Monitor activities related to rural electrification in all its economic, statistical and technical aspects;
- To support and promote rural development initiatives and the functioning of basic social services in rural areas.

It is under the technical supervision of the Minister of Electric Power, under the budgetary authority of the Minister for Budgeting and under the accounting supervision of the Minister of Public Accountancy.

ADER is provided with legal entity and administrative and financial autonomy.

In this context, ADER's responsibilities include promoting and encouraging the submission of projects for Rural Electrification. In addition, it periodically decides on the applications for funding and subsidies for the development of such projects.

Since its operational implementation in 2004, the ADER's has helped the development of electrification of a large number of rural communities in collaboration with private companies and village associations from 10 to 500kW. Some agencies with specialised solidarity in rural area (IEPF, Fondem Madagascar, etc...) can help and contribute to the creation of village associations projects. Currently production centres in rural areas produce approximately 720 MWh / year.

The source of funding for these projects comes from donations, grants, loans and equity that establish a price after validation by the EOR. Donations and grants can represent a significant proportion of funds to be raised.

In terms of planning, the objective of ADER is to establish a rural electrification plan for each of the 22 regions.

To this day, 6 regions (Analamanga, Androy, Anosy, Atsimo Andrefana, Ihorombe and Vakinankaratra) have been, with the help of the IED, the objects of a regional plan with the support of the rural electrification planning tool GEOSIM. This decision-supporting software

extracts and processes data introduced into the Geographical Information System (GIS) which requires in advance a certain amount of sectoral data to be gathered before being processed.

For each region, a list of clusters development (Fokontany priority) was established using criteria defined with the regional authorities.

A selection was made by district while focusing on non-electrified areas to establish a rural electrification plan by region.

GIS assists and supports the ADER since 2009 in planning and monitoring of technical studies (APS, APD) conducted by national design offices and in the financing of little hydropower plants selected (6) less than 1MW. Several hydrological studies (16) are currently underway.

The National Fund for Electricity

The National Fund for Electricity (FNE) was created in 2002 to finance the rural electrification development programs et on which were levied some investment subsidies given to holding operators of Autorisation or Concession.

It is operational since 2004, managed by ADER which assists and allocates grants from the National Energy Fund (NEF) to private rural electrification projects.

The resources consist of:

- loans and donations from financial institutions and international organizations granted to the state or local communities of Madagascar;
- special contribution from kWh consumption;
- credits and various grants or any other resources authorized by the Finance Act.

Currently this funding is not enough to develop many planned projects, especially projects of a larger size.

The project "Integrated Growth Poles" in Madagascar

The PIC is a project of the Malagasy government to fight against poverty and under its National Land Planning Strategy (SNAT). It aims to stimulate economic growth by promoting the private sector with financial support from the World Bank in sectors of Madagascar such as the electricity sector through horizontal actions (electrification scheme, demand, pricing , performance improvement).

To achieve its goals of private sector development, the PIC has opted for an approach that is in the spirit of public-private partnership (or PPP).

Four clusters were identified (Nosy Be, Fort Dauphin, Diego and Tulear) targeting different sectors of activity such as tourism, food processing, mining or port infrastructure.

Several PIC studies were involved in the project of Nosy Be and the Anosy region in partnership with RTA from thermal production. The hydropower site Bevory (12MW) on Ramena was proposed on the big island to be the supplier of the island of Nosy Be by submarine cable.

Two other studies on the Diana Region and the Atsimo-Andrefana region are underway with a search for hydroelectric sites around the communities of Toliara and Antsiranana and their respective peripheries. To supply the community of Antsiranana, three sites have sufficient power, they are Bevory, Andranomamofona of North Mahavavy, and Ampandriambazaha on the same river. The Bevory project which has been designed to supply Nosy Be and Ambanja is not suitable to supply Antsiranana, even if his power could be doubled considering its excessive distance.

The site of Andranomamofona (8 MW) was not kept due to the low energy yield and the installed power is low and unguaranteed. The Ampandriambazaha site (30MW) which has been the subject of a sketch study by the Hydelec company is a possible candidate, but not within 10 years, taking into account foreseeable difficulties during the realisation of its long line connection of 200km. Given the importance of the works to be done and the lack of studies, commissioning cannot take place before 2024.

Other sites have been identified such as Ambilobe and Anjanzanal, respectively 1.1 and 0.5 MW but with insufficient capacity to be the supplier of Antsiranana.

For the region of Tulear, and with present understanding, there is only the hydropower site of Nosy-Ambositra (20MW), north of Tulear in the region of Morombe, on the Mangoky River which is adapted for the construction of an important hydropower facility. This project could power Tulear and the region of Morombe but would require nearly 300Km of wiring. For the moment no studies have been carried out. This could be considered a possible candidate to power the community of Tulear and its region, if the investments can be spread out between multiple entities.

The group of hydropower sites proposed in the PIC should be considered as priority between the 30 sites to choose.

1.2.2 The regulatory framework for hydropower projects

The list of regulations applicable to dam, hydropower plant, power line, and roads to works construction projects is given in the appendix.

Act No. 98-032 of 20 January 1999 on the reform of the electricity sector in Madagascar, which marked the liberalisation of activities of generation, transmission and distribution of electricity, requires a revision to monitor the market and to facilitate the entry of new investors in the electricity sector. A draft amendment supplementing certain provisions of the law was proposed and validated in Parliament in 2008. It has been suggested to introduce other more incentive procedures such as consultation, the call for applications and the spontaneous application, and to raise the level of permits for hydropower plants of 150 kW to 1000 kW for the distribution of 500 kW to 1000 kW, following the increasing number of investors who seek to work on potential hydropower sites. Indeed, the provisions were

considered unattractive and insufficient, and do not facilitate the required investments, insofar as only the long and complex procedures that are related to the process of tender are applicable.

1.2.2.1 Procedures for granting of concession and authorisation

The allocation of concessions / authorisations falls within the jurisdiction of the Minister of Energy: choice of planning, developing public-private partnership, contract awarding method: competitive bidding or unsolicited application mode.

For the terms and conditions of licensing Production and distribution of electricity, the tender is the general rule. Spontaneous application must remain an exception.

In the electricity sector, the awarding of a contract for authorisation of a production unit is granted by the Minister by way of "bylaw" and the granting of a concession by the Council of Ministers by "decree". In the draft amendment to the law, it was suggested to raise the threshold power of hydropower facilities to 1000kW, instead of 150kW.

Types of contracts according to the production units are:

Production Unit	Capacity to install	Contract	Granted by
Thermal Hydropower	W ≤ 500 kW W ≤ 150 kW *(project : 1000kW)*	Authorisation	Bylaw of the MoE
Thermal Hydropower	W > 500 kW W > 150 kW *(project : 1000kW)*	Concession	Decree

To the distribution grid, granting concession is given by "Decree."

To the distribution grid, the allocation is based on the peak capacity:

Distribution Grid	Capacity (Pp) required	Contract	Grant
Peak capacity	Pp ≤ 500 kW (project : 1000kW)	Authorisation	Bylaw of the MoE
Peak capacity	Pp > 500 kW (project : 1000kW)	Concession	Decree

The proposed amendment of the law provides procedures of concession awards and of the following authorisations:

- Tenders;
- Consultation;
- Call for nominations;
- Unsolicited applications.

1.3 THE TYPES OF RENEWABLE ENERGY IN MADAGASCAR

The hydropower potential of the country is about 7,800 MW, but less than 2% are operated.

For the solar field, almost all regions of the country have more than 2,800 hours of annual sunshine.

Regarding the wind potential in general, the North (around Antsiranana) and the South (around Taolagnaro) have wind speeds greater than 7m / s which favour the production of electricity.

1.3.1 Hydropower

1.3.1.1 Generalities

Madagascar has a significant hydropower resources mainly located in the Centre, North West, North and East of the country, except in the south where potential sites are rare and riverflow is irregular. Hydropower sites are often identified from various documents (maps, aerial photos, etc.) and therefore available information is insufficient.

Consulted literature speaks of a hydropower potential of about 7,800 MW spread throughout the island, though it is not clear whether this is theoretical potential or usable potential. Currently, about 160 MW are operated representing approximately 2.06% of this potential. This power is mainly distributed on the interconnected grids of Toamasina (6.8 MW), Antananarivo (143.9 MW) and Fianarantsoa (5.9 MW) and 3.5 MW at Maroantsetra. The largest hydropower plant in the country is the plant of Andekaleka, currently equipped with three turbines (2x29 + 1x34 = 92 MW) of the 9 hydropower plants in service connected to the JIRAMA grids (Antananarivo, Toamasina and Fianarantsoa).

In 2013, the production of hydropower plants was at 809 GWh or 57% of total electricity generation (1,423 GWh gross to net 1405 GWh). The total consumption of electricity by the population though was 954 GWh. The difference between consumption and hydropower production is supplied by thermal power plants.

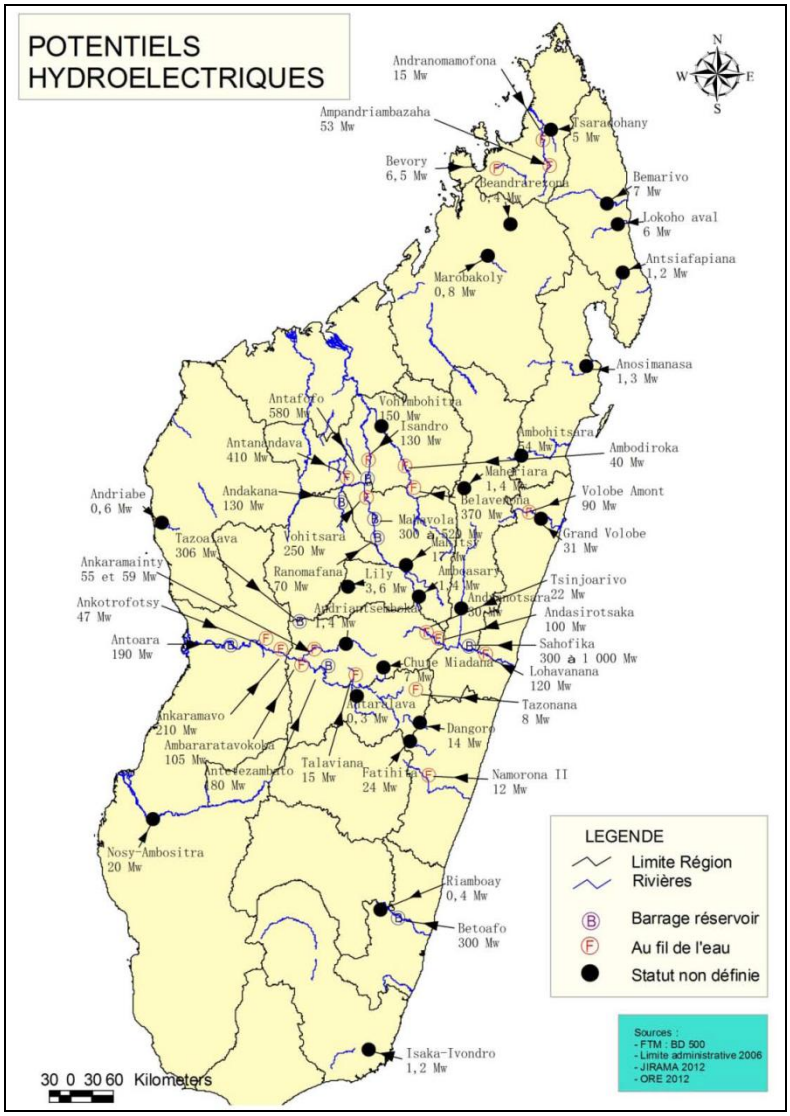


Chart 6 Location map of hydropower sites, origin WWF, September 2012

This map shows a few places where investors have expressed interest which have been the object of either preliminary studies or PDS or DDP and can serve a group of municipalities in one or more regions, sites that could replace thermal power plants currently. These sites will be bid in the expansion plan to be submitted to donors and / or private investors or through unsolicited applications or by tender.

Hydropower resources provide a sustainable response to the following two issues:

- meet the demand of economic activities and growing urban populations and rural populations who should also benefit from the development of large sites where costs are relatively lower compared to small sites; several candidate sites of significant size (greater than 150 MW) are located near highly populated areas of the country (Antananarivo, Antsirabe, Toamasina, Fianarantsoa) which should be interconnected in one common grid;

- Gradually increase the level of access of rural populations and geographical coverage from micro hydropower plants, which can produce closer to consumers by scaling works in relation to local demand, and which are very interesting and cost effective technology.

Hydropower is a natural renewable energy resource that can work with other intermittent renewables (wind, solar, biomass with bagasse or husked rice, geothermal, etc.) according to areas to cover long term needs of rural populations. The objective of the Government is a fast commitment towards hydropower to meet the country's needs and to enable sustainable development.

Currently micro and pico hydropower plants are also in operation for rural electrification (Antetezambato - Ambositra 42kW), managed by private associations, NGOs, local communities.

Private companies have expressed their interest in education, financing, construction and operation of hydropower plants of IPP's kind (Independent Power Producer's); the Ministry of Energy granted permissions for the study of finalisation of the file for a license application. Sites of interest to private companies have already been the object of either preliminary studies or studies of draft summary, or studies of detailed design carried out by the Ministry of Energy.

The dealer transportation network funds the studies and construction of transmission lines from the main plant to centres of consumption, but depending on the case, the IPP's promoter may also participate.

The investment cost per kW installed for hydropower projects of more than one MW is still very high compared to the average thermal output (between 2000 and 4000 U.S. $ / kW), operating costs vary in the range (3 - 6 U.S. $ / MWh).

Tax incentives have been taken by the Government to develop renewable energies such as small hydropower since 2010 exempting materials and equipment ENR.

1.3.1.2 Hydrology

The main rivers drain approximately 335,405 km2 of water, or 57% of the total land area. The water resources above ground are estimated at 332 km3 and groundwater resources at 55 km3. The 13 most important deductions are an estimated 493 million m3, of which 108 million are for irrigation and 385 million to hydropower.

The effects of climate change are felt in Madagascar. They are manifested by more frequent and sudden climatic events, but also by long-term and continuous changes. Significant warming is manifested by an increase in average air temperatures over the entire territory. Since 1950, average annual precipitation values for the northern part of Madagascar tend to decrease while those of temperatures increase. In the southern part it is the opposite, precipitation tends to increase with temperature. Detecting changes in annual precipitation is difficult because changes during the year may be offset, and it is mainly the distribution of rainfall during the year that varies.

On hydrological regimes, phenomena are cited such as "capture" between the two rivers Mahajamba and Kamoro currently evolving towards Mahajamba. We also observe the decreasing level and siltation of Lake Alaotra. Over the past 25 years, the average annual

number and intensity of cyclones affecting Madagascar increased (50 cyclones, Class 4-5 between 1990 and 2004 against 23 between 1975 and 1989).

All these events enormously disrupt the agricultural calendar causing yield losses and also causing devastation of crops by flooding and silting of plots. Among the specific measures to fight against these phenomena, the priority measure is the rehabilitation of meteorological stations, gauging stations of large reservoirs and rivers to monitor hydrographical systems and also for the larger lakes to better understand the importance and the evolution of variations.

We note that only the rivers around the city of Antananarivo have gauging scales as part of a flood alert system and the protection of the city in case of flooding.

1.3.2 Solar power

With 2.000 kWh/m²/year, Madagascar is among the richest countries in solar energy potential. This energy is currently used for cooking, heating, drying and generating electricity for telecommunications, lighting, storage of medicinal products, air conditioning and pumping.

For solar drying, the market is still to be tried, and existing facilities were not advertised. To facilitate increased access to this source of energy, a real extension is necessary. A program of rural pre-electrification by solar kits has been started and will continue according to the top rural electrification project.

More than 1,000 solar photovoltaic systems have been installed since the 90s. These are support tools in social and community activities in rural areas, in communities that are not receiving power, and their integration into social programs should be more common: health, education, security, street lighting, telecommunications, etc.

The "solar" thermal also presents many opportunities in urban areas. The gradual replacement of heating systems in hotels, hospitals and homes will contribute to clip demand during peak seasons.

Lowering prices on the world market for solar generators makes this technology attractive to potential users. However, the customs duties and taxes associated with the product are very discouraging and limit its popularisation in Madagascar. With many remote locations on the Island, solar power is the only alternative to modern energy.

1.3.3 Wind power

Wind energy resources are considerable but not evenly distributed over the national territory. This form of energy remains competitive for pumping and power generation especially in:

- the north (annual average wind speed of between 6 and 8 m / s at 50m high);
- the highlands (annual average wind speed of between 6 and 6.5 m / s at 50m high).
- the south (annual average wind speed of more than 6 and 6.5 m / s at 50m high);

- the far south: Taolagnaro, Tsihombe, Itampolo, Androka, Vohimena and Tanjona the average wind speed is greater than 8 to 9 m/s at 50 m high

The installation of hybrid plants is to be considered as a future action. In addition, wind farms with an injection to the grid are to be included in the programmes that are to be suggested to private sectors as part of the independent power production (IPP).

