CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 03 - in effect as of: 28 July 2006

CONTENTS

Annexes

SECTION A. General description of project activity

A.1. Title of the project activity:

Title: Small-Scale Hydropower Project Sahanivotry in Madagascar
Version: 04.3
Date of Submission: 25/08/2013

Revision history:
• Version 01 (completed on 13/05/2008): submitted to DOE for validation
• Version 02 (completed on 26/10/2009): revised to the request of the DOE
• Version 03 (completed on 27/01/2010): revised to the request of the DOE
• Version 04.0 (completed on 14/06/2012): submitted to DOE for validation opinion after conversion into large-scale project.
• Version 04.1 (completed on 25/07/2012): revised to the request of the DOE
• Version 04.2 (completed on 12/10/2012): revised to the request of the DOE
• Version 04.3 (completed on 25/08/2013): revised to the request of the UNFCCC secretariat

A.2. Description of the project activity:

The project

Sahanivotry Hydro Power Plant (hereafter referred to as “SHPP”), Madagascar is located on the river Ampamehana within Sahanivotry village about 30 km of Antsirabé, Antananarivo Province, Madagascar.

The SHPP is a run-of-river hydropower plant with a capacity of 16.5 MW with an average electricity generation of app. 80 GWh (up to 90 GWh in optimal years) per year[1]. The plant will be connected via a 63 kV transmission line to the substation of the regional grid of Antananarivo (hereafter referred to as RI TANA) operated by JIRAMA. The estimated annual emission reduction amounts to 44,196 t CO_2e.

The project will be implemented by HYDELEC Madagascar SA (hereafter referred to as “HYDELEC”), a private company established in 1999. HYDELEC is a company with a pioneering vision for the future of Madagascar’s electricity sector. The cost reduction of electricity generation in Madagascar by the implementation of sustainable and environmentally friendly technologies such as the small hydro power is one of the company’s objectives.

SHPP has a very special role for the future development of the electricity sector in Madagascar being a first mover in various senses: SHPP is the first hydro power project realised in Madagascar for 25 years and it is the first privately owned hydro power plant in Malagasy history. SHPP will be the first CDM project in Madagascar and will be able to sell carbon credits. Therefore, SHPP is an example to be followed and implemented by other privately owned groups.

[1] Generators design capacity was slightly upsized to 16.5 MW as compared to the initially registered design of 15 MW, in order to protect the turbines, secure the operation and to fulfil the environmental conditions in dry season. This did not result in any changes to the expected power generation from hydrological studies, which remained constant as the product of a more conservative updated plant load factor and consequent design capacity modification.

The electricity sector

Madagascar is among the Least Developed Countries (LDC) of the world. It ranks 143 of 177 countries on the Human Development Index (HDI). The World Bank has estimated that 70% of Malagasy live on less than 1 US $ per day.
Reliability and coverage of electricity is one of the challenges to be faced by the country. It has increased over the past years. However the national coverage rate is still only around 15% with access in rural areas lower than 5%.

As a net importer of oil, the energy sector is vulnerable to external oil pricing fluctuations with the price of oil having more than doubled between 2001 and 2007. Simultaneously, there has been a decrease in the proportion of hydroelectric power generation leading to a greater reliance on thermal production. Thermal production accounted for 21% of total power generation in 1997 but rose to 35% by 2004.

As of 2006, the national utility JIRAMA has not been structured to meet the increasing demand for energy required due to the high growth economy of 9.8% in 2003, a further expansion in 2004 (5.3%), 2005 (4.5%) and 2006 (4.8%). This is due to lack of finance, old equipment and machinery, as well as an inadequate management system.

The project is expected to help the country meet its increasing demand for power reliably in a cost-effective and environment-friendly manner. This is the country's first privately owned and operated hydro power project and is expected to pave the way for similar investments in the future.

The Madagascar Action Plan 2007-2012 (MAP) sets the framework for a sustainable future of the country. Ensure accessible and adequate energy at affordable and competitive cost is one goal. The use of renewable energy sources such as hydro will play a major role.

In the past five years, demand for electricity in Madagascar has grown at an annual average rate of approximately 7%.

The implementation of the project activity contributes to sustainable development in Madagascar. In particular, the project

- diversifies sources for electricity generation and decreased dependence on imported energy source above all fuel oil. SHPP will make a contribution to increase the power generation capacity at affordable and competitive cost.
- decreases environmental pollution caused by fossil-fuel fired plants by utilisation of renewable hydro power sources available in the project region. In addition to CO_2 emissions reductions, the project will mitigate other pollutants, such as SO_2, NOx and particulates associated with power generation from fossil fuels.
- improves the environmental equilibrium through the afforestation of 40,000 trees on the project site.
- supports the Malagasy government to achieve the goal of accessible and adequate energy supply to affordable and competitive costs.
- increase employment opportunities to local people both during construction and operation of the project in the area where the project is located.

SUMMARY OF POST REGISTRATION CHANGES

The post-registration changes undertaken are summarized as follows:

- The PDD was updated from small-scale to large-scale framework, using the latest version of ACM0002 methodology (version 13.0) and related tools;

Generators design capacity was slightly upsized to 16.5 MW as compared to the initially registered design of 15 MW, in order to protect the turbines, secure the operation and to fulfil the environmental conditions in dry season. These justifications were addressed by letter to the CDM-EB (attached in PDD Annex 4 p.59-60).

This did not result in any changes to the expected power generation from hydrological studies, which remained constant as the product of a more conservative updated plant load factor and consequent design capacity modification. It is supported by ex-post analysis of monthly power production lower than ex-ante estimate (monthly generation records and supporting invoices provided to the DOE), thus no impact on the revenues accounted for in the IRR calculation.

Moreover the expected investment as per the AfDB financial model did not decrease as a result of the upsizing (cumulated investment spreadsheet provided to the DOE); hence the registered IRR calculation and results are still valid and conservative, including the sensitivity analysis.

A.3. Project participants:

Name of Party involved(*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Madagascar (host)	HYDELEC Madagascar SA	No
Austria	Kommunalkredit Public Consulting (Purchasing Party)	No

HYDELEC is a private company established in 1999 and registered in Antananarivo, Madagascar. 99% of HYDELEC's shares are held by Energy Engineering Investment Ltd (hereafter referred to as EEI), a private company established in 2001 and registered in Mauritius.

Its main activity is the design, installation and operation of hydro and thermal power plants and wind parks. HYDELEC's mission is to reduce the costs of power generation in Madagascar by the implementation of sustainable and environmentally friendly technologies such as the one being considered in the SHPP project.

Since the year 2000 HYDELEC operates a 12 MW diesel fuelled power plant (IPP) at Ambohimanambola to be decommissioned in 2009. HYDELEC has obtained four hydro concessions for Sahanivotry (16,5MW), Mahitsy (8 MW), Volobe (3.5 MW) and Maroantsetra (1 MW) and is planning to install a 1.25 MW wind farm in Diego. Due to the difficult political and economic situation in Madagascar, the Sahanivotry HPP is the only advanced renewable project of Hydelec.

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

Madagascar

A.4.1.2. Region/State/Province etc.:

Vakinankaratra (Region), Antananarivo (Province)

A.4.1.3. City/Town/Community etc.:

Sahanivotry

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

The project is located about 30 km from Antsirabé on the river Ampamehana within Sahanivotry village, Antananarivo Province, Madagascar. The Ministry of Energy granted to HYDELEC for a period of 30 years the right to use 70 ha of land that belongs to Sahanivotry village for the construction and operation of the SHPP. The geographical co-ordinates of the project are 47°08' East (longitude) and 20°12' South (latitude). The physical location of the project is shown in Figure 1.

Figure 1 – The project location

A.4.2. Category(ies) of project activity:

The proposed project activity falls into Sectoral Scope 1: Energy Industry (renewable source).

Category: Renewable based grid connected electricity generation

A.4.3. Technology to be employed by the project activity:

The project is a run-off river hydropower plant with a total capacity of 16.5 MW that does not require a reservoir and will supply the electricity to RI Tana. The project will use three new Pelton turbines and three new generators provided by Hunan Lingling Hengyuan Generating Equipment Co., Ltd (China). Transformer and the 63 kV transmission line will be supplied by the French company BP Automation.

The key technical indicators of the power plant are shown below.