Finally, the wind pumping (multi-paddles) is an alternative to drainage system for drinkable water or herds drinking points.

The North Country has very many sites with annual average wind speeds greater than 8 m / s at 50m high. Nosy Be has very favourable wind resources, with sites where the average speed is greater than 9 m/s to 50 m high.

Cap Diego and the surrounding areas are really the best areas in the northern region of Madagascar to develop the first major wind projects. In fact, many sites can be identified depending on feasibility constraints:

- a significant wind resource, average speed at 50 m > 9 m/s;
- the proximity of roads access ;
- the proximity of urban centres;
- a potential for economic development;

Several sites can also be used, where the wind speeds are greater than 7.5 m/s at 50m: the coastline, close to the town of Sambava, Antsirabe area, the town of Marambato and its surroundings.

The centre of Madagascar (region extending from 16 ° to 24 ° south latitude): in this region, the average wind resource is between 6 and 6.5 m/s at 50 m.

The south: the far south of Madagascar is favourably exposed to winds.

For areas where vegetation and terrain do not play covering roles, an average wind resource greater than 6 to 6.5 m/s at 50 m high is estimated.

Several sites have an average wind speed greater than 8-9 m/s at 50 m. It must essentially cover the entire coast line of the far south of the country, particularly:

- Taolagnaro and Lokaro and surroundings;
- The South-East area near Tsihombe, by the seaside, windswept, with an average wind resource of 8 m/s to 50 m la zone;
- More to the South-West, the sites near Itampolo, Androka and Tanjona Vohimena, have speeds greater than 8 - 9 m/s at 50 m.

Installation of wind farm projects in the north and the far south are underway by private operators.

1.3.4 Other Types of Energy

Geothermal

The country has a few resource sites for geothermal energy. Madagascar s geothermal resources could be developed for the production of electricity and for direct recovery of heat potential (heating, drying of agricultural products, fish, spa, air conditioning, sea water desalination, etc).

However, in the current economic conditions, the implementation of this technology requires significant financial and technical efforts. A project has been started by the Geological and Mining Research Bureau (BRGM) to evaluate the geothermal potential.

Mineral Coal

Madagascar has a huge amount of coal (with a potential of around 3 billion tonnes including the Sakoa site), but the operating costs are very high. However, regarding the global current situation in the energy sector, the replacement of thermal diesel or Heavy Fuel Oil plants by coal begins to be an option in the medium term, thereby stabilising the costs of electricity. The current desire to use local resources requires the exploitation of identified coal deposits.

There are other potential resources of fossil fuels, with coal deposits in the south of the island (Sakoa) , and the natural gas reserves which are yet to be confirmed and the use of which could satisfy the industrial demand in the coming years.

Bagasse

Bagasse is a direct by-product developed from sugar. The energy efficiency of these facilities needs improving so as to increase power and do electrical cogeneration with JIRAMA grid.

Molasses

Molasses is operated for the production of ethanol. Its use as an alternative fuel is currently being tested.

Biofuel

Nowadays, projects of larger or smaller spans begin to emerge. The industry needs the support of donors to finance R&D and operations. The State will equally ensure the facilitation of land acquisition procedures and the establishment of a legislative and fiscal framework.

Currently, partnership agreements have been signed with private operators for the putting in place of facilities for ethanol production. Studies have shown that 975 million litres of ethanol that is used for domestic energy consumption can save our forests, given that in Madagascar, 80% of energy comes from wood. We need 975,000 ha of sugar cane. It currently lists 200 000 ha in Madagascar.

It is estimated that in 2009 the domestic production of Jatropha seeds economically justified the establishment of manufacturing plants for biodiesel.

Rice husk

Rice husk is primarily intended for firing construction bricks. This resource provides a very significant development potential for rice production areas.

Biogas

Biogas is a product of animal or vegetable waste. Technology, which is relatively easy, is availiable in rural area and its extension is encouraged. A project of producing electricity from household waste is being studied by the private sector in the region of Alasora - Antananarivo Atsimondrano.

Wood energy

The predominance of wood in the country's energy consumption, with 80% of total assets, has significant impacts on terrestrial and aquatic ecosystems. In some areas, unregulated gathering of wood creates real environmental degradation. Hence the need for a local approach, particularly in fragile ecology areas and in the areas of the supply basins of some major cities.

The relatively high electricity prices (from the connection, the indoor facilities, to the consumption) are a handicap to the access of the population to electricity.

Interventions in the field of wood energy can also lead to a massive reduction in greenhouse gas emissions, the combined effect of reducing the combustion of wood energy due to demand management, and the increased natural regeneration thus the CO_2 sequestration capacity of natural forests.

1.4 PROGRAMS AND SUPPORT PROJECTS TO DEVELOP SMALL HYDROPOWER

Programs and support projects to develop little hydropower projects have been primarily focused for micro hydraulics lower than 1 MW especially since the creation of the ADER in 2002 (Decree 2002-1550 of December 3, 2002) with more targeted funding.

Whereas, few projects have been recently developed and few studies made for small hydro ranging between 1 and 20 MW.

Technical studies undertaken (reconnaissance, sketching, feasibility or PDS) and support programs for all hydropower sites are summarised below.

The third generator (33.4 MW) of Andekaleka ([1]) has been commissioned since 2012 by JIRAMA installed by the Chinese company Sinohydro.

Since 2013, the PIC project intervenes in regional electrification schemes in four priority areas of growth with the completion of study offer-request at minimal cost. Several hydropower sites of little hydraulics have been identified as interesting:

- Bevory at 12 MW (studied in 1988 by Coyne & Bellier for a capacity of 6 MW) to power the island of Nosy Be and the resort of Ambanja;
- Nosy Ambositra at 20 MW to power the community of Toliary and which has not been studied to date;
- and Ampandriambazaha at 30 MW to power the community of Antsiranana and had been the object of a preliminary study by the company Hydelec.

Other smaller hydropower projects have been identified in these studies (under finalisation) for the sites of Tsiafampina (4 MW), of Andranomamofona (8 MW), and of the two small installations Ambilobe and Anjanzanal respectively 1.1 and 0.5 MW.

Many studies have been conducted in the context of rural electrification over the last 10 years for projects of less than 1 MW by ADER but also by other agencies with national consulting firms and private companies.

The construction of the hydropower plant of Ampasimbe Onibe (660kW) on Fanifarana River Atsinanana region is provided by the "rHYyvière" program. This project is cofinanced by the Tectra dealer, ADER and the European Union, a sum of 1, 5 million USD (TBC) for an estimated duration of 12 months work. Two other micro-projects are also planned :) Sahasinaka-Fenomby-Mahabako (80 kW), the development of Tolongoina (60 kW) has been in service since 2013.

Key stakeholders and project managers are mainly small hydropower:

- The EU, GRET and rHYvière program which were launched in 2008 to develop the micro-electricity;

[1] According to figures released in 2008, it amounted to 24 million Euros an dis funded y the Arab Development Bank (BADEA) and the Kuwait Fund. The Work thus lasted almost 5 years. In addition to installing machinery itself, dredging the retention pond and unblocking the supply channels of the turbines were also made during this period (Andekaleka also faces a water problem because it doesn't have a water storage tank which is the case of the Mandraka plant which includes the Mantasoa lake). The European Investment Bank may finance studies and project implementation of a 4th Andekaleka generator (totalling more than USD 20M) and other donors to the control dam of Fempona (between 100 and 300 hm3) including a 51MW plant (with 3 generators for a design flow of 36 m3 / s at a drop height of 168 m) for an estimated $ 240 million (including USD 184 million for the dam and USD 56 million for the plant). In 2014, China has shown a renewed interest in the resumption of Ambodiroka hydropower project (40 MW) on the river Betsiboka, 23 km from Maevatanàna to strengthen the capacity of Maevatanàna's, Mahajanga's and Antananarivo's grid production. It is estimated at 200 million USD for commissioning after 2020. An agreement and a contract was signed in 2006 for a project for 27MW; remained to be finalised the funding agreement between the governments and the implementation of various studies of commissioning contemplated at the time of the facts for 2015.

• UNIDO with the GEF (for the private operation or grant making), has shortlisted a number of priority sites for small hydropower plants with ADER in Sava (Bemanavy at 100 kW and Bejono at 400 kW) and around the Alaotra Lake (Androkabe at 1 MW and Maheriara at 350 kW), and the Ankompanihy site (4 MW). For these projects, PDS or DDP studies have been carried out.

- The ADER develops management plans with funding by the GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH) for 3 regions.
- The ADER conducted PDS studies of the Marobakoly hydropower project;
- RIAED and GVEP (supported by the European Commission, the IEPF and ADEME RIAED et GVEP);
- The engineering IED has developed the software Geosim for planning of rural electrification based on GIS technology;
- The E8 program with GIZ for the Lokoho project;
- The development of Lily, whose concession is owned by the company SAEE (3.5 MW), has been the subject of several proposals for funding ($ 7 M) including the FMO;
- Sociétés privées de droits malgaches ou opérateurs : Hydelec, EDM, etc. ;
- The ADB finance electrification projects on the island of Nosy Be and the project Saranindo (250 kW);
- The Office of National Education: BETC Nanala, Help, BE2, SM2E, etc.;
- Electricians Without Borders (ESF) with the project Rian'Ilemena;
- The company Tectra who will participate in the implementation and co-financing of the project Ampasimbe (660 kW) on the Fanifarana river that will supply electricity to four locations in the east and the rural district of Foulpointe;
- Private companies of Malagasy rights or operators: Hydelec, EDM, etc.;

- After the project Sahanivotry (currently 15 MW) commissioned in 2008, which supplies the grid RIA, the Hydelec company has completed several projects with Mahitsy (12 MW) in 2009, Maroantsera (2.4 MW) in 2009 and Voloina (2 MW) in 2010;
- HFF that made the Tsiazompaniry project (5.2 MW) in 2010 has two projects in planning (Vatomandry and Tsiroanomandidy).

2 Activities of the pre-diagnostic phase

2.1 MOBILISATION

Within the framework contract "PROVISION OF DATA AND SMALL HYDROPOWER RESOURCE MAPPING SERVICES", the consortium SHER Consulting Engineers in association with MHyLab was selected following a restricted invitation to tender for the study "Renewable Energy Resource Mapping: Small Hydro Madagascar". For this study, the consortium has partnered with the company ARTELIA-MADAGASCAR (Ex-SOMEAH). The specific contract was signed on 6 May 2014. Starting benefits was set at 12 May 2014's Mission start activities took place from 20 to 28 May 2014 in Antananarivo. The team present on-site consisted of the following experts:

- Gérard Chassard, Head of Mission;
- Pierre Smits, Assistant to Head of Mission;
- Gérard Malengé, Electrical engineer;
- Serge Lala Rakotoson, Hydrologist;
- Thomas Dubois, Civil Engineer;

During this mission, the team of experts focused on data collection and meetings with relevant institutions. Letters were written for the different requests for documents, by GIS layers and lists of sites.

2.2 PROGRAM OF MEETINGS AND INSTITUTIONS MET

The meeting schedule was developed and organised by the World Bank.

Time	Meetings	Venue
Wednesday 21 May 2014		
9:00	Inception Workshop	World Bank
15:00	OER Mrs Aimée Andrianasolo, Executive Chairman	OER Office
Thursday 22 May 2014		
10 :00	MoE Mr Ibrahim Abdallah / CEO Mr Tovo Ramanantsoa	MoE Office at Ampandrianomby

Time	Meetings	Venue
14:30	JIRAMA Mr. Augustin Ramanantsahala	JIRAMA Office Ambodifilaho (22 268 68)
16:30	INSTAT Mr Ravelomanantsoa Paul Gérard / CEO	INSTAT Office, 3rd floor Room 312
Friday 23 rd May 2014		
9:00	JIRAMA/DGAE Mm. Albert Ravelojaona	JIRAMA Office Antsahavola (22 361 34 ou 35)
14:30	DGRE /Min Eau Mr. Randrema Raymond	DAIEC - Ambohijatovo
Monday 26 May 2014		
9:00	European Union Mr. Claudio Bacigalupi, Section Head of infrastructure, transport and energy	EU Office
11 :00	ONUDI Niel Maïté, Chargé de Mission in economic development, energy and environment	UNIDO office
14:00	FTM Mr. Franck Razafindraibe, DG	FTM Office Ambanidia
14:00	Directorate General of Meteorology Mr Simon Razafindrabe, Head of Hydrology / Mr. Helison Razafindrakoto	Weather Office Room 33 Ampandrianomby
16:00	ONE Mr. Rakotoary Jean Chrysostôme, MD	ONE Office Antaninarenina
Tuesday 27 May 2014		
10:00	ADER + GIZ Mr Rakotoarimanana Mamisoa	Next to Assist building Alarobia
12:00	World Bank Coralie GEVERS, Local Representative	
14:00	Project PIC Andiantavy Hary, Electricity AT	Maison de la Réunion Isoraka
16:30	Wrap up meeting	Conference Room MoE Ampandrianomby

Table 1 Meeting Programme

2.3 GATHERED DATA AND MISSING DATA

2.3.1 Documentation and Survey

During the process of pre-diagnosis, the consultant team was able to collect from the various partners of many documents and sites list. The consultant also delved into his archives to complete this compilation. The documents list and collated studies are presented in Appendix 6.1.

2.3.2 Geographic Database (GIS data)

The GIS (Geographic Information System) can be described as part of two large groups:

- Raster data: it represents reality by means of uniform grid cells of a specific resolution. Each square (or grid cell) covers a geographical area and an attribute value is assigned to the cell;
- Vector data: graphics data described as points, lines, or surfaces (areas) with attributes.

The geographic data collected in the initial phase, which will supply the information system of the study can be summarised in the following table:

Raster Layers	Characteristics
Topographical Maps	1:1 000 000
	1:500 000
	1:100 000
Digital terrain model (MNT) :	SRTM v4.1 - 90m
	ASTER GDEM v2 - 30m
Geology	1:1 000 000
Soil map (ISRIC-WISE, 2006)	1:1 000 000
Map of soil degradation (ISRIC-GLASOD, 1991)	1:1 000 000
Bioclimates map	1:2 000 000
Map of agricultural potential	1:1 000 000
Soil map	1:1 000 000
	1:10 000 000
Geomorphological map	1:1 000 000
Satellite pictures	Landsat 1999
	Landsat 2005
	NOAA RFE v1 (Daily satellite rainfall estimates from 01/01/1995 to 31/12/2000)

	NOAA RFE v1 (Daily satellite rainfall estimates from 01/01/1995 to 31/12/2000)
	NOAA RFE v2 (Daily satellite rainfall estimates since 01/01/2001)
Map of the distribution of the population	FAO, CIAT, 2005
Average monthly precipitation and temperature	WorldClim
Daily Potential Evapotranspiration	USGS PET (Daily Potential Evapotranspiration since 01/01/2001)
Precipitation pattern	Collaborative Historical African Rainfall Model (Monthly rainfall from Jan 1961 to Dec 1996)
Vector layers	
Localities	FTM BD 500 000 FTM BD 200 000 FTM BD 10 000 - Antananarivo
Elevation	
Hydrography	
Land Use	
Roads	
Geology	
Rivers and Lakes	
Vegetation	IEFN 2000
	Clark 2005
	Kew 2007
Protected Areas	Koloala
Mining concessions	BCMM
Forested Areas	4 regions: Betsiboka, Bongolava, Analamanga, Itasy)
Data of the Census	2012
Administrative boundaries	2006 - Regions, Districts, Communes
Administrative boundaries	2009 – Fokontany (Greater Tana)
Location of potential and existing sites	Data ADER, MEM & OER

Table 2 Collected geographic data (GIS)

2.3.3 Hydrological data

For the inputs assessment, the consultant will use the best available data from the Madagascar Data Bank of Rainfall (BDHM) - data managed by the General Department of Meteorology (DGM). Although much of these data are from the time of ORSTOM (before 1980), 82 stations with a sufficiently long history have been identified with the Department of Hydrology DGM

(see Table 3) General Department of Meteorology (DGM). The data control of these stations has been made by this department.

The recently acquired data correspond to data that have been collected under the system of flood warning of the river Ikopa and its tributaries, managed by the Authority for the Protection against Flooding on the Plain of Antananarivo (APIPA).

This system which covers the upper basin of Ikopa (4,400 km2), and was commissioned in 2001, is composed of:

- 6 rainfall stations;
- 4 hydrometric stations;
- 8 hydro-rainfall stations.

The resulting data covered the period 2001-2008. Since 2008, the overall quality of the data collection system has generally deteriorated.

Note that, to compensate for the lack of recent hydrometric data, it is planned to use the best knowledge we have of rainfall by the implementation of hydrological modelling (rainfall-runoff). There is indeed daily rainfall estimated by satellite since 2001 (RFE v2 NOAA spatial resolution of ~ 10 km). Moreover, the DGM has recently produced decadal rainfall grids of the period from 1983 to 2010 with a spatial resolution of 2 km. The control of these grids was also made through the DGM.

In addition, information on monthly rates available from the GRDC (Global Runoff Data Centre) has been received for 35 stations and will also be analysed and incorporated into the hydrological database. The list of stations is shown on Table 4 - Data gauging stations available at GRDC.