Table 1 – Key technical indicators of the power plant

Turbines	Manufacturer	Model	Type	Rated Power	Rated head	Rated flow
3	Hunan Lingling Hengyuan Generating Equipment Co., Ltd (China)	CJA237-W-140/2x18	Pelton	5,676 kW	210 m	3.12m^3/s
Generator	**Manufacturer**	**Model**	**Type**	**Rated Power**	**Rated voltage**	**Rated rotation speed**
3	Hunan Lingling hegyuan Generating Equipment Co., Ltd (China)	SFW5500-14/2420	-	5.5 MW	6.3 kV	428.6 r/min
Power output (optimum year)	**Gross Energy**		**Auxiliary consumption, transmission losses**		**Net energy export to the grid**	
	90 GWh		1.6%		88.56 GWh	

Source: China Foreign Trade Sales Contract 24/04/2007; HYDELEC. This sales contract gives an annual net generation figure of 88.56 GWh per year. This figure is too high based on the local framework conditions. As you can see in B.5, the annual generation figure is projected to be app. 81 GWh. The real generation figures for the first year of operation (October 2008-September 2009) were 77 GWh which proves that the assumption of 81 GWh is more realistic than the 89 GWh (which are based on optimal conditions).

The project has been implemented according to the following time schedule:

Table 2 – Time schedule of project implementation

Nr	Milestones	Key Dates
1	**Authorization**	**02/2001-11/2007**
1.1	Concession for the installation and operation of SHPP with an installed capacity of 10 MW Issuing Authority: Ministry of Energy and Mines (MEM)	17/02/2001
1.2	Approbation of the concession contract for the production of energy at HPP with an installed capacity of 10 MW Issuing Authority: MEM	23/03/2001
1.3.	Autorisation for starting construction and increasing capacity from 10 to 15 MW Issuing Authority: MEM	07/03/2007
1.4	Authorization for the increase of capacity by 5 MW at SHPP. Issuing authority: MEM	28/11/2007

2	**Power Purchase Agreement with Jirama**	**02/2001-08/2007**
2.1	Signature of Power Purchase Agreement (PPA)	17/02/2001
2.2	PPA amendment Nr. 1	27/06/2001
2.3	PPA amendment Nr. 2	12/10/2006
2.4	PPA amendment Nr. 3	16/08/2007
3	**Financing**	**07-09/2007**
3.1	Loan Agreement with African Development Bank (AfDB)	05/07/2007
3.2	Loan Agreement with BFV-Société Générale and Mauritius Commercial Bank (Madagascar) S.A.	06/09/2007
4	Construction	03/2007-09/2008
4.1	Start of construction	03/2007
4.2	Procurement and installation of HPP	05-09/2008
5	**Start operation**	**10/2008**

Environmental safe technology

The implemented technology has been used worldwide since decades. It is environmentally safe.

Characteristics of the SHPP and its construction will not cause any negative damage to the ecosystem. In addition, the project conserves local biodiversity by planting local 40,000 trees on the project site.

Employment, training and medical service

HYDELEC employs around 150 local technicians and local workers during the installation, testing and start up of the hydropower plant. During this period, the local technicians receive practical training in order to being able to operate and maintain SHPP during the lifetime of the project.

Evidence on training in terms of sponsoring of education and training at the Advanced Institute of Technology, training schedule including list of participants and the operation material have been provided to the DOE.

A full time medical doctor is employed at the construction site providing medical services to the employees and their families.

During operation around 20 Malagasy people will be employed, of which administrative personal, technicians in charge of the HPP operation and supporting personal (e.g. security people).

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

The expected emission reductions are calculated based on the net electricity sales and combined margin emission factor of 548 tCO_2/GWh for the RI TANA. Annual estimates of emission reductions as well as total emission reductions for the chosen crediting period of 10 years are furnished below.

Table 3 – Estimation of annual emission reductions

Years	Annual estimation of emission reductions in

	tonnes of CO_2e
01/05/2010 – 31/12/2010	29,464
01/01/2011 – 31/12/2011	44,196
01/01/2012 – 31/12/2012	44,196
01/01/2013 – 31/12/2013	44,196
01/01/2014 – 31/12/2014	44,196
01/01/2015 – 31/12/2015	44,196
01/01/2016 – 31/12/2016	44,196
01/01/2017 – 31/12/2017	44,196
01/01/2018 – 31/12/2018	44,196
01/01/2019 – 31/12/2019	44,196
01/01/2020 – 30/04/2020	14,732
Total estimated reductions (t CO_2e)	**441,960**
Total number of crediting years	10
Annual average over the crediting period	44,196

The amount of emission reductions that will occur due to the project activity vary directly with the net energy generated by the project and the emission coefficient factor. Table 3 - above is based on the expected annual net production of 80.65 GWh[2] and an average emission factor of the grid equal to 548 tCO_2/GWh.