Code	Nom	Rivière	Latitude (Sud)	Longitude (Est)
1250706503	ANTSAMPANDRANO	AMBOROMPOTSY	19.37 .00	47.03.00
1250201206	PONT RTE D'ARIVONIMAMO	ANDROMBA	18.58.00	47.25.00
1250201203	ANTSAHALAVA	ANDROMBA	18.52.00	47.52.00
1250201209	BEHENJY	ANDROMBA	19.13.00	47.30.00
1251100101	MANINGORY	ANDROMBA	17.24.10	48.38.20
1250201215	TSINJONY	ANDROMBA	19.07.45	47.30.40
1250501510	AMPASIMATERA	BEMARIVO	16.03.00	47.45.00
1251204003	AMBOASARY - EST	BESALY	24.21.00	45.57.00
1250200105	AMBODIROKA AMONT	BETSIBOKA	16.55.20	46.56.55
1253600115	AU BAC DE VOHILAVA	FARAONY	21.47.00	47.54.00
1251600110	NOSIARIVO (PONT ROUTE ANKAZOABO)	FIHERENANA	22.46.00	44.29.00
1250704305	AMBOHIMANDROSO RN 7 (P.K. 85)	IHAZOLAVA	19.29.00	19.29.00
1250104005	IHOSY	IHOSY	22.23.10	46.06.35
1250200203	AMBOHIMANAMBOLA	IKOPA	18.56.43	47.35.56
1250200212	ANOSIZATO	IKOPA	18.56.17	47.29.57
1250200221	ANTSATRANA (AMPOTAKA)	IKOPA	17.25.04	46.52.33
1250200225	BEVOMANGA AMONT	IKOPA	18.48.00	47.19.00
1250200224	BEVOMANGA AVAL	IKOPA	18.48.30	47.19.12
1250200212	ANOSIZATO	IKOPA	18.56.17	47.29.57
1250200230	BAC DE FIADANANA	IKOPA	18.09.45	46.56.54
1250200224	BEVOMANGA AVAL	IKOPA	18.48.30	47.19.12
1250703001	ILEMPONA	ILEMPONA	19.39.00	47.19.00
1251802003	FATIHITA	IVOANANA	21.03.00	47.45.00
1253200109	AU BAC DE RINGARINGA	IVONDRO	18.10.00	49.15.00
1250204503	NIAKOTSORANO (PONT TSARATANANA)	KATSAOKA	18.55.16	47.22.14
1250303505	MAROFAHITRA	KITSAMBY	19.16.00	46.46.00
1250307505	IFANJA	KOTOMBOLO	18.52.00	46.45.00
1250306906	ANTAFOFO CHUTES AVAL	LILY	19.01.30	46.41.00
1254400105	ANDAPA (JIRAMA)	LOKOHO	14.37.00	49.39.00
1250302505	MIANDRIVAZO	MAHAJILO	19.26.00	45.26.00
1253400107	AMBILOBE PONT NOUV. ECHELLE ORANGE	MAHAVAVY - NORD	13.12.00	49.03.00
1250600110	SITAMPIKY	MAHAVAVY - SUD	16.40.30	46.06.20
1250201905	SABOTSY-PONT GIROD	MAMBA	18.50.00	47.33.10
1250304505	AMBATOLAHY	MANAMBOLO	20.01.00	45.32.00
1252400115	TSIHOMBE	MANAMBOVO	25.19.00	45.29.00
1254100110	AU BAC D'ELANARY	MANAMPANIHY	24.04.03	47.04.03
1250205001	ANJOZOROBE	MANANARA	18.25.00	47.55.00
1250305005	SAHANIVOTRY	MANANDONA	20.08.00	47.05.00
1251800105	ANTSINDRA	MANANJARY	20.58.00	47.43.00
1253000101	AU BAC DE MAZAVALALA AMONT (MAHAZOA)	MANAMPATRANA	22.42.00	47.19.00
1251200115	IFOTAKA (AMPAIPAIKA)	MANDRARE	24.48.00	46.09.00
1250700110	MANGORO GARE	MANGORO	18.51.00	48.06.00
1250401515	BETROKA	MANGOKY	23.16.00	46.06.00
1250100115	BEVOAY RIVIERE	ANGOKY	21.50.10	43.52.18
1250401505	IANAKAFY	MANGOKY	23.21.00	45.26.00
1250100145	VONDROVE	MANGOKY	21.48.43	44.08.32
1250401515	BETROKA	MANGOKY	23.16.00	46.06.00
1250302002	ANKOTROFOTSY	MANIA	19.48.00	45.32.00
1251100101	ANDROMBA	MANINGORY	17.24.10	48.38.20
1250102010	FANORO	MATSIATRA	21.26.00	47.12.00
1250102009	IKIBO	MATSIATRA	21.16.08	47.02.50
1250802005	MENARAHAKA (RN27)	MENARAHAKA	22.38.00	46.29.00
1251400121	TRANOROA	MENARANDRA	24.42.00	45.04.00
1251900105	DABARA (PONT)	MORONDAVA	20.25.00	44.47.00
1254300110	VOHIPARARA	NAMORONA	21.14.00	47.23.00
1250400140	TONGOBORY	ONILAHY	23.21.00	44.19.00
1250702015	ILEMPONA	ONIVE	19.38.00	47.19.00
1250702010	TSINJOARIVO	ONIVE	19.37.00	47.42.00
1250201203	ANTSAHALAVA	ANDROMBA	18.52.00	47.20.00
1250201209	BEHENJY	ANDROMBA	19.13.00	47.30.00
1250201206	PONT RTE D'ARIVONIMAMO	ANDROMBA	18.58.00	47.25.00
1253200109	AU BAC DE RINGARINGA	IVONDRO	18.10.00	49.15.00
1252400115	TSIHOMBE	MANAMBOVO	25.19.00	45.29.00
1250302005	FASIMENA	MANIA	20.17.00	46.48.00
1250202315	AMBATOFOTSY AU P.K. 22	SISAONY	19.04.21	47.32.56
1253502003	AMBODIMANGA	RAMENA	13.45.00	48.30.00
1250306505	P.K 197.5	SAHANIVOTRY	20.06.00	47.05.00
1250803005	SAHAMBANO (RADIER RN 27) AMONT	SAHAMBANO	22.29.00	46.17.00
1251700105	BRICKAVILLE (VOHIBINANY)	RIANILA	18.49.00	49.04.00
1250503205	ANDAMPIHELY	SALOHY	15.39.00	48.36.00
1253500103	AMBANJA	SAMBIRANO	13.41.00	48.28.00
1250305505	SANDRANDAHY	SANDRANDAHY	20.20.00	47.18.00
1250503005	KALANDY	SANDRANGITA	15.44.00	48.43.00
1250202315	AMBATOFOTSY AU P.K. 22	SISAONY	19.04.21	47.32.56
1250202305	AMPITATAFIKA	SISAONY	18.56.40	47.29.00
1250202311	ANDRAMASINA	SISAONY	19.11.10	47.35.20
1250202313	ANKAZOBE	SISAONY	19.05.50	47.35.10
1250500101	ANTAFIATSALANA (PONT RN 32)	SOFIA	15.30.00	48.37.00
1252902510	ANKOBAKOBAKA	TSINJOMORONA	15.03.00	48.09.00
1250300110	BETOMBA	TSIRIBIHINA	19.42.00	44.58.00
1251702503	ANDEKALEKA AVAL	VOHITRA	18.44.00	48.58.00
1251702509	ROGEZ	VOHITRA	18.48.00	48.36.00

Table 3 Hydrometric stations of exploitable MDBR for the mission

grdc_no	river	station	country_code	lat	long	area
1389090	MANGOKY	BEVOAY	MG	-21.83	43.87	53225
1389100	MANGOKY	BANIAN	MG	-21.9	44	50000
1389200	MORONDAVA	DABARA	MG	-20.55	44.28	4650
1389230	TSIRIBIHINA	BETOMBA	MG	-19.72	44.96	45000
1389250	MANAMBOLO	AMBATOLAHY	MG	-19	45	1893
1389300	LINTA	EJEDA	MG	-24.37	44.52	1700
1389320	MENARANDRA	TRANOROA	MG	-24.7	45.07	5330
1389330	MANIA	ANKOTROFOTSY	MG	-19.8	45.53	17990
1389350	MAHAJILO	MIANDRIVAZO	MG	-19.5	45.5	14375
1389430	MANANANTANANA	TSITONDROINA	MG	-21.32	46	6510
1389450	IHOSY	IHOSY	MG	-22.38	46.12	1500
1389460	MANDRARE	ANDABOLAVA	MG	-24.22	46.32	4033
1389470	MANDRARE	AMBOASARY	MG	-25.03	46.38	12435
1389480	ZOMANDAO	ANKARAMENA	MG	-21.95	46.63	610
1389490	MANIA	FASIMENA	MG	-20.28	46.82	6675
1389500	IKOPA	ANTSATRANA	MG	-17.42	46.85	18550
1389520	BETSIBOKA	AMBODIROKA	MG	-16.93	46.93	11800
1389530	IKOPA	BAC FIADANANA	MG	-18.15	46.93	9450
1389540	MANANDONA	SAHANIVOTRY	MG	-20.12	47.08	973
1389550	IKOPA	BEVOMANGA	MG	-18.82	47.32	4151
1389560	MATSIATRA	IKIBO	MG	-21.55	47.07	2107
1389580	ONIVE	TSINJOARIVO	MG	-19.63	47.7	2990
1389600	MANANARA	MAROANGATY	MG	-22.93	46.97	14160
1389670	BEMARIVO	AMPASIMATERA	MG	-16	47.68	6515
1389680	MANANJARI	ANTISINDRA	MG	-20.65	47.72	2260
1389690	MANGORO	MANGORO	MG	-18.85	48.1	3600
1389700	MAEVARANO	AMBODIVOHITRA	MG	-14.6	48.53	2585
1389710	RAMENA	AMBODIMANGA	MG	-13.75	48.5	1080
1389720	VOHITRA	ROGEZ	MG	-18.8	48.6	1910
1389750	SAMBIRANO	AMBANJA	MG	-13.75	48.5	2980
1389760	SOFIA	ANTAFIANTSALANA	MG	-15.5	48.62	4100
1389780	IAROKA	BAC AMPITABE	MG	-19	48.95	1263
1389790	VOHITRA	ANDEKALEKA	MG	-18.73	48.97	1825
1389800	MAHAVAVY	AMBILOBE	MG	-13.15	49.07	3210
1389820	IVONDRO	RINGARINGA	MG	-18.18	49.25	2545

Table 4 Gauging stations data available at GRDC

2.3.4 Missing Data

The consultant must still collect the data from the Foreign Missions (China, Korea, Germany, Japan, Turkey, India, etc.) that have not been archived in national institutions.

3 Proposed methodology for analysis

- Collecting existing bibliographic data,
- Constitution of the complete database (characteristics and information on every known site),
- Criteria definitions,
- Using « SiteFinder » to find new sites of 1 to 20 MW,
- Determining the 30 promising sites to visit,
- Determining the 20 sites which will benefit from extra visits and the 10 river basins that will be equipped with hydrologic / hydrological measuring stations.

3.1 DEVELOPMENT OF THE DATABASE OF ALL POTENTIAL AND EXISTING SITES

The first step of analysis is to clean and concatenate the sites lists and the individual studies collected from different institutions (Department of Energy, OER, JIRAMA, ADER, etc.). An initial disposal of sites being found several times through different sources will be conducted. This work is accompanied by a careful examination of the geographic locations of sites to verify the relevance to their geographical location (is the site really on a river) and check that sites with different names are actually the same geographical site. An audit work of coordinate systems is also required. The selected datum is WGS84 and all the sites will be geo-referenced in this global standard.

In his methodology, the consultant will also include the existing sites in the database and in the geographic information system. Foreseen by the terms of reference of the study, this analysis seems essential to have a complete picture of hydropower in Madagascar and avoid that potential projects ignore existing projects

The consultant will also carry out an analysis of the hydropower potentials, throughout Madagascar, through his internally developed "SiteFinder" application. SiteFinder needs a Digital Terrain Model and information on the average of the annual precipitation to identify, by calculation, the sections of rivers with high potential for hydropower.

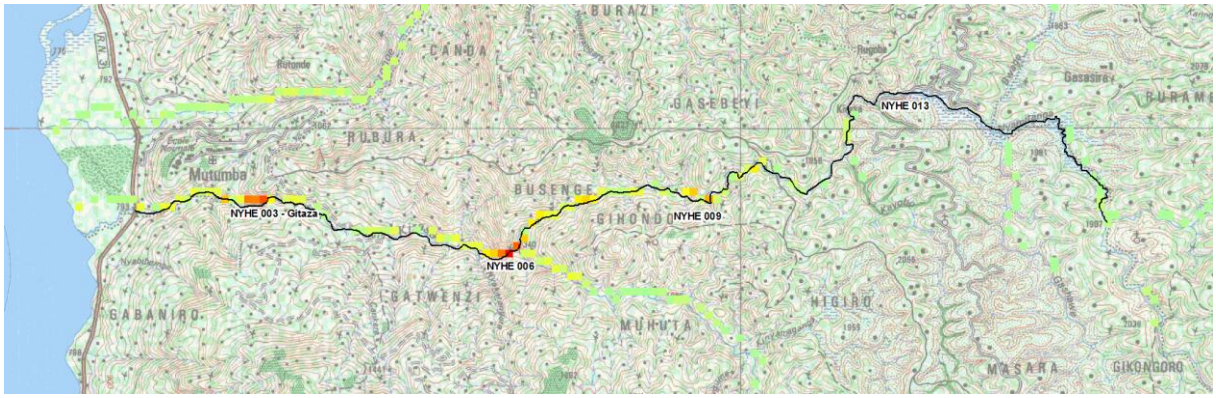


Chart 7 Example of results given by SiteFinder (the red pixels locate sections with high potential)

SiteFinder will be adjusted to best match the power range under study (1 MW-20 MW)

At the end of this stage, the product will be geo-referenced data including all existing and potential sites in the capacity range of about 50 kW up to larger projects data.

The study does not take into account the pico power less than 50kW. In fact, projects of only a few pico-kW can be installed almost anywhere where there is a stream comprising a low natural or artificial fall by implanting a threshold.

3.2 ANALYSIS OF SMALL HYDRO SITES (1-20 MW)

Following a preliminary analysis of documents and lists of sites collected during the starting phase we think we'll get a final list of about 600-800 geo-referenced sites of any capacity. Within this list, it should result in approximately 150 to 200 small hydro sites between 1 MW and 20 MW.

To this list of sites which are studied at very different levels, our methodological proposal is to analyse and calculate the following parameters:

- Location: site name, Province, Region, District, Commune, Fokontany (Village, Hamlet),
- River name,
- Geographical coordinates of the structure constructed across the river,
- Watersheds delineated from the DEM,
- Type of structure (run-of-river, with reservoir),
- Total head (verified on the basis of topographic maps and / or DEM),
- Mean annual flow,
- Flow of equipment,
- Equipment power,

- Average annual energy yield,
- Destination of the production: centres of consumption likely to be supplied (grid, towns, villages and hamlets),
- Studies carried out: levels of education, name of the Design Office and years of implementation,
- Other information.

And select sites with the following 11 criteria hierarchy (Step 1):

- 1. Energy Policy and Development Initiatives,
- 2. Mean annual flow (estimated by the hydrological model),
- 3. Potential capacity (based on standard performance over water),
- 4. Average annual energy yield,
- 5. Low flow discharge (available 70% of the time),
- 6. Approximate length of the access track(s),
- 7. Estimated length of the power line to closest centres for consumption,
- 8. Connection to existing interconnected grids (where one or more hydropower plants exist),
- 9. Connecting to a remote centre powered by thermal energy,
- 10. Indicative cost of the project,
- 11. Environmental impacts.

This information will be recorded in the database of potential sites

3.3 METHODOLOGY TO SELECT 30 POTENTIAL SITES

The end of phase 1 and 2, the Consultant will advise on a classification of sites to select the 30 promising sites which will visited in Phase 3 - Prioritization of small hydro and seminar sites.

The classification criteria that we suggest to implement are the following:

- Non-protected areas or sensitive (map ONE),
- unstudied PDS - DDP level sites,
- supported low flow (for sites to be connected to remote centres),

- Attractive indicative cost of installed kW (comparison between hydropower sites),
- Cost of kWh produced (must be less than that of the thermal).

Site visits will be on sites that have obtained the highest scores.

3.4 SELECTION OF THE 20 PRIORITY SITES

Site visits will allow to check at an early stage the assumptions used in the phase of literature review, including through a preliminary recognition during which the Consultant will prepare a preliminary outline of the structures (location of the dam, of the linear structures of the transport of water, and of the central and operation), will consider and prevent possible risks in subsequent phases of studies such as geological, hydrological and environmental risks.