A.4.5. Public funding of the project activity:

The African Development Bank (AfDB) is lending 6 M. € over the next 7 years towards the financing of the project based on normal commercial conditions. Evidence has been provided to the DOE. The AfDB required the development of this project under CDM, but does not claim any compensation in the form of Certified Emission Reductions (CERs) for the repayment of the loan. AfDB funding does not result in a diversion of official assistance.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

The approved baseline and monitoring methodology that is applied to the proposed Project is ACM0002 (version 13.0.0) "Consolidated baseline methodology for grid-connected electricity generation from renewable sources".

In line with the application of the ACM0002 methodology, the project refers to the following tools:

[2] According to Sahanivotry's production calculation details (provided to the DOE), the generation potential of 80.65 GWh was conservatively estimated from statistically-adjusted historical flows, accounting for a 5-year recurrent deficit period and 10 days of maintenance stoppage per annum, multiplied by the waterfall height and typical electro-mechanical equipment's efficiency. It relies on the overall generation potential from the river flow (provided it is realized), and not the precise electrical capacity of the equipments, thus the figure being independent from the subsequent upsizing of the turbines from 15 to 16.5 MW due to technico-environmental constraints.

- “Tool to calculate the emission factor for an electricity system” (version 03.0.0),
- “Tool for the demonstration and assessment of additionality” (version 07.0.0),
- “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (version 02).

In addition, the following Guidelines are also employed:

- “Guidelines on the assessment of investment analysis” (version 5)
- “Guidelines for objective demonstration and assessment of barriers” (version 1)
- “Guidelines on common practice” (version 2).

For more information about the methodology, please refer to the following website:
http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The ACM0002 (version 13.0.0) methodology is applicable to grid-connected renewable power generation project activities that: (a) install a new power plant at a site where no renewable power plant was operated prior to the implementation of the project activity (greenfield plant); (b) involve a capacity addition; (c) involve a retrofit of (an) existing plant(s); or (d) involve a replacement of (an) existing plant(s).

It therefore applies to SHPP, as a Greenfield hydropower project providing electricity to RI TANA.

Furthermore, the following table shows how the project activity meets the applicability conditions:

Table 4- Applicability of the project regarding ACM0002 (version 13.0.0) conditions

Applicability conditions of the methodology ACM0002	Project activity specifications
The project activity is the installation, capacity addition, retrofit or replacement of a power plant/unit of one of the following types: hydro power plant/unit (either with a run-of-river reservoir or an accumulation reservoir), wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit;	The project is the installation of a new run-off-river hydro power plant; it is a Greenfield project and does not involve any reservoir.
In the case of capacity additions, retrofits or replacements (except for wind, solar, wave or tidal power capacity addition projects which use Option 2: on page 10 to calculate the parameter $EG_{PJ,y}$): the existing plant started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and no capacity expansion or retrofit of the plant has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;	

In case of hydro power plants, one of the following conditions must apply: • The project activity is implemented in an existing reservoir, with no change in the volume of reservoir; or • The project activity is implemented in an existing reservoir, where the volume of reservoir is increased and the power density of the project activity, as per definitions given in the Project Emissions section, is greater than 4 W/m²; or • The project activity results in new reservoirs and the power density of the power plant, as per definitions given in the Project Emissions section, is greater than 4 W/m².	

The monitoring methodology is used in conjunction with the approved baseline methodology ACM0002.

In addition, the applicability conditions included in the tools referred to above apply.

Table 5- Applicability of the project regarding methodological tools conditions applied in the PDD.