The consultant will pay particular attention so that the outcome of this very preliminary stage and recommendations will be consistent with the WB's Safeguards policies, including: Operational Policy 4.01: Environmental Assessment; Operational Policy 4.04: Natural Habitats; Operational Policy 4.12: Involuntary Resettlement; Operational Policy 4.10: Indigenous Peoples; Operational Policies 4.37: Safety of Dams. The consultant will also carry out a classification of these sites according to their sensitivity to induced erosion of the watershed sediment transport. An estimate of the loss of production due to solid transport and the cost of desilting works will be taken into account.

The consultant will collate data about the 30 sites in a database and write an estimation of the costs and the expected outputs for each of them. The LCOE (*Levelized Cost Of Electricity* or in French: *Coût moyen actualisé de l'électricité*) will be calculated for each site with relative projects durations and discount rate.

Sites already considered may also be selected as priorities as those of PIC.

The choice of the 20 priority sites will be made among those which get the best LCOE (Levelized Cost of Electricity) by region, provided that the other criteria:

- Hydrological risks;
- Average annual Producible;
- Geological Problems;
- Environmental risks;
- Respect of the criteria « World Bank's Safeguards policies »(socio-environmental);
- Sensitivity to sediment transport (in terms of loss of production and in terms of additional costs);
- Indicative average cost updated of electricity (LCOE) in relation to investment in energy
- Execution time (administrative, land, engineering, financing, tendering, construction and others)

are at least satisfactory. Prioritisation will be suggested and validated during a participatory workshop.

3.5 SUMMARY OF THE ANALYSIS AND PRIORISATION PROCESS

The following diagram summarises the analysis and prioritization process through the study phases.

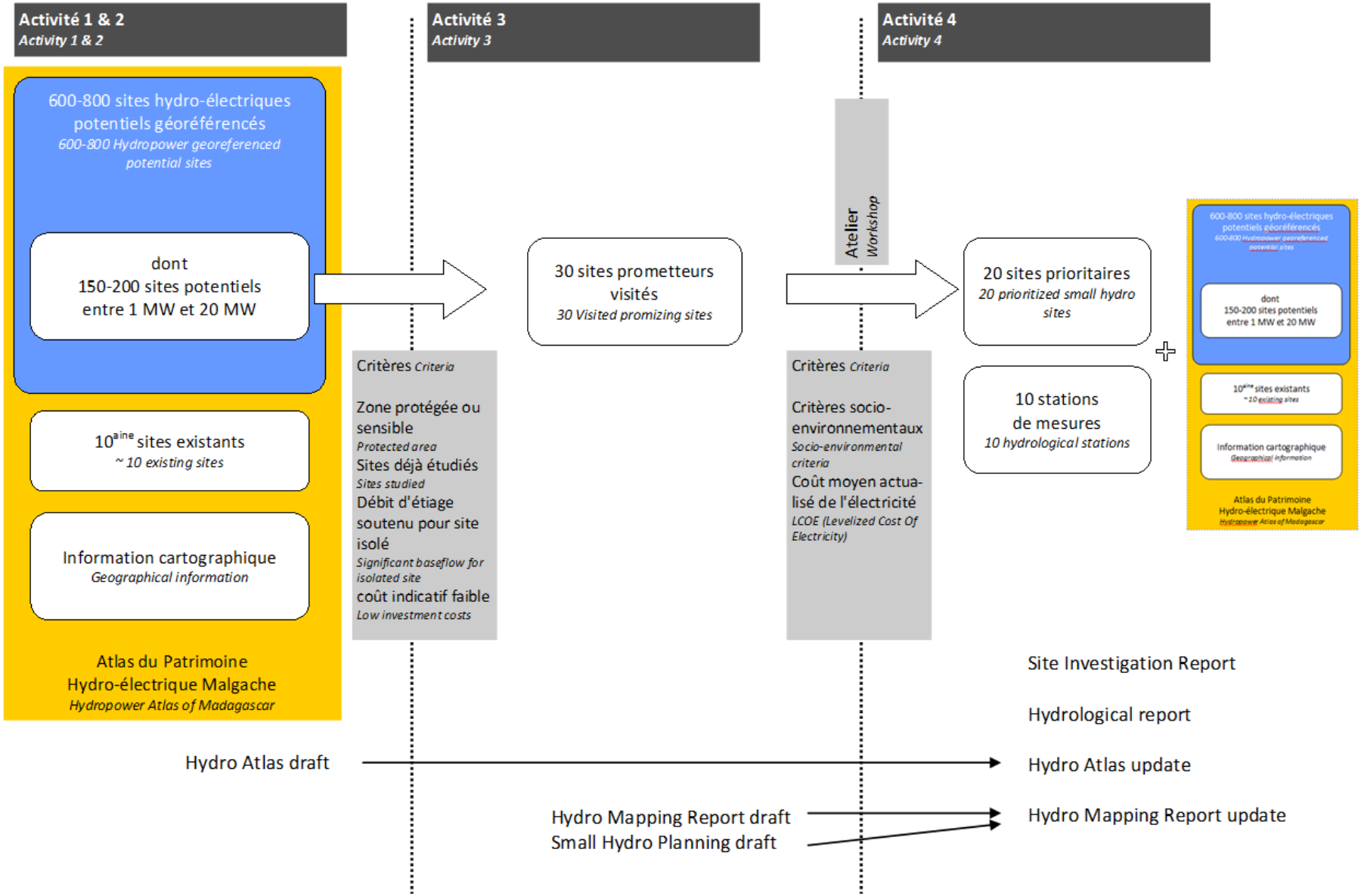


Chart 8 Analysis and Prioritisation Procedures

4 Updated Timeline

Presented below is the updated timeline according to the conclusions of the mission pre-diagnostic.
Information on rainy season is given indicatively.

Années	2014								2015												2016				
Mois	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5
Saison des pluies																									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
ACTIVITÉ 1 : COLLECTE DE DONNÉES ET PRODUCTION DE L' ATLAS HYDRO , EXAMEN ET VALIDATION DU PETIT POTENTIEL HYDROELECTRIQUE																									
DEMARRAGE : PRE-DIAGNOSTIC DU POTENTIEL HYDROELECTRIQUE DE MADAGASCAR																									
1 Réunions des parties prenantes à Antananarivo, collecte de données et compilation																									
2 Analyse pré-diagnostic , y compris l'évaluation institutionnelle																									
3 Définition des besoins des utilisateurs et spécifications techniques pour la SIG / BD																									
Rapport-de démarrage et de collecte des données		x																							
Réunion de la décision de présenter la discussion et de décision sur la méthodologie finale		x																							
CREATION D'UNE BASE SIG POUR LES INFORMATIONS NATIONALES SUR LE DEVELOPPEMENT HYDROELECTRIQUE																									
RECHERCHE DE SITES HYDRO NON IDENTIFIES																									
ANALYSE ET PRIORISATION DES SITES HYDRO LES PLUS PROMETTEURS																									
CONCEPTION DE L'ATLAS HYDRO																									
Hydro Atlas					x																				
ACTIVITÉ 2 : PLANIFICATION DES SITES DE PETITE HYDRAULIQUE																									
REVUE DETAILLEE DES PROGRAMMES D'ELECTRIFICATION POUR LA PETITE HYDROELECTRICITE A MADAGASCAR																									
IDENTIFICATION ET LOCALISATION DES SITES DE PETITE HYDRAILIQUE A PLANIFIER																									
PRIORITISATION DES SITES LES PLUS PROMETTEURS																									
ACTIVITÉ 3 : PRIORISATION DES PETITS SITES HYDRO ET SEMINAIRE																									
INVESTIGATIONS SUR LES 30 SITES PROMETTEURS																									
Rapport draft de plannification petite hydro et Rapport draft cartographie hydro								x																	
Atelier								x																	
PLANNING DETAILLE DE L'ACTIVITE 4									x																
ACTIVITÉ 4 : COLLECTE DE DONNÉES ET VALIDATION FINALE																									
INVESTIGATION SUR LES 20 SITES PRIORITAIRES																									
Rapport des investigations des sites											x														
SUIVI HYDROLOGIQUE																									
Rapport hydrologique																							x		
Atelier																								x	
MISE A JOUR DES DELIVRABLES DE L'ACTIVITE 3																									
Mise à jour de l'Atlas Hydro, du Rapport de plannification petite hydro et du Rapport cartographie hydro																									x

Legend
- Intervention
- Approbation WB/Client
- Workshop/Réunion
- x Rapport contractuel

5 Preliminary Conclusions

This ESMAP project launching step has allowed collecting of relevant data first and having a good overview of the field of small hydropower and its evolution over time through a hundred of collected technical and institutional documents.

To undertake the following steps of the study, the project team can have a complete set of maps, topographical, climatic, hydrological and geographical data.

With the GIS (Geographic Information System), we can merge the different lists of sites while avoiding duplication, and clarify any confusion between sites, such as place names, location and superposition.

This first clarification allows us to distinguish more than 600 sites that form the backbone of unexploited hydropower potential in Madagascar. The use of the "SiteFinder" tool will allow the detection of a number of potential new sites. The new database created will provide a comprehensive overview of the country's hydropower. The consultant will also take into account the mapping of existing sites, which was not initially foreseen in the terms of reference.

The database associated with the GIS will be strengthened, developed and re-analysed in the remainder of the study. It may be used by all entities including Electric Sector OER to which it can have access.

At this stage, with sufficient data, we believe that we can reach comfortably the activity objectives 1-4: identification of sites of small hydro planning, prioritisation of the most promising sites and collection of field data of these.

The selection of thirty promising sites will be guided by factual criteria validated during workshops such as the ability and regularity of the energy, the environmental issues, the topography and geology uncertainties, the sites which technical and economic studies are at a more advanced stage, etc.

Field visits to selected sites provide the latter with elements of topography, hydrology, geology and environment; new items for some sites and complementary to others.

Particular attention will be given to the site and equipment selection of hydrological measurements.

A gauging monitoring campaign will be established for minimum period of twelve months. The local agency responsible for coaching, implementing and hydrological monitoring will be appointed by the Ministry of Energy.

6 Annexes

6.1 BIBLIOGRAPHY

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2003	ETUDE D'AVANT PROJET SOMMAIRE DE L'AMENAGEMENT HYDROELECTRIQUE DU SITE DE BEANDRAREZONA SUR LA RIVIERE BEANDRAREZONA	?
2003	MONOGRAPHIE DE LA REGION DE SOFIA	Ministère de l'agriculture, de l'élevage et de la peche
2002	Etat d'inventaire des sites susceptibles d'alimenter la région de Toamasina	JIRAMA
2002	Etat d'inventaire des sites susceptibles d'alimenter le réseau interconnecté TANA et la province d'Antananarivo	JIRAMA
2001	Aménagement hydroélectrique d'Antafofo	EDF
2001	Aménagement hydroélectrique d'Antetezambato	EDF
2001	Aménagement hydroélectrique de Lohavanana	EDF
2001	Aménagement hydroélectrique de Volobe	EDF
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R3-0 ETUDE PRELIMINAIRE DES CANDIDATS HYDROELECTRIQUES	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R3-1 PEMC du Parc de Production	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R3-2A ETUDE DU RESEAU CIBLE 2015	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R3-2B PEMC DU RESEAU	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R4 PLAN D'INVESTISSEMENT A COURT TERME	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R5 ELABORATION DES COUTS DE FOURNITURES	EDF Sogreah
2001	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R6 SYNTHESE GENERALE	EDF Sogreah
2000	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R1 ETUDE DU MARCHE	EDF Sogreah
2000	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R2-1 IDENTIFICATION DES CANDIDATS HYDRAULIQUES	EDF Sogreah

Date de publication	Titre	Auteur
2000	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R2-2 IDENTIFICATION DES CANDIDATS THERMIQUES	EDF Sogreah
2000	Mini centrale hydroélectrique de la "Lokoho aval" à Andapa - étude de faisabilité	Tractebel Engineering
2000	La dynamique du secteur privé à Madagascar	AFD
1999	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT RM Mesures d'urgence	EDF Sogreah
1999	PLAN D'EXPANSION AU MOINDRE COUT DU RESEAU INTERCONNECTE D'ANTANANARIVO RAPPORT R0 DONNEES D'ENTREES DU PROJET	EDF Sogreah
1998	Données hydrologiques de la rivière Vohitra	JIRAMA
1993	Inventaire de la ressource en eau et mini-centrales	ORSTOM
1993	Fleuves et rivières de Madagascar	ORSTOM Pierre Chaperon, Joël Danloux, Luc Ferry
1992	Actes des Journées de l'Eau Gestion des ressources en eau	ANDRIAMBOAVONJY et al.
1991	Etude des crues: Les données d'observations et estimation des débits maximums	ORSTOM
1989	Etude d'inventaire de sites pour aménagements hydroélectriques - Recensement des sites	Someah
1988	Mini et microcentrales hydroélectrique à Madagascar TOME 2	COYNE et BELLIER
1988	Etudes de mini et micro centrales hydroélectriques à Madagascar	Coyne&Bellier
1986	Aménagements connexes à la construction du barrage réservoir d'Ankarahotra	APD - Note hydrologique
1986	Réhabilitation de l'aménagement Hydroélectrique du Grand Volobe	Coyne&Bellier
1984	Etude d'hydrologie à usage agricole	ORSTOM
1982	Etude hydrologique de la Vohitra supérieure : Ankorahotra	Direction de la Météorologie
1981	Aménagement Hydroélectrique du Grand Volobe	Etude Préliminaire - Annexes
1981	Plan d'Equipement de la Zone Interconnectée Volume 1 - Tome 1 - Eléments de base	Coyne&Bellier
1981	Plan d'Equipement de la Zone Interconnectée - Vol 2 Aménagement hydroélectrique de Sahofika sur l'Onive	Coyne&Bellier
1981	Plan d'Equipement de la Zone Interconnectée - Vol 3 Aménagement hydroélectrique de Mahavola sur l'Ikopa	Coyne&Bellier
1981	Etude d'hydrologie à usage agricole Rapport d'installation et premières mesures	ORSTOM

Date de publication	Titre	Auteur
1980	Barrage réservoir d'Ankorahotra - Rapport de factibilité	DAFECO
1978	Cyclones intéressant Madagascar (puis Saison cyclonique)	Direction de la Météorologie
1976	Etudes hydrologiques dans l'Ankaizina 1974-1976	ORSTOM
1972	Aménagement de la Vohitra - Chute d'Andekaleka	DAFECO
1972	ANNUAIRE HYDROLOGIQUE DE MADAGASCAR ANNEE 1968 -1969	ORSTOM
1971	Annuaires hydrologiques	ORSTOM
1971	BIOLOGIE COMPARÉE DE TILAPIA RENDALLI (BOULENGER) (Pisc. Cichl.) AU LAC ITASY ET AU LAC DE MANTASOA	ORSTOM, J. Moreau
1971	Propriété des Andosols de l'Itasy et de l'Ankaratra	ORSTOM
1970	Annuaire hydrologique de Madagascar	ORSTOM - Ministère des Mines et de l'Industrie de Madagascar
1969	Annales de Géologie Contribution à l'étude des surfaces d'aplanissement sur les Hautes Terres centrales malgaches	ORSTOM (Bourgeat et Petit)
1969	Application de la méthode de dilution (Jaugeages chimiques) sur les rivières de Madagascar	ORSTOM
1968	CARACTÈRES DES SURFACES D'APLANISSEMENT SUR LES HAUTES TERRES MALGACHES	ORSTOM (Bourgeat et Petit)
1967	Données hydrologiques de base	ORSTOM
1966	Données hydrologiques préliminaires pour 3 aménagements de Madagascar (Rogez/VOHITRA, Ranomafana/IKOPA, Volobe/Ivondro)	ORSTOM
1965	Etudes hydrologiques et programme de la décennie	UNESCO
1965	Bassins versants expérimentaux de l'Ankaboka	ORSTOM
1965	Etude des étiages des rivières Onilahy, Linta, Ménarandra et Manambovo en 1963 et 1964	ORSTOM
1965	NOTE HYDROLOGIQUE sur les RIVIERES des HAUTS-PLATEAUX de MADAGASCAR	ORSTOM
1965	L'Efaho à Fanjahira - Note Hydrologique	ORSTOM
1964	Monographie Hydrologique de l'Ikopa et de la Betsiboka	ORSTOM
1964	TENDANCES ACTUELLES DES i' ETUDES HYDROLOGIQUES DE LA RECHERCHE SCIENTIFIQUE ET TECHNIQUE OUTRE-MER	ORSTOM
1962	Annales de Géographie Le massif volcanique de l'Itasy (Madagascar)	René Battistini
1959	Annuaire hydrologique de la France d'Outre-Mer	ORSTOM
1954	Mémoires de l'insitut Scientifique de Madagascar ETUDE SUR LES "LAVAKA"	Riquier
?	Aménagement hydroélectrique au site d'Ampandriambazaha sur le Mahavavy nord	Hydelec SA
?	Inventaire des sites	JIRAMA
?	ASSESSING THE IMPACTS OF CLIMATE CHANGE ON MADAGASCAR'S BIODIVERSITY AND LIVELIHOODS	Conservation International & WWF

Date de publication	Titre	Auteur
?	Chute de l'Onibe à Andriamamovoka	EDF
?	Etude d'inventaire de sites pour aménagements hydroélectriques - Etude de reconnaissance de sites - rapport définitif	Someah
?	Listing de sites potentiels (hydro)	ADER
?	Sites hydroélectriques potentiels ORE	ORE

List of documents available in EDF-CIH's (73370 Le Bourget du lac - France)

Objet	Etude	Auteur	Disponibilite
Ankorahotra (Vohitra)	Rapport de factibilité 2 dossiers	EDF Août 1980	Archives CNEH
Ankorahotra	Etude d'impact 1 dossier	SOGREAH - SOMEAH Mars 1983	Photocopie document JIRAMA - Archives CNEH
Ankorahotra	APD barrage 1 dossier (2 volumes) 1 cahier de plans	COB 1982	Photocopie document JIRAMA - Archives CNEH
Ankorahotra : Aménagements connexes à la construction du barrage réservoir	APD 4 documents 3 dossiers de plans	EEDR MAMOKATRA Novembre 1986	Document consultable à JIRAMA (ex. unique) - Sommaire en archive au CNEH
Aménagement hydro-électrique de la Vohitra à Andekaleka (Rogez)	Rapport d'ingénierie 1 volume	SNC Juillet 1977	Photocopie document JIRAMA - Archives CNEH
Aménagement hydroélectrique de la Vohitra à Andekakeka	Plans d'exécution pour les principaux ouvrages	Cartier 1979-1980	Photocopie document JIRAMA - Archives CNEH
Aménagement hydroélectrique de la Vohitra à Andekakeka	Détail estimatif (génie civil et électro-mécanique) pour la réalisation des groupes 3 et 4		Photocopie document JIRAMA - Archives CNEH
Aménagement hydroélectrique de la Vohitra à Andekakeka	Rapport de visite		Photocopie document JIRAMA - Archives CNEH
PEZI Sites de Sahofika (Onivé) et Mahavola (Ikopa)	3 volumes 2 cahiers de plans	COB Mars 1981	Photocopie document JIRAMA - Archives CNEH
Grand Volobe (Ivondro)	Etude préliminaire 4 volumes	UNEFICO Mars 1982	Photocopie document JIRAMA - Archives CNEH
Etude de reconnaissance de sites hydroélectriques : - Ampano (Mania) autre nom : Antetezambato / Antatatsanahari	Rapport d'étude 1 dossier	JIRAMA Novembre 1983	Photocopie document JIRAMA - Archives CNEH

Objet	Etude	Auteur	Disponibilite
- Ankotrofotsy (Mania) Amboetsi (Mandrare) - Dangoro (Maitinandry)			
Etude de l'alimentation en électricité de la ville de Toamasina	Rapport d'étude 2 volumes	IED Juin 1997	Photocopie document JIRAMA - Archives CNEH
Inventaire EDF : Possibilités hydroélectriques des hauts plateaux malgaches	Inventaire 3 tomes	EDF 1964	Archives CNEH
Mini et microcentrales hydro. à MADAGASCAR	1 volume	COB Octobre 1988	Photocopie document JIRAMA - Archives CNEH
Aménagement d'ANTARALAVA (mini)	Rapport d'étude 1 note	MAGRAMA Mars 1993	Photocopie document JIRAMA - Archives CNEH
Aménagement de MAROANTSETRA (mini)	Actualisation de l'étude économique (1 note)	TR-ENGINEERING Septembre 1997	Photocopie document JIRAMA - Archives CNEH
Aménagement d'AMBODIROKA	Fiche signalétique	COB Décembre 1990	Archives EDF
Fiches d'inventaire de la JIRAMA Sites de 1 MW à 50 MW	Plans et fichier informatique (invent.xls)	JIRAMA	Plans récupérés à la Direction de l'Equipement Electricité (JIRAMA) - Archives CNEH

6.2 POWER STATIONS AND HYDROELECTRIC POWER PLANTS EXPLOITED BY JIRAMA

Source : JIRAMA

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
RI TANA ANTSIRABE	ANDEKALEKA	5505	VEVEY:JEUMONT	Francis	1982	29000	
		5506	VEVEY:JEUMONT	Francis	1982	29000	
		5507	HEC	Francis	2012	34000	
	MANDRAKA	5501	VEVEY/ALSTHOM	Pelton		6000	
		5502	VEVEY/ALSTHOM	Pelton		6000	
		5503	VEVEY/ALSTHOM	Pelton		6000	
		5504	VEVEY/ALSTHOM	Pelton		6000	
	ANTELOMITA	5206	ESCHER WYSS/ALSTHOM	Francis		1516	
		5207	ESCHER WYSS/ALSTHOM	Francis		1516	
		5208	ESCHER WYSS/ALSTHOM	Francis		1516	
		5209	ESCHER WYSS/ALSTHOM	Francis		500	
		5210	ESCHER WYSS/ALSTHOM	Francis		1516	
		5211	ESCHER WYSS/ALSTHOM	Francis		1516	
		5212	ESCHER WYSS/ALSTHOM	Francis		1516	
	MANANDONA	5213	ESCHER WYSS/SEM BBC	Francis		480	
		5214	ESCHER WYSS/ALSTHOM	Francis		480	
	Sahanivotry	HYDELEC		Francis	2008	15000	
	Tsiazompaniry	HFF		Francis	2010	5200	
	Ambohim/mbola	1306	PIELSTICK	18PC2 2V	1972		6000
		1307	PIELSTICK	18PC2 2V	1973		6000
		1308	PIELSTICK	18PC2 2V	1981		6000
		CT.IPP.1	CATER		2004		10000
		CT.IPP.2	CATER		2004		9200
		CT.IPP.3	CATER		2004		800
	Ambohim/mbola 2	0581	DEUTZ	BV16M640	2009		6250
		0582	DEUTZ	BV16M640	2009		6250
		0583	DEUTZ	BV16M640	2009		6250
		0584	DEUTZ	BV16M640	2009		6250
	Ambohim/mbola AGGREKO	Am.AGGR			2012		28000
	Tana Nord AGGREKO	Tn.AGGR			2012		0
	Ambohim/mbola HYDELEC	CTHD			2012		8000
	Mandroseza						40000
	PIA						25000
1B-DIR TANA 1	Ambatondrazaka	445	CATER	3408DITA	1992		200
		04122	CATER	3412STA	2009		640
		1428	POYAUD	6SCPZIr	1979		180
		2205	VOLVO	TAD1630G	1998		360
		2315	MITSUBISHI	S6R-PTA	2008		500
		24169	OLYMPIAN	2306	2006		320
	Amparafaravola	2289	VOLVO	TAD 733 GE	2009		160
		2431	PERKINS	1004	1996		56
		2265	VOLVO	TAD 733 GE	2008		160

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
	Andilamena	2232	VOLVO	TAD 733 GE	2008		160
		2264	VOLVO	TAD 733 GE	2008		160
		2470	PERKINS	P70	1997		56
		2504	JOHN DEERE		2006		100
	Anjozorobe	2483	PERKINS	P70	1998		56
		2484	PERKINS	P70	1998		56
		24129	OLYMPIAN	1306	2000		128
		24179	PERKINS	2428/1800	2009		80
	Anosibe An'Ala	0575	DEUTZ	BF 4L 914	2010		50
		2260	VOLVO	TD 520 GE	2008		50
		2490	PERKINS	1004.4TG	1998		50
		2499	PERKINS	1004-4TG	1998		50
		24204	PERKINS		2012		80
	Manakambahiny	0558	DEUTZ	BF 6L 914C	2009		82
		2432	PERKINS	1004	1996		56
		24168	PERKINS	P90	2004		72
	Tanambe	2235	VOLVO	TAD 731 GE	2008		120
		2248	VOLVO	TAD 731 GE	2008		120
		2503	JOHN DEERE		2006		80
		2293	VOLVO	TAD 941 GE	2010		250
1C-DIR TANA 2	Ampefy HYDRAULIQUE	5801	CIMELTA		1987		30
	Ankazobe Thermique	0576	DEUTZ	BF 6L 914	2010		82
		0585	DEUTZ	BF 4L 914	2010		50
		2492	CUMMINS	6CTA83G	1998		120
		24132	OLYMPIAN	1306	2000		128
	Fitososona HYDRAULIQUE	5702	BOUSSANT	FAH (B250)	1959		50
	Fenoarivo Centre	318	BERLIET	LE 520	1978		50
		2473	PERKINS	1004	1997		56
		2474	PERKINS	1004	1997		56
	Tsiazompaniry Thermique	0363	BERLIET	LE 520	1979		50
	Tsiazompaniry HYDRAULIQUE	5701	BOUSSANT	FAH (B250)	1956		50
	Tsiroanomandidy	446	CATER	3408DITA	1998		200
		0486	CATER	3306B	2000		200
		2316	MITSUBISHI	S6R-PTA	2008		500
R2-DIR TOAMASINA	Toamasina IV	0571	DEUTZ		2009		6.000
		0572	DEUTZ		2009		6.000
		0573	DEUTZ		2009		6.000
	Volobe HYDRAULIQUE	5201	ESCHERWYSS	T800FAV	1931	1.520	
		5202	ESCHERWYSS	T800FAV	1931	1.520	
		5203	ESCHERWYSS	T800FAV	1955	1.520	
		5401	NEYRPIC	FAV	1977	2.200	
	Toamasina	Tm.EN1.1	WARTSILA	9L20	2008		1.500
		Tm.EN1.2	WARTSILA	9L20	2008		1.500
		Tm.EN1.3	WARTSILA	9L20	2008		1.500
		Tm.EN1.4	WARTSILA	9L20	2008		1.500
		Tm.EN1.5	WARTSILA	9L20	2008		1.500
		Tm.EN2.6	AVK	9L20	2009		1.400
		Tm.EN2.7	AVK	18V32	2009		5.114
		Tm.EN2.8	AVK	18V32	2009		6.300
	Ambodiatafana	0464	CATER	3304	1993		50
		0465	CATER	3304	1993		50
	Antanambao Manampotsy	0594	DEUTZ	BF 4L 914	2011		50
		0595	DEUTZ	BF 4L 914	2011		50
		2489	OLYMPIAN	4236	1998		32
	Brickaville	4112	CATER	3304	2003		90

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
		2259	VOLVO	TAD 734 GE	2008		200
		2462	PERKINS	P160	1997		128
		2274	VOLVO	TAD734GE	2009		200
	Fenerive Est	2225	VOLVO	TAD1241GE	2008		300
		2286	VOLVO	TAD1241GE	2009		300
		04118	CATER	3412	2007		640
		1219	MGO	V12	2012		480
		Fe.HFF.1	CATER		2012		364
	Foulpointe	2285	VOLVO	TAD 941 GE	2009		250
		2279	VOLVO	TAD 733 GE	2009		160
		24135	OLYMPIAN	GEP200	2000		160
		24197	CUMMINS		2011		160
	Mahanoro	2273	VOLVO	TAD731GE	2009		120
		2290	VOLVO	TAD 941 GE	2009		250
			CATER	3306	2012		200
		0473	CATER	3306	1994		145
	Mananara Nord	04111	CATER	3306	2001		200
		0549	DEUTZ	BF 6L 914	2009		117
		2475	PERKINS	1006	1997		80
		24104	PERKINS	1006-6TG	1999		80
		24102	CUMMINS	6CTA83G	1998		120
		24205	CUMMINS		2012		160
		24148	OLYMPIAN	GEP110	2000		80
	Maroantsetra HYDRAULIQUE	CH.HD.1		FAH	2010		1.288
		CH.HD.2		FAH	2010		1.288
	Marolambo	0506	DEUTZ	F5L912ICXN	1990		36
		0592	DEUTZ	BF 4L 914	2010		50
		0593	DEUTZ	BF 4L 914	2010		50
	Sainte Marie	2213	VOLVO	TAD 740 GE	2004		200
		2222	VOLVO	TAD1241GE	2008		300
		2223	VOLVO	TAD1241GE	2008		300
		2224	VOLVO	TAD1241GE	2008		300
		2287	VOLVO	TAD 1241 GE	2009		300
	Soanieran'Ivongo	0514	DEUTZ	F6L912	2008		50
		0515	DEUTZ	F6L912	2008		50
		2282	VOLVO	TAD 733 GE	2009		160
		0574	DEUTZ	BF 4L 914	2010		50
	Vatomandry	2266	VOLVO	TAD 941 GE	2008		260
		24122	OLYMPIAN	1306-9TG2	2000		128
		24180	PERKINS	2330/1500	2009		80
	Ambodiriana HYDRAULIQUE	5301	MAGNAT'S	FAH	1953	90	
		5402	NEYRPIC	FAH	1953	40	
		5403	NEYRPIC	FAH	1953	40	
	Vavatenina	2249	VOLVO	TD 520 GE	2008		50
		2250	VOLVO	TD 520 GE	2008		50
		2251	VOLVO	TD 520 GE	2008		50
		2252	VOLVO	TD 520 GE	2008		50
		2256	VOLVO	TD 520 GE	2008		50
		24134	OLYMPIAN	GEP200	2000		160
			CUMMINS		2012		200
R3-DIR MAHAJANGA	Mahajanga city	2318	MITSUBISHI	S12R-PTA	2008		1.000
		2319	MITSUBISHI	S12R-PTA	2008		1.000
		ALCO	WARTSILA	18V32	2008		6.500
		BARBOSSA	WARTSILA	18V32	2009		6.500
		Mu.HFF.G1	CATER	3606TA	2003		1.800
		Mu.HFF.G2	CATER	3516TA	2008		1.400
		Mu.HFF.G3	CATER	3512	2010		1.200
		Mu.HFF.G4	CATER	3516TA	2006		1.400
		Mu.HFF.G5	CATER	3508B	2008		1.400

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
		Mu.HFF.G6	CATER	3512	2010		1.280
	Ambato-Boéni	0537	DEUTZ	BF 6L 914	2009		82
		0538	DEUTZ	BF6L914C	2009		117
		2275	VOLVO	TAD733GE	2009		160
	Ambatomainty	0541	DEUTZ	BF 6L 914	2009		82
		0590	DEUTZ	F4 L 914	2010		34
		0591	DEUTZ	F4 L 914	2010		34
		2478	PERKINS	4236	1997		32
	Anahidrano	0544	DEUTZ	F4 L 914	2009		34
	Analalava	0438	CATER	D3304-4B	1991		85
		0472	CATER	3304-4B	1994		85
		0524	DEUTZ	F6L912	2008		50
		0560	DEUTZ	F6 L 914	2009		58
	Antsalova	0543	DEUTZ	F4 L 914	2009		34
		24114	PERKINS	NS40 IIM	1998		32
		24113	PERKINS	NS40 IIM	1998		32
	Antsohihy	0488	CATER	3306B	2000		200
		04105	CATER	3306-ATAAC	2002		200
		0512	DEUTZ	BF8M1015CP	2008		360
		0513	DEUTZ	BF8M1015CP	2008		360
		0526	DEUTZ	BF6L914C	2009		117
		0527	DEUTZ	BF6L914C	2009		117
		1433	POYAUD	B6L85	2011		442
		1434	POYAUD		2011		320
		Me.EN.1	CUMMINS		2008		160
	Bealanana	2244	VOLVO	TAD 731 GE	2008		120
		2245	VOLVO	TAD 731 GE	2008		120
		2440	PERKINS	P70	1996		56
	Befandriana Nord	436	CATER	D3306DI	1991		136
		546	DEUTZ	BF 6L 914C	2009		106
		0547	DEUTZ	BF 6L 914C	2009		106
		2414	PERKINS	T430.122	1992		50
		24136	OLYMPIAN	1006	2000		80
		24137	OLYMPIAN	1006	2000		80
	Besalampy	0518	DEUTZ	F6L912	2008		50
		0559	DEUTZ	F4 L 914	2009		34
		2465	PERKINS	4236	1997		48
		24139	OLYMPIAN	1006	2000		80
	Kandreho	0564	DEUTZ	F4 L 912	2009		26
		2438	PERKINS	4236	1996		32
		2439	PERKINS	4236	1996		32
	Maevatanana	437	CATER	D3304-4B	1991		85
		04103	CATER	3306-ATAAC	2002		200
		2228	VOLVO	TAD 941 GE	2008		260
		1079	CATER	3406DI			200
	Maintirano	435	CATER	D3306DI	1991		136
		516	DEUTZ	BF6L913	2008		86
		0517	DEUTZ	F6L912	2008		50
		1420	POYAUD	6PZI	1982		80
		2277	VOLVO	TAD 731 GE	2009		120
		2278	VOLVO	TD 520 GE	2009		50
		24128	OLYMPIAN	1306	2000		128
		24206	CUMMINS		2012		135
	Mampikony	0439	CATER	3304-2B	1991		50
		0441	CATER	D3304-2B	1991		50
		2253	VOLVO	TAD 733 GE	2008		160
		2254	VOLVO	TAD 733 GE	2008		160
		0440	CATER	D3304-4B	1991		85
	Mandritsara	2246	VOLVO	TAD 733 GE	2008		160
		2247	VOLVO	TAD 733 GE	2008		160
		2421	CUMMINS	6CT836	1992		100