Applicability conditions of the"Tool to calculate the emission factor for an electricity system" (version 03.0.0)	**Project activity specifications**
This methodological tool determines the CO_2 emission factor for the displacement of electricity generated by power plants in an electricity system;	The project is the installation of a new run-off-river hydro power plant; it displaces the electricity generated by power plants in the electricity system of the region of Antananarivo.
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).;	The project activity supplies electricity to a grid.
In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	The project is not located in an Annex I country.
Applicability conditions of the"Tool for the demonstration and assessment of additionality" (version 07.0.0)	**Project activity specifications**
Applicable geographical area should be the entire host country.	The geographical area selected is the host country
Measure (for emission reduction activities) is a broad class of greenhouse gas emission reduction activities possessing common features. Four types of measures are currently covered in the framework: (a) Fuel and feedstock switch; (b) Switch of technology with or without change of energy source (including energy efficiency improvement as well as use of renewable energies); (c) Methane destruction; (d) Methane formation avoidance.	The project activity is covered under (b) switch of technology.
Output is good/services produced by the project activity.	The output is electricity
Applicability conditions of the "Tool to calculate project or leakage	**Project activity**

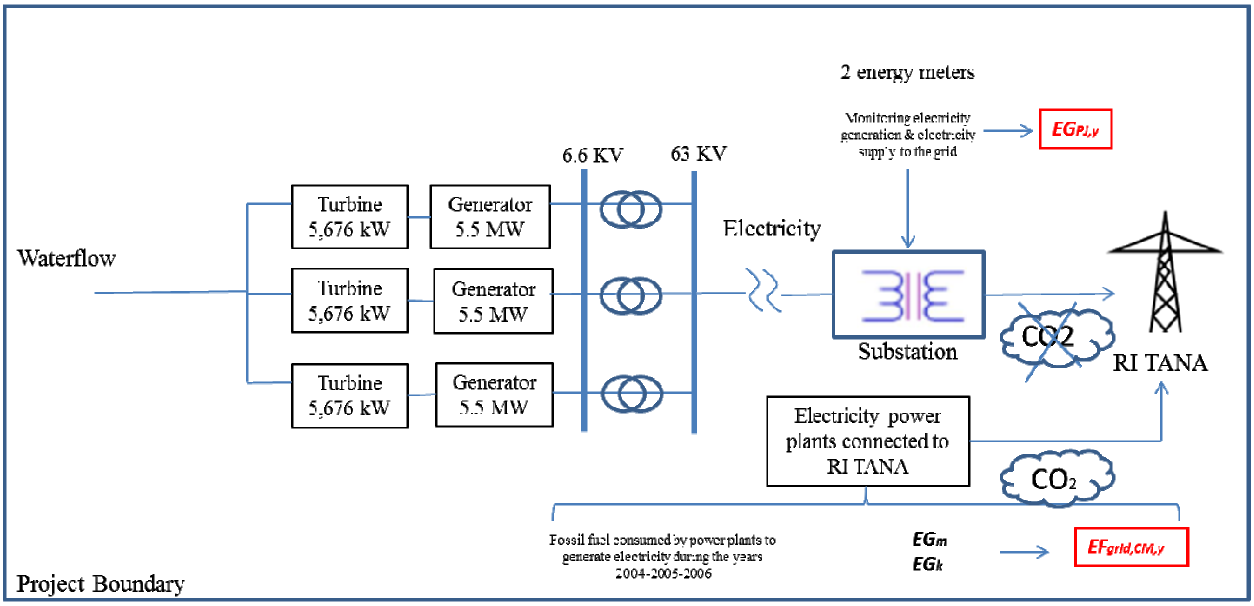
CO_2 emissions from fossil fuel combustion" (version 02)	**specifications**
This tool provides procedures to calculate project and/or leakage CO_2 emissions from the combustion of fossil fuels. It can be used in cases where CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted and its properties. Methodologies using this tool should specify to which combustion process *j* this tool is being applied.	CO_2 emissions from fossil fuel combustion are calculated based on the quantity of fuel combusted

B.3. Description of the sources and gases included in the project boundary:

In accordance with the methodology ACM0002 / Version 13.0.0 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources": "the spatial extent of the project boundary includes the project power plant and all power plants connected physically to the electricity system that the CDM project power plant is connected to." The electricity displaced by the project is the electricity generated within the interconnected RI TANA, which represents around 70% of national electricity consumption. The spatial scope of the project boundary covers the project site including the area of influence of the power line up to the substation and all power plants connected physically to RI TANA. The power line will be located between the site of the power house and JIRAMA substation located near the city of Antsirabé; it will be circa 19 km long.