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
		24105	CUMMINS	6CTA83G	1998		120
		24208	CUMMINS		2012		160
			CUMMINS		2012		200
	Marovoay	457	CATER	3408B	1992		200
		04104	CATER	3306-ATAAC	2002		200
		2219	VOLVO	TAD1241GE	2008		300
		2280	VOLVO	TAD 733 GE	2009		160
		24196	PERKINS	GCB 330A	2009		200
	Mitsinjo	0577	DEUTZ	F4 L 914	2010		34
		0578	DEUTZ	BF 4L 914	2010		50
		2241	VOLVO	TD 520 GE	2008		50
		2479	PERKINS	4236	1997		32
		2480	PERKINS	4236	1998		32
	Morafenobe	2443	PERKINS	4236	1997		32
		2444	PERKINS	4236	1997		32
		24158	PERKINS		2000		50
		24195	PERKINS	2502/1500	2009		30
	Port-Bergé	0561	DEUTZ	BF 6L 914C	2009		106
		2255	VOLVO	TAD 731 GE	2008		120
		2281	VOLVO	TAD 733 GE	2009		300
	Soalala	2239	VOLVO	TD 520 GE	2008		50
		2240	VOLVO	TD 520 GE	2008		50
		2481	PERKINS	4236	1997		32
		2482	PERKINS	4236	1998		32
	Tsaratanana	2229	VOLVO	TD 520 GE	2008		50
		2230	VOLVO	TD 520 GE	2008		50
		2420	PERKINS	T6 354 4	1992		63
		24159	PERKINS		2002		52
R4-DIR FIANARANTSOA	RI Fianarantsoa	0103	AGO	V16VSDL240	1972		1400
		0511	DEUTZ	BV08M628	2002		1600
		2329	MITSUBISHI	S12H PTA	2009		850
	Namorona (Ambodikimba)	5101	EBARRA	JEC151FAV	1980	2800	
		5102	EBARRA	JEC151FAV	1980	2800	
	Manandray	5204	ESCHERWYSS	FAH en PF aux	1932		140
		5205	ESCHERWYSS	FAH en PF aux	1932		140
		5404	NEYRPIC	FAH	1963		170
	Befotaka	0589	DEUTZ	ADG 22	2010		17
		2447	PERKINS	3 152.4	1997		17
		2448	PERKINS	3 152.4	1997		17
	Betroka	0550	DEUTZ	BF 6L 914	2009		117
		2231	VOLVO	TD 733 GE	2008		160
		2491	PERKINS	1006-6TG	1998		80
		24182	PERKINS	1104C-44TAA	2009		80
		24207	CUMMINS		2012		160
	Farafangana	0434	CATER	D3406BDI	1991		150
		0467	CATER	3406BDI	1993		150
		2276	VOLVO	TAD731GE	2009		120
		2283	VOLVO	TAD 733 GE	2009		160
		24191	PERKINS	GCB 330A	2009		200
		24198	CUMMINS		2011		240
		2429	PERKINS	2006-TAG	1996		260
		24209	CUMMINS		2012		280
	Iakora	24107	PERKINS	NS40 IIM	1998		33,6
		24108	PERKINS	NS40 IIM	1998		33,6
		24189	PERKINS	2502/1500	2009		30
	Ihosy	466	CATER	3406BDI	1993		150
		2217	VOLVO	TAD1241GE	2008		300
		2218	VOLVO	TAD1241GE	2008		300
		24187	PERKINS	GCB 330A	2009		200
		24202	CUMMINS	NT-855-G2	2012		196

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
	Ikalamavony	0551	DEUTZ	BF 6L 914C	2009		82
		2450	PERKINS	T4236	1997		48
		2459	PERKINS	1006TG1/2	1997		80
	Ikongo	0562	DEUTZ	F4 L 914	2009		34
		24115	PERKINS	NS40 IIM	1999		33,6
		24116	PERKINS	NS40 IIM	1999		33,6
	Ivohibe	0565	DEUTZ	F4 L 912	2009		26
		0588	DEUTZ	BF 4L 914	2010		50
		2467	PERKINS	P60	1997		48
		2468	PERKINS	P60	1997		48
	Manakara	04106	CATER	3406	2002		300
		2288	VOLVO	TAD 1241 GE	2009		300
		2305	MITSUBISHI	S6R-PTA	2007		500
		24192	PERKINS	GCB 330A	2009		200
		Mk.HFF.1	CATER	3406	2010		220
	Mananjary	0487	CATER	3306B	2000		200
		2215	VOLVO	TAD1241GE	2008		300
		2216	VOLVO	TAD1241GE	2008		300
		24188	PERKINS	GCB 330A	2009		200
		24203	CUMMINS		2012		120
	Midongy Sud	0507	DEUTZ	F4L912	1992		30
		0523	DEUTZ	F4L912	2008		30
		2446	PERKINS	4236	1997		32
	Nosy Varika	0519	DEUTZ	F4L912	2008		30
		0520	DEUTZ	F4L912	2008		30
		2449	PERKINS	T4236	1997		48
	Ranohira	0461	CATER	3304BDI	1992		90
		0480	CATER	3304BDI	1997		85
		0552	DEUTZ	BF 6L 914C	2009		82
		0587	DEUTZ	BF 4L 914	2010		50
		2904	IVECO	8061I0605A500	2000		50
	Vangaindrano	0460	CATER	3304	1992		50
		2242	VOLVO	TAD 731 GE	2008		120
		2243	VOLVO	TAD 731 GE	2008		120
		2407	CUMMINS	CMS 55/2	1990		40
		24201	PERKINS		2012		100
	Vohipeno	2445	PERKINS	4236	1997		32
		2496	PERKINS	1004-4TG	1998		50
		24175	OLYMPIAN	GEP110	2008		80
		24176	OLYMPIAN	GEP110	2008		80
	Vondrozo	0580	DEUTZ	F4 L 914	2010		34
		24117	PERKINS	P44E	1999		35,2
		24164	PERKINS	P30E	2002		24
R5-DIR ANTSIRANANA	Antsiranana	04121	CATER	C32	2008		800
		1008	MAN	16V 30/45	1974		1600
		1009	MAN	16V 30/45	1971		1600
		2801	ABC	8DZC-1000-166A	1999		1600
		Ds.EDM	CUMMINS	V16	2004		2000
		Ds.EN.1	WARTSILA	9WL20	2007		1500
		Ds.EN.2	WARTSILA	9WL20	2007		1500
		Ds.EN.3	WARTSILA	9WL20	2007		1500
		Ds.EN.4	WARTSILA	9WL20	2007		1500
	ENELEC/AGGREKO	Ds.EN.5	WARTSILA	9WL20	2007+2012		13500
	Ambanja	0453	CATER	3406BDI	1992		150
		04110	CATER	3408	2003		400
		2291	VOLVO	TAD 1241 GE	2009		300
		2311	MITSUBISHI	S6R-PTA	2007		500
		2326	MITSUBISHI	S12A2-PTA	2008		640
		24200	PERKINS	3008/CSL	2011		440
		Aj.HFF.C	CATER	3406	2012		220

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
		Aj.HFF.O	CATER	3406	2012		220
	Ambilobe	04127	CATER	3412STA	2009		640
		2309	MITSUBISHI	S6R-PTA	2007		500
		2310	MITSUBISHI	S6R-PTA	2007		500
	Ampanefena	0478	CATER	3304BDI	1997		50
		0553	DEUTZ	BF 6L 914C	2009		106
		0570	DEUTZ	BF 4L 914	2010		50
		2458	PERKINS	2006	1997		280
	Andapa	2210	VOLVO		2004		200
		2221	VOLVO	TAD1241GE	2008		300
		2267	VOLVO	TAD 941 GE	2008		260
	Anivorano Nord	0443	CATER	D3304-4B	1991		85
		0476	CATER	3304BDI	1996		50
		0477	CATER	3304BDI	1996		50
		0528	DEUTZ	F6 L 914	2009		58
		0569	DEUTZ	BF 6L 914	2010		82
	Antalaha	0490	CATER	3406DITA	2000		300
		2207	VOLVO	TWD1630G-400	1998		300
		2313	MITSUBISHI	S6R-PTA	2008		500
		2314	MITSUBISHI	S6R-PTA	2008		500
		2327	MITSUBISHI	S12H PTA	2009		850
		2330	MITSUBISHI	S12H PTA	2009		850
		1218	MGO	V16	2012		1200
	Antsirabe Nord	0554	DEUTZ	F6 L 914	2009		58
	Nosy Be	04115	CATER	3516B	2004		1600
		04120	CATER	C32	2008		800
		04123	CATER	C32	2009		800
		24170	CUMMINS	QST30	2007		800
		24171	CUMMINS	QST30	2007		800
		1103	MERCEDES		2011		550
		1104	MERCEDES		2011		550
		1105	MERCEDES		2011		550
		04128	CATER		2011		400
		Nb/HFF+HFF PIC	CATER/	3412 / 3512B	2011+2012		1840
	Sambava	04109	CATER	3406C	2002		300
		04113	CATER	3406	2003		292
		04124	CATER	C18	2009		500
		04125	CATER	3412STA	2009		640
		2320	MITSUBISHI	S12R-PTA	2008		1000
	Vohemar	447	CATER	3406B	1992		150
		0498	CATER	3306B	2000		200
		04108	CATER	3406C	2002		300
		2220	VOLVO	TAD1241GE	2008		300
		2270	VOLVO	TAD 941 GE	2008		260
R6-DIR ANTSIRABE	Morondava	0499	CATER	3508B	2000		590
		04102	CATER	3406C	2002		300
		04126	CATER	3412STA	2009		640
		2203	VOLVO	TAD1630G	1998		360
		2226	VOLVO	TAD 941 GE	2008		260
		2261	VOLVO	TAD1641GE	2008		400
		2262	VOLVO	TAD 1242 GE	2008		320
		2263	VOLVO	TAD 1242 GE	2008		320
		Mr/HFF	CATER	3456	2012		364
	Ambatofinandrahana	0545	DEUTZ	F6 L 914	2009		58
		0546	DEUTZ	F6 L 914	2009		58
		2271	VOLVO	TD 520 GE	2008		50
		24146	OLYMPIAN	1306-9TG2	2000		128
	Ambositra	429	CATER	3406B	1990		200
		0433	CATER	D3412DITA	1992		280

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
		0509	DEUTZ	BF12M716V12	1996		350
		2209	VOLVO	TAD1630GE	2003		360
		2321	MITSUBISHI	S6R-PTA	2008		500
	Belotsiribihina	0423	CATER	D3304-DI	1985		85
		2257	VOLVO	TAD 731 GE	2008		120
		2258	VOLVO	TAD 731 GE	2008		120
		24145	OLYMPIAN	1306-9TG2	2000		128
		24181	PERKINS	1104C-44TAA	2009		80
	Mahabo	0414	CATER	D3304-2B	1976		50
		0521	DEUTZ	F6L912	2008		50
		0567	DEUTZ	F6 L 914	2009		58
		2202	VOLVO	TD71AG	1993		100
		2227	VOLVO	TD 520 GE	2008		50
		2451	PERKINS	T 4236	1997		48
		24194	PERKINS	1104C-44TAA	2009		80
	Manandriana	0555	DEUTZ	F4 L 914	2009		34
		0556	DEUTZ	BF 4L 914	2009		50
		0557	DEUTZ	BF 4L 914	2009		50
	Miandrivazo	0531	DEUTZ	F6 L 914	2009		58
		0532	DEUTZ	F6 L 914	2009		58
		0533	DEUTZ	BF 6L 914	2009		82
		0534	DEUTZ	BF 6L 914	2009		82
		24123	OLYMPIAN	1306-9TG2	2000		128
		24133	OLYMPIAN	1306	2000		128
R8-DIR TOLIARY	Toliary	0482	CATER	3516-AITA	1999		1000
		2307	MITSUBISHI	S12R-PTA	2007		1000
		2308	MITSUBISHI	S12R-PTA	2007		1000
		2324	MITSUBISHI	S12R-PTA	2008		1000
		2325	MITSUBISHI	S12A2-PTA	2008		640
		2328	MITSUBISHI	S12H PTA	2009		850
		Tu.HFF.G2	CATER	3516B	2009		1600
		Tu.HFF.G1 & G3	CATER		2012		2600
		Tu.HFF.G8	CATER	3516B	2008		1600
	Amboasary Sud	24177	OLYMPIAN	GEP110	2008		80
		24178	OLYMPIAN	GEP110	2008		80
		04129	CATER		2011		200
	Ambovombe	0529	DEUTZ	BF6L914C	2009		117
		0530	DEUTZ	BF6L914C	2009		106
		0566	DEUTZ	BF6L914C	2009		117
		24127	OLYMPIAN	1306	2000		128
	Ampanihy Ouest	535	DEUTZ	F6 L 914	2009		58
		536	DEUTZ	F6 L 914	2009		58
		0596	DEUTZ	BF 4L 914	2010		50
	Ankazoabo Sud	0540	DEUTZ	F6 L 914	2009		58
		0542	DEUTZ	F6 L 914	2009		58
		0474	CATER	3304	1996		50
		2456	PERKINS	4236	1997		48
	Bekily	2236	VOLVO	TD 520 GE	2008		50
		2237	VOLVO	TD 520 GE	2008		50
		2437	PERKINS	P70	1996		56
		24112	PERKINS	NS40 IIM	1999		34
	Beloha	0563	DEUTZ	F4 L 914	2009		34
		0586	DEUTZ	F4 L 914	2010		34
		2488	OLYMPIAN	4236	1998		32
	Benenitra	Gr.solaire		TGK 160m	2001		7,2
		0568	DEUTZ	F4 L 914	2009		34
		2410	PERKINS	4236	1992		32
	Beroroha	0579	DEUTZ	F4 L 912	2010		26
		24183	PERKINS	2502/1500	2009		30
		Br.ADER	PRAMAC		2007		32

REGIONS	CENTRALES	GROUPES Numéro	Marque	Type	Date de mise en service	PUISSANCE KW	
						HYDRO Existant	Thermique Existant
	Betioky Sud	458	CATER	3304	1992		50
		539	DEUTZ	F4 L 914	2009		34
		2268	VOLVO	TAD 731 GE	2008		120
	Bezaha	0471	CATER	3304	1993		50
		2233	VOLVO	TD 520 GE	2008		50
		2234	VOLVO	TD 520 GE	2008		50
		24144	OLYMPIAN	1006	2000		80
	Manja	24150	OLYMPIAN	1006	2000		80
		24173	OLYMPIAN	GEP110	2008		80
		24174	OLYMPIAN	GEP110	2008		80
	Morombe	459	CATER	3304	1992		50
		2238	VOLVO	TAD 731 GE	2008		120
		24147	OLYMPIAN	GEP110	2000		80
		24160	OLYMPIAN	GEH 175	2001		128
		24149	OLYMPIAN	1006	2000		80
		24161	OLYMPIAN	GEP 175	2002		128
	Sakaraha	2269	VOLVO	TAD 734 GE	2008		200
		2272	VOLVO	TAD734GE	2009		200
		2284	VOLVO	TAD 1241 GE	2009		300
	Taolagnaro	Fd.QMM			2011		3800
	Tsihombe	0468	CATER	3304	1992		50
		0522	DEUTZ	F6L912	2008		50
		2455	PERKINS	4236	1997		48

6.3 INCEPTION MISSION'S MEETING'S PRESENCE SHEETS

Mission d'inception du Consultant sectionné dans le cadre de la mise en cartographie stratégique des mini hydro à Madagascar (P145350)

Atelier du 21 mai 2014

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Mission d'inception du Consultant sectionné dans le cadre de la mise en cartographie stratégique des mini hydro à Madagascar (P145350)

Atelier du 21 mai 2014

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Mission d'inception du Consultant sectionné dans le cadre de la mise en cartographie stratégique des mini hydro à Madagascar (P145350)

Atelier du 21 mai 2014

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Mission d'inception du Consultant sectionné dans le cadre de la mise en cartographie stratégique des mini hydro à Madagascar (P145350)

Atelier du 21 mai 2014

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6.4 LEGAL FRAMEWORK APPLICABLE TO HYDROPOWER PROJECTS

- Les textes réglementaires applicables aux projets de construction de barrage, de centrale hydro-électrique de ligne électrique et de route sont :
- Loi N°98-032 du 20 Janvier 1999 portant réforme du Secteur de l'Électricité
- Décret N°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
- Décret N°2001-803 du 19 Septembre 2001 précisant l'organisation et le fonctionnement de l'Organisme Régulateur des Secteur de l'Électricité
- Décret N°2003-194 modifiant le décret N° 2001-803 du 19 septembre 2001 précisant l'organisation et le fonctionnement de l'Organisme Régulateur du Secteur de l'Electricité (ORE)
- Loi N°2002-1550 du 07 Octobre 2002 instituant l'Agence de Développement de l'Électrification Rurale (ADER)
- Décret N°2003-510 modifiant le Décret N°2002-1550 du 03 Décembre 2002 instituant l'ADER
- Loi N° 2002-001 du 07 octobre 2002 portant création du Fonds National de l'Electricité (FNE)
- Arrêté N° 6678-2001 du 19 Juin 2001 relatif aux déclarations et autorisations d'auto production d'énergie et électrique
- Arrêté N°4634-2001 du 13 Avril 2001 fixant La composition de la commission d'Appel d'Offres, la procédure de dépouillement et les modalités d'évaluation des offres pour la production et la distribution d'énergie électrique
- Arrêté N°12592 / 2001 fixant les montants et les modalités de paiement des frais d'instruction de demande d'Autorisation et des frais d'inscription de Concession et d'Autorisation
- Décret N° 2001-849 Portant conditions et modalités de fixation des prix de l'électricité
- Code de l'Eau: loi n° 98-029 du 20/01/99 (gestion, consommation et mise en valeur des ressources en eaux)
- Décret n°2003/192 fixant l'organisation, les attributions et le fonctionnement de l'Autorité Nationale de l'Eau et de l'Assainissement (ANDEA)

- Décret n°2003-793 fixant la procédure d'octroi des autorisations de prélèvement d'eau.
- (JO N°2885 du 26 janvier 2004, p.804)
- Décret N° 2003-942 relatif à l'utilisation hydroélectrique de l'eau
- Décret N° 2003-939 portantes organisations, attribution, fonctionnement et financement de l'Organisme Régulateur du Service Public de l'Eau et de l'assainissement (SOREA)
- Décret N° 2003-944 relatif au déclassement des cours d'eau, d'une section de ce cours d'eau ou d'un lac du domaine public
- La CONSTITUTION du 18 Septembre 1992, révisée le 08 Avril 1998.
- MECIE : décret n°99-954 du 15/12/99 modifié par le décret n° 2004-167 du 03/04/2004
- CHARTE DE L'ENVIRONNEMENT : Lois n°90-033 du 21/12/90 modifié par la loi n°97-012 du 06/06/97 (politique environnementale)
- POLLUTIONS INDUSTRIELLES : loi 99-021 du 19/08/99 (gestion et contrôle des pollutions industrielles)
- Ordonnance n°62-023 du 19/09/62 relative à l'expropriation pour cause d'utilité publique du Journal Officiel n°244 du 28/09/62 p.1951
- Arrêté Provincial n°292/PRO/DS/F du 30/09/1958 (périmètre de reboisement et de restauration)
- La loi n°2001-005 du 11 février 2003 portant Code de Gestion des Aires Protégées (COAP)
- Loi n°2005-019 du 17 octobre 2005 fixant les principes régissant les statuts des terres
- Loi n°2006-031 fixant le régime juridique de la propriété foncière privée non titrée
- Décret n°2003/464 de la 15/04/03 portante classification des eaux de surface et réglementations des rejets d'effluents liquides
- Décret n°2003/191 portant création des Agences de Bassin et fixant leur organisation attributions et fonctionnement
- Loi n° 94-007 du 26 Avril 1995 relative aux pouvoirs, compétences et ressources des
- Collectivités décentralisées.

- Loi 99.021 du 19 août 1999 portant politique de gestion et de contrôle des pollutions d'origine industrielle.
- Décret N° 2003-943 relatif aux déversements, écoulements, rejets, dépôts directs ou indirects dans les eaux superficielles ou souterraines
- Loi n° 93-005 du 28 Janvier 1994 portant orientation générale de la politique de la décentralisation
- Décret N° 2003-945 relatif à l'organisation administrative de l'eau et au transfert de compétences entre les différentes collectivités décentralisées
- Décret n° 96.248 du 27 Mars 1996 déterminant le titre des Représentants de l'Etat auprès des collectivités territoriales décentralisées
- Loi n° 94-001 du 26 Avril 1995 fixant le nombre, la délimitation, la dénomination et les chefs- lieux des collectivités décentralisées
- Loi n° 94-007 du 26 Avril 1995 relative aux pouvoirs, compétences et ressources des collectivités territoriales décentralisées
- Loi n° 94-008 du 26 Avril 1995 fixant les règles relatives à l'organisation, au fonctionnement et aux attributions des collectivités territoriales décentralisées,
- Arrêté n° 6830/2001 fixant les modalités et les procédures de participation du public l'évaluation environnementale
- Décret n° 95-607 du 10 septembre 1995 portant création et organisation de l'Office National pour l'Environnement, et ses modificatifs
- Ordonnance 90-007 du 20 Août 1990, portant orientation de la politique de l'eau et de l'électricité modifiée
- Arrêté N°12592 / 2001 fixant les montants et les modalités de paiement des frais d'instruction de demande d'Autorisation et des frais d'inscription de Concession et d'Autorisation
- Loi n° 96-025 du 30 Septembre 1996 relative à la gestion locale des ressources naturelles renouvelables,
- Décret n° 2000-027 du 13 janvier 2000 relatif aux communautés de base chargées de la gestion locale des ressources naturelles renouvelables
- Loi N° 60-004 du 15 Février 1960 relative au domaine privé de l'Etat, ensemble les textes qui l'ont modifiée et complétée ; (Décret N° 64-205 du 21 mai 1964, 'ordonnance n° 62-047 du 20 septembre 1962 *(J.O. n°356, du 30.5.64, p. 1036),* modifié par décret n°76-165 du 21 avril 1976 *(J.O n° 1125 du 8.5.76, p. 1140).*

- Loi N°60-146 du 3 octobre 1960 relative au régime foncier de l'immatriculation, ensemble les textes qui l'ont modifiée et complétée ;
- Décret n°2000-028 du 14 février 2000 relatif aux médiateurs environnementaux *(J.O. n° 2627 du 14.02. 2000, p. 1439)*
- Ordonnance N°82-029 du 6 novembre 1982 relative à la protection, la sauvegarde et la conservation du patrimoine national *(J.O. n° 1525 du 6.11.82, p. 2513)*
- Décret N°83-116 du 3 mars 1983fixant les modalités d'application de l'ordonnance n° 82-029 du 6 novembre1982 sur la sauvegarde, la protection et la conservation du patrimoine national (J. O.N° 1557 du 23.4.83, p. 946), modifié et complété par le décret n° 91-017 du 15 juin1991 (J.O. n° 205)
- Ordonnance N°83-030 du 27 décembre 1983 tendant à renforcer la protection, la sauvegarde et la conservation du domaine privé national et du domaine public (J.O. n°1606 du 7.1.84, p. 8)
- Ordonnance N°60-099 du 21 septembre 1960 réglementant le domaine public (J.O. n°122, du 24.9.60, p.1909), modifiée par ordonnance n° 62-035 du 19 septembre 1962 (J.O. n° 244, du 28.9.62, p. 1975) TITRE PREMIER : DEFINITION, CONSISTANCE, CONSTITUTION ETCONDITION JURIDIQUE DU DOMAINE PUBLIC.
- Décret N° 64-291 du 22 juillet 1964 fixant les règles relatives à la délimitation, l'utilisation, la conservation et la police du domaine public (J.O. n° 368 du 1.8.64, p.1493)
- Loi no 97.017 du 08 Août 1997 portant révision de la législation forestière
- Décret No 98-781 fixant les conditions générales d'application de la loi no 97.017 du 08 Août 1997 portant révision de la législation forestière.
- Décret no 97.1200 du 02 Octobre 1997 portant adoption de la Politique Forestière Malagasy.
- Ordonnance modifié le N° 060-127 du 03 octobre 1960 fixant le régime des défrichements et des feux de végétation
- Loi n° 94-027 portant code d'hygiène, de sécurité et d'environnement du travail (Jorn N° 2337 du 04.12.94 - p. 3670-3671)
- Loi N°98-026 portant refonte de la charte routière
- Instruction interministérielle de 1998 réglementant les modalités de fixation et de gestion des taxes communales et surtaxes sur l'eau et l'électricité
- Ordonnance N°74-002 du 04 Février 1974 portant orientation de la politique de l'eau et de l'électricité

- Ordonnance N°74-003 du 09 Février 1974 portant réorganisation des secteurs de l'eau et de l'électricité
- Ordonnance N°75-024 du 17 Octobre1975 créant la Jiro sy Rano Malagasy
- Ordonnance N°75-032 du 31 Octobre 1975 portant la dissolution de SMEE et confiant à la JIRAMA ses anciennes attributions

6.5 ADMINISTRATIVE DIVISION

Madagascar (587.040 km2) is sub-divided into 6 provinces (Antananarivo, Antsiranana, Tomasina, Toliara, Fianarantsoa et Mahjunga) and 22 regions, for a total population of 22,5 million inhabitants (average density of 26hab/km2).

Région N°	Nom	Capitale	Population	Superficie km²	Densité
1	Diana	Diégo Suarez	485 800	19 266	25,2
2	Sava	Sambava	805 300	25 518	31,6
3	Itasy	Miarinarivo	643 000	6 993	91,9
4	Analamanga	Antananarivo-Renivohitra	2 811 500	16 911	166,3
5	Vakinankaratra	Antsirabe	1 589 800	16 599	95,8
6	Bongolava	Tsiroanomandidy	326 600	16 688	19,6
7	Sofia	Antsohihy	940 800	50 100	18,8
8	Boeny	Mahajanga	543 200	31 046	17,5
9	Betsiboka	Maevatanana	236 500	30 025	7,9
10	Melaky	Maintirano	175 500	38 852	4,5
11	Alaotra-Mangoro	Ambatondrazaka	877 700	31 948	27,5
12	Atsinanana	Taomasina	1 117 100	21 934	50,9
13	Analanjirofo	Fenerive est	860 800	21 930	39,3
14	Amoron'i Mania	Ambositra	693 200	16 141	42,9
15	Haute Matsiatra	Fianarantsoa	1 128 900	21 080	53,5
16	Vatovavy -Fitovinany	Manakara	1 097 700	19 605	56,0
17	Atsimo-Atsinanana	Farafangana	621 200	18 863	32,9
18	Ihorombe	Ihosy	189 200	26 391	7,2
19	Ménabe	Morondava	390 800	46 121	8,5
20	Atsimo-Andrefana	Toliara	1 018 500	66 236	15,4
21	Androy	Ambovombe Androy	476 600	19 317	24,7
22	Anosy	Taolagnaro	544 200	25 731	21,1

Population globale	*Régions*	*Villes*	*Habitants*
4 638 000 hab.	Analamanga	Antananarivo	1 391 500 hab.
	Bongolava	Antsirabe	182 800 hab.
	Itasy	Antanyfotsy	70 625 hab.
	Vakinankaratra	Soavinandriana	40 450 hab.
		Faratsiho	37 560 hab.
		Manjakandriana	31 850 hab.

Province d' Antsiranana

Population globale	*Régions*	*Villes*	*Habitants*
1 188 500 hab.	Diana	Antsiranana	82 950 hab.
	Sava	Antalaha	34 150 hab.
		Sambava	31 550 hab.
		Ambanja	30 350 hab.

Province de Taomasina

Population globale	*Régions*	*Villes*	*Habitants*
2 593 000 hab.	Alaotra	Taomasina	206 400 hab.
	Analanjirofo	Amparafaravola	51 550 hab.
	Mangoro	Ambatondrazaka	43 150 hab.
	Atsinanana	Mananara Avaratra	41 250 hab.
		Mahanoro	39 900 hab.
		Soanierana Ivongo	39 300 hab.
		Vavatenina	37 000 Hab.

Province de Toliara

Population globale	*Régions*	*Villes*	*Habitants*
2 229 550 hab.	Androy	Toliara	115 400 hab.
	Anosy	Ambovombe	66 900 hab.
	Atsimo Andrefana	Tolagnaro	45 150 hab.
	Ménabé	Morondava	36 800 hab.
		Amboasary	36 100 hab.
		Betioky	31 150 hab.

Province de Fianarantsoa

Population globale	*Régions*	*Villes*	*Habitants*
3 366 000 hab.	Amoron'i Mania	Fianarantsoa	167 250 hab.
	Atsimo Atsinanana	Nosy Varika	37 150 hab.
	Haute Matsiatra	Manakara	35 500 hab.
	Vatovavy-Fitovinany	Ikongo	32 400 hab.
	Ihorombe	Fandriana	31 450 hab.
		Ambositra	30 350 hab.

Province de Mahajunga

Population globale	*Régions*	*Villes*	*Habitants*
1 734 000 hab.	Betsiboka	Mahajanga	154670 hab.
	Boeny	Marovoay	31 250 hab.
	Melaky		
	Sofia		

6.6 LIST OF SITES IDENTIFIED DURING THE PRE-DIAGNOSTIC PHASE

MADAGASCAR

HYDROELECTRIC SITES (less than 60 MW)

SITES HYDROELECTRIQUES (SITES < 60 MW)

REGION	SITE	River	Réf. études existantes	Débit équip m3/s	Head (m)	Installed Capacity (MW)	Study Level
DIANA	Andranomamofona	Mahavavy Nord / Run of river	INV JIRAMA	20	103	15	on map
	Ampandriambazaha	Mahavavy Nord / Run of river	INV JIRAMA	50	150	53	on map
	Bevory	Ramena / Run of river	Mini-micro COB	10	89	6,5	Preliminary (1987)
MENABE	Ankaramainty	Iandratsay / Run of river	PEMC-RI TANA	50	140	55	on map
	Ankotrofotsy	Mania / Run of river	INV JIRAMA	115	56	47	Reconnaissance
BETSIBOKA	Ambodiroka	Betsiboka / Run of river	INV JIRAMA	90	56	40	Feasability (1982)
VAKINAKARATRA	Tsinjoarivo	Onive / Run of river	PEMC-RI TANA	50	54	22	Preliminary (1959)
	Talaviana	Manandona/with Storage capacity	PEMC-RI TANA	15	121	15	Preliminary (1959)
VATOVAVY FITOVINANY	Namorona II	Namorona/Run of river	INV JIRAMA	16	92	12	Reconnaissance
AMORONI MANIA	Tazonana	Maintinandry/Run of river	PEMC-RI TANA	10	100	8	Preliminary (1987)

March 2008

CENTRALES HYDROELECTRIQUES EXISTANTES A MADAGASCAR EXPLOITEES PAR JIRAMA							
REGIONS	Nom	Groupes			Date mise en service	Puissance (MW)	Localisation
		Numéro	Marque	Type			
RI TANA ANTSIRABE	ANDEKALEKA	5305	VEVEY:JEUMONT	Francis	1982	28,00	Rivière VOHITRA au PK 206 sur la férre cote ouest de madagascar
		5306	VEVEY:JEUMONT	Francis	1982	28,00	
		5307	HEC	Francis	2012	34,00	
	MANDRAKA	5501	VEVEY/ALSTHOM	Pelton		6,00	Mandrka se situe prés du Village de Marozevo sur la RN2 PK 75km de la capital Antananarivo
		5502	VEVEY/ALSTHOM	Pelton		6,00	
		5503	VEVEY/ALSTHOM	Pelton		6,00	
		5504	VEVEY/ALSTHOM	Pelton		6,00	
	ANTELOMITA	5206	ESCHER WYSS/ALSTHOM	Francis		1,52	Commune Ambatomanga district Manjakandriana 35 km de la capital
		5207	ESCHER WYSS/ALSTHOM	Francis		1,52	
		5208	ESCHER WYSS/ALSTHOM	Francis		1,52	
		5209	ESCHER WYSS/ALSTHOM	Francis		0,50	
		5210	ESCHER WYSS/ALSTHOM	Francis		1,52	
		5211	ESCHER WYSS/ALSTHOM	Francis		1,52	
		5212	ESCHER WYSS/ALSTHOM	Francis		1,52	
	MANANDONA	5213	ESCHER WYSS/SEM BBC	Francis		0,48	Region Vakinankaratra à 11 km Ville d'antsirabe sur la route RN7 vers le sud puis 7km de route en terre à l'est
		5214	ESCHER WYSS/ALSTHOM	Francis		0,48	
	Sahanivotry	HYDELEC		Francis	2008	15,00	Region Vakinankaratra à 27 km Ville d'antsirabe sur la route RN7 vers le sud
	Tsiazompaniry	HFF		Francis	2010	5,20	
R2-DIR TOAMASINA	Volobe HYDRAULIQUE	5201	ESCHERWYSS	T800 FAV	1931	1,52	Se situé à 335 km de la capital Antannarivo sur la rn 2, prés du pont de Panandrahana puis par route secondaire de 35 km en remontant la Rivière
		5202	ESCHERWYSS	T800 FAV	1931	1,52	
		5203	ESCHERWYSS	T800 FAV	1955	1,52	
		5401	NEYRPIC	FAV	1977	2,20	
	Ambodiriana HYDRAULIQUE	5301	MAGNAT'S	FAH	1953	0,09	Ambodiriana à 32 km d'Antsapanana sur la rn2 vers la route pour VATOMANDRY puis 8 km route en terre
		5402	NEYRPIC	FAH	1953	0,04	
		5403	NEYRPIC	FAH	1953	0,04	
R4-DIR FIANARANTSOA	Namorona (Ambodikimba)	5101	EBARRA	JEC 151 FAV	1980	2,80	Route vers Manakara à 374 km de la capital sur la rn 7 puis à 40km sur la
		5102	EBARRA	JEC 151 FAV	1980	2,80	
Puissance totale hydraulique installée						159,29	
Sites de puissance inférieure à 20 MW							

ETAT D'INVENTAIRE DES SITES SUSCEPTIBLES D'ALIMENTER LA REGION DE MAHAJANGA

Site	Rivière	B.V. (km^2)	Module m3/s	Hauteur de chute (m)	Débit équipé (m3/s)	Puissance installée (MW)	Product (GWh/an)	Réf. études existantes	Niveau d'étude	Aglomérations alimentées
Antafofo	Ikopa	18 650	443	195	370	579	4 350	SETHEM-EDF	Préliminaires (59)	RIA+Mahajanga
Antafofo	Ikopa	18 650	458	130	100	105	4 173	PEMC-RI TANA	Préliminaires 2000	RIA+Mahajanga
Ambodiroka	Betsiboka	-	271	134	279	300	2 090	SETHEM-EDF	Préliminaire	Mahajanga
Ambodiroka	Betsiboka	-	271	70,5	72	42	280	JIRAMA COB CAMCE Chine	APD FAISABILITE	Mahajanga
Ambodiroka	Betsiboka	-	271	56,4	45	19,5	157	JIRAMA COB	Faisabilité	Mahajanga
Andriabe	Demoka	1356	12	8,6	10	0,6	5	Inventaire JIRAMA	Reconnaissance	Maintirano
Marobakoly	Anjingo	1500	7,2	20,7	5	0,8	6,5	Inventaire JIRAMA	Reconnaissance	Antsohy
Beandrarezona	Beandrarezona	-	-	35,8	1,6	0,43	3	SAEE	Préliminaire	Bealanana

Source JIRAMA 2002 - Mise à jour ORE 2007

Sites de puissance inférieure ou égale à 20 MW

ETAT D'INVENTAIRE DES SITES SUSCEPTIBLES D'ALIMENTER LA REGION DE TOLIARA

Site	Rivière	B.V. (km²)	Module m3/s	Hauteur de chute (m)	Débit crues (m3/s)	Débit équipé (m3/s)	Puissance installée (MW)	Product (GWh/an)	Réf. études existantes	Niveau d'étude	Aglomérations alimentées
Isaka Ivondro	Efaho	21	1,49	157	600	1	1,2	2,1	JCI	Préliminaire	Amboasary Taolagnaro
Anosy Ambositra	Mangoky	55000	490	15		160	20	158	Inventaire JIRAMA	Inventaire sur carte	Morombe - Manja - Tuléar- Morondava - Industrie minier

Source JIRAMA 2002 - Mise à jour ORE 2007

Sites de puissance inférieure ou égale à 20 MW

Annexe 5

Liste des sites hydroélectriques à Madagascar

	FARITANY	FIVONDRONANA	SITES	FLEUVES - RIVIÈRES	PUISSANCE	SITUATION
1	Antsiranana	Antsiranana II	Lac Mahery	Besokatra-Sakaramy-Riv. Des Makis	4,75 MW	Et. prélim.
2	Antsiranana	Andapa	Lokoho Aval	Lokoho	2,08 MW	Avant proj.
3	Antsiranana	Ambilobe	Anjalazata	Mahavavy	505 kW	Reconn. s.t.
4	Toamasina	Mananara-Avaratra	Vohibato	Mananara	18,7 MW	Reconn. s.t.
5	Antsiranana	Ambilobe	Tsaradohany	Mahavavy	1638 kW	Reconn. s.t.
6	Toamasina	Soanierana-Ivongo	Bevory – Anosibe	Marimbona	30 MW	Reconn. s.t.
7	Antsiranana	Ambilobe	Ambilobekely	Mahavavy	1638 kW	Reconn. s.t.
8	Toamasina	Fenoarivo-Est	Ambodisatrana - Ambatobe	Lazafo	(350) kW	Et. prélim.
9	Antsiranana	Ambilobe	Andranomamofona	Mahavavy	1944 kW	Reconn. s.t.
10	Toamasina	Vavatenina	Andramamovoka	Onibe	22 MW	Et. préfais.
11	Antsiranana	Ambanja	Bevory (Andriamanjavona)	Ramena	6,35 MW	Avant proj.
12	Toamasina	Moramanga	Ambohimanatrika	Mangoro	6 MW	Reconn. aérienne
13	Mahajanga	Befandriana-Avaratra	Andavatsobeha	Somboana	54 kW	Reconn. s.t.
14	Toamasina	Moramanga	Ankorahotra	Vohitra	>50 MW	Avant proj.
15	Mahajanga	Befandriana-Avaratra	Tsaralalana	Antsahamaloto	19 kW	Reconn. s.t.
16	Toamasina	Moramanga	Fanovana	Sahatandra	3,2 MW	Reconn. s.t.
17	Mahajanga	Mahajanga II	Androka	Mahajamba	5 MW	Et. prélim.
18	Toamasina	Moramanga	Ambatolaona	Mandraka	18 MW	Et. prélim.
19	Mahajanga	Mitsinjo	Sitampiky	Mahavavy	12 MW	Et. prélim.
20	Toamasina	Moramanga	Est-Beparasy	Mangoro		Reconn. aérienne
21	Mahajanga	Maevatanana	Ambodiroka	Betsiboka	297 MW	Et. préfais.
22	Toamasina	Anosibe An'ala	Andramarolasy	Mahamavo	236 kW	Reconn. s.t.
23	Mahajanga	Maevatanana	Antanandava	Ikopa	410 MW	Et. prélim.
24	Toamasina	Anosibe An'ala	Ambatomaro	Mangoro		Reconn. aérienne
25	Mahajanga	Maevatanana	Antafofo	Ikopa	772 MW	Et. prélim.
27	Mahajanga	Tsaratanana	Vohombohitra	Betsiboka	150 MW	Et. prélim.

28	Toamasina	Anosibe An'ala	Andranotsara	Mangoro	15 MW	Et. prélim.
29	Mahajanga	Maevatanana	Isandrano	Ikopa	126 MW	Et. prélim.
31	Antananarivo	Ankazobe	Vohitsara	Ikopa	252 MW	Et. prélim.
32	Toamasina	Marolambo	Antena-Sahofika	Onive	245 MW	Reconn. s.t.
33	Antananarivo	Anjozorobe	Angadanoro	Mananara	(55) kW	Avant proj.
34	Toamasina	Anosibe An'ala	Andasirotsaka	Onive	16 MW	Reconn. s.t.
35	Mahajanga	Morafenobe	Ambonarabe	Kimanambolo	11 MW	Reconn. s.t.
36	Antananarivo	Antanifotsy	Tsinjoarivo	Onive	5,5 MW	Et. préfais.
37	Antananarivo	Ankazobe	Mahavola	Ikopa	520 MW	Et. préfais.
38	Fianarantsoa	Ambositra	Tazonana-Dangoro	Maintinandry	510 kW	Avant proj.
39	Mahajanga	Maintirano	Andriabe	Demoka		Reconn. s.t.
40	Fianarantsoa	Ifanadiana	Rangoatra	Mananjary	26,5 MW	Et. prélim.
41	Antananarivo	Arivonimamo	Farahantsana	Ikopa	5,2 MW	Et. prélim.
42	Fianarantsoa	Mananjary	Andrianahomby	Mananjary	32,5 MW	Et. prélim.
43	Antananarivo	Ankazobe	Manjakony	Kotoratsy (Ikopa)	5 MW	Reconn. aérienne
44	Fianarantsoa	Ifanadiana	Fatihita	Ivoanana (Mananary)	16,7 MW	Et. préfais.
45	Antananarivo	Fenerive-Centre	Ranomafana	Ikopa	51 MW	Et. prélim.
46	Fianarantsoa	Ifanadiana	Tsaratango	Namorona	0,5 MW	Reconn. s.t.
47	Mahajanga	Antsalova	Antsalova	Soahany	120 kW	Reconn. s.t.
48	Fianarantsoa	Ifanadiana	Anosy	Namorona	1,6 MW	Reconn. s.t.
49	Antananarivo	Tsiroanomandidy	Ampitabepoaky I	Manambolo	765 kW	Et. préfais.
50	Fianarantsoa	Ifanadiana	Ambohimiarina	Namorona	1,66 MW	Reconn. s.t.
51	Antananarivo	Andramasina	Tsiazompaniry	Varahina (Ikopa)	2,3 MW	Et. préfais.
52	Fianarantsoa	Ifanadiana	Mangalahenatra	Namorona	1,25 MW	Et. prélim.
53	Antananarivo	Andramasina	Andramasina	Sisaony	5 MW	Reconn. aérienne
54	Fianarantsoa	Manakara	Asakatody	Faraony	4 MW	Reconn. s.t.
55	Antananarivo	Andramasina	Tsinjony	Andromba		Reconn. aérienne
56	Fianarantsoa	Manakara	Sahasinaka	Faraony	2,2 MW	Reconn. s.t.
57	Antananarivo	Faratsiho	Ampanobe	Kitsamby	5 MW	Reconn. aérienne
58	Fianarantsoa	Manakara	Marofototra	Faraony	11,7 MW	Et. prélim.

59	Antananarivo	Faratsiho	Ambohiboto	kitsamby	10 MW	Reconn. aérienne
60	Fianarantsoa	Manakara	Fenomby	Faraony	13,5 MW	Reconn. s.t.
61	Toliara	Miandrivazo	Antafofo	Mahajilo	50 MW	Reconn. s.t.
62	Fianarantsoa	Manakara	Manera	Faraony		Et. prélim.
63	Antananarivo	Betafo	Andriantsemboka	Iandratsay	(1,5) MW	Et. préfais.
64	Fianarantsoa	Ikongo	Tantamaly	Faraony		Reconn. s.t.
65	Toliara	Miandrivazo	Ankotrofotsy	Mania	47 MW	Reconn. s.t.
66	Fianarantsoa	Ikongo	Ikongo	Ikongo		Reconn. s.t.
67	Antananarivo	Betafo	Ikankana-Ampohobe	Ipongy (Mania)	8 MW	Reconn. aérienne
68	Fianarantsoa	Ikongo	Ambohitsara	Faraony	2 MW	Reconn. s.t.
69	Fianarantsoa	Fandriana	Miadana	Sahanivotry (Mania)	5 MW	Et. prélim.
70	Fianarantsoa	Ifanadiana	Ambatolahy	Namorona	2,8 MW	Et. prélim.
71	Fianarantsoa	Ambatofinandrahana	Antetezambato	Mania	89 MW	Reconn. s.t.
72	Fianarantsoa	Ambohimahasoa	Namorona, Projet Andriamamovoka (I,II,I)	Namorona	1,2 - 0,88 - 1,0	Et. prélim.
73	Toliara	Mahabo	Tambazo	Tambazo (Sakeny)	83 kW	Reconn. s.t.
74	Fianarantsoa	Farafangana	Rianambo	Manantsimba	68 MW (415) kW	Avant proj.
75	Fianarantsoa	Ambatofinandrahana	Tsinjorano – Aval	Mania	36,8 MW	Et. prélim.
76	Toliara	Amboasary-Sud	Mahafaly	Mandrare	6,5 MW	Et. prélim.
77	Fianarantsoa	Ambatofinandrahana	Tsinjorano - Amont	Mania	17 MW	Reconn. s.t.
78	Toliara	Amboasary-Sud	Andetsa	Mandrare	10,8 MW	Et. prélim.
79	Fianarantsoa	Ambatofinandrahana	Andrapeto	Mania	40 MW	Reconn. s.t.
80	Toliara	Amboasary-Sud	Amboetsy	Mandrare		Reconn. s.t.
81	Fianarantsoa	Ambatofinandrahana	Antaralava	Imorona	(640) kW	Avant proj.
83	Fianarantsoa	Ambositra	Talaviana	Manandona (Mania)	7,31 MW	Et. prélim.
85	Fianarantsoa	Ikalamavony	Tsitongampiana	Manambovona	505 kW	Reconn. s.t.
87	Fianarantsoa	Ihosy	Ambatomalama	Ianaboro	(165) kW	Avant proj.
89	Mahajanga	Antsohihy	Marobakoly	Anjingo	420 kW	Reconn. s.t.

Légende:
Reconn. aérienne = Reconnaissance aérienne aérienne + étude sur document
Reconn. s.t = reconnaissance sur terrain
Et. prélim. = étude préliminaire
Avant proj. = avant projet

Source: ADER

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Annexe 6

Liste des sites ayant fait l'objet d'étude de reconnaissance (RECN) pour aménagement hydroélectrique P< 5 MW

NOM DU SITE	RIVIÈRE	LOCALITÉS SUSCEPTIBLES D'ÊTRE DESSERVIS	ANNÉE D'ÉTUDE	STADE ACTUEL	PUISSANCE ESTIMÉE (MW)
Faritany d'Antsiranana					
Analalava	Antsahatopy	Vohémar	1988	Reconnaissance	
Irodo	Irodo	Antsiranana	1981	Reconnaissance	
Lokoho	Lokoho	Andapa	1999	Faisabilité	2,08
Tsiafampiana	Ramena	Ambanja	1983	Reconnaissance	
Faritany de Fianarantsoa					
Ambalamarina	Manambovona	Ikalamavony	1984	Reconnaissance	
Ambatomalama	Ianaboro	Ihosy	1985	APS	0,165
Andriamamovoka	Isandra/Mania	Ambositra	1979	Reconnaissance	0,85
Andriamamovokakely	Mananano	Manakara	1985	Reconnaissance	
Andriana	Andriana	Imerina Imady	1988	Reconnaissance	
Antaralava	Imorona	A/tofinandrahana	1979	APS	
Befanaova	Sahambano	Ihosy	1987	Reconnaissance	
Iritsoka	Iritsoka	Betroka	1982	Reconnaissance	
Kitra	Maintinandry	Ambositra	1987	Reconnaissance	
Rianambo	Manatsimba	Farafangana	1980	APS	
Riampotsy	Sahavorona	Ambositra	1987	Reconnaissance	
Tazonana	Maintinandry	Ambositra	1982	Préliminaire	1,5
Tsitongapiana	Manambovona	Ikalamavony	1984	Reconnaissance	
Itete	Itete	Vagaingrano	1993	Reconnaissance	2,74
Faritany de Toliara					
Chute R2D	Canal DABARA	Mahabo	1981	APS	
Dongalahy	Canal Taheza	Bezaha	1979	Réalisé	
Fanjahira	Efaho	Taolanaro	1987	APS	1,05
Isaka-Ivondro	Efaho	Taolanaro	1988	APS	1,2

Beandrarezona	Beandrarezona	Bealanana	1982	APS	0,21
Ambihinora	Namela	Maintirano	1984	Reconnaissance	
Ambonarabe	Kimanambolo	Maintirano	1984	Reconnaissance	
Ampasimbe	Kimanambolo	Maintirano	1984	Reconnaissance	
Andriabe	Demoka	Maintirano	1984	Reconnaissance	
Antsalova	Soahany	Antsalova	1984	Reconnaissance	
Andavatsobeha	Somboano	Befandriana-N	1987	Reconnaissance	
Marontandrano	Marotandrano	Marotandrano	1987	Réalisé	0,012
Tsaralalana	Antsahamaloto	Mandritsara	1987	Reconnaissance	
Andohariana	Bemarivo	Mampikony	1988	Reconnaissance	1,09
Marobakoly	Anjingo	Antsohihy	1988	Reconnaissance	0,377
Faritany de Toamasina					
Ambatobe	Iazafo	Fenerive-Est	1980	APS	
Ambodiriana	Voloina	Maroantsetra	1996	APD-DAO	0,47
Ambodisatrana	Iazafo	Fenerive-Est	1980	Reconnaissance	
Andramarolasy	Mangoro	Anosibe An'Ala	1984	Reconnaissance	
Andriamanjavona	Marimbona	Soanierana Ivongo	1984	Reconnaissance	
Andriampotsy	Fotsialanana	Soanierana Ivongo	1984	Reconnaissance	
Androkabe	Lovoka	Imerimandroso	1985	Reconnaissance	
Vodiriana	Maningory	Ambatondrazaka		Reconnaissance	5
Andramaramby	Lovoka	Ambatondrazaka		Reconnaissance	0,924
Faritany d'Antananarivo					
Ambodiriana	Ambodiriana	Anjozorobe	1980	Reconnaissance	
Ampitabepoaky I	Manambolo	Tsiroanomandidy	1984	APS	0,765
Ampitabepoaky II	Manambolo	Tsiroanomandidy	1984	Reconnaissance	
Andriantsemboka	Iandratsay	Ankazomiriotra	1989	APS	
Angadanoro	Mananara	Anjozorobe	1986	APS	0,055
Antafofokely	Mazy	Analavory	1988	Reconnaissance	
Antsavily	Mazy	Analavory	1988	Reconnaissance	
Fenoarivo-be	Masiaka	Fenoarivo-be	1986	Reconnaissance	
Fiadanana	Jangoany	Fenoarivo-be	1986	Reconnaissance	
Kavita	Lily	Ampefy	1985	Réalisé	0,42
Manankazo	Manankazo	Ankazobe	1988	Reconnaissance	

Source: ADER

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