Therefore, the project boundary will include all the direct emissions related to the electricity produced by the power plants connected to RI TANA that will be replaced by the proposed project activity as it is shown below.

Figure 2: Project boundary flow diagram



The GHG emission sources in the project boundary are listed in Table 4 below.

Table 6 - Source and gases included in the project boundary

	Source	Gas	Included?	Justification/Explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source (Fossil Fuel-fired power plants of RI TANA)
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project Activity	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Minor emission source
		CH_4	No	Neglected because no reservoir is involved
		N_2O	No	Minor emission source

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

According to methodology ACM0002 (Version 13.0.0) and since the project is the installation of a new grid-connected renewable power plant the baseline scenario is the following:

"Electricity delivered to the grid by the project activity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in the combined margin (CM) calculations described in the "Tool to calculate the emission factor for an electricity system"."

According to the Madagascar Action Plan (MAP) 2007-2012, the current trend in the energy sector is the development of fossil fuel power plant. Simultaneously, there has been a decrease in the proportion of hydroelectric power generation leading to a greater reliance on thermal production. Thermal production accounted for 21% of total power generation in 1997 but rose to 35% by 2004.

So, continuation of current practice for power generation in Madagascar involves a significant share of fossil fuel consumption, including in capacity additions to meet the demand increase, as reflected by the rather high Combined Margin emission factor of 0.548 tCO_2/MWh calculated in B.6.1.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

The additionality of the project activity is be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the Board, which is available on the UNFCCC CDM website.

Step 0: Demonstration whether the proposed project activity is the first-of its-kind

This step is optional; it is not applied as it is considered that the proposed project activity is not the first-of-its-kind.

Step 1: Identification of alternatives to the project activity consistent with current laws and regulations

Step 1a: Define alternative to the project activity

The proposed project activity involves the implementation of a hydropower plant of 16.5 MW installed capacity to generate and export electricity to the regional grid of Antananarivo. The realistic and credible alternatives available to the project participants or similar project developers to provide comparable output are as follow:

- Scenario 1 - Installation of a new run-of-river hydropower plant with an installed capacity of 16.5 MW without being realized as a CDM project activity;
- Scenario 2 - Construction of a power plant using other sources of renewable energy with equivalent amount of annual electricity output;
- Scenario 3 - Construction of a new thermal power plant with equivalent amount of annual electricity output;
- Scenario 4 - Continuation of current situation (existing power plants).

Of the four potential baseline scenarios:

- Scenario 1 (new 16.5 MW hydro power plant) has been considered, and the barriers related to this alternative are explained in step 3 below.
- Scenario 2 (other renewable project) has been excluded due to the unavailability of accurate and well organized renewable energy resource data for the project region, as well as the difficulties and barriers of renewable energy technology and investment in Madagascar (see section B.5).
  Other renewable electricity sources are also not prioritized in the Least Cost Development Plan.
- Scenario 3 (new thermal power plant) is realistic[3], but has not been chosen as baseline due to the difficult project financing situation for the whole energy sector (see section B.5). In addition, it is not considered the most conservative CDM baseline approach as increased thermal capacity in RI TANA will lead to an increase of the grid carbon emission factor.
  Scenario 4: This alternative is considered to be the most realistic and most conservative baseline scenario not facing prohibitive barriers.

Outcome of Steps 1a: In the absence of the proposed project activity, the only realistic alternatives available to the project activity or similar project developers to provide comparable output are, as described below:

Scenario 1 – The proposed project activity not undertaken as a CDM project activity.
Scenario 4 – Continuation of the current situation.

Step 1b: Consistency with mandatory laws and regulations:

To date, there are no restrictions regarding the local regulations and policies preventing the implementation of any of the identified alternatives.

All four baseline scenarios are in line with the regulatory or legal requirements existing for power plants:

- Law No. 98-032 of 20 January 1999 ended the monopoly of JIRAMA (State Water and Electricity Corporation) by opening up electric power generation, transmission and distribution to competition.

[3] In February 2008, a new 40 MW_e power plant was commissioned at Mandroseza (Antanarivo). The power plant runs with heavy fuel oil and will be employed for base-load operation.

This law authorizes the intervention of private operators through the award of concessions or permits. They are awarded through a bidding process based on a Development Master Plan.

- The Least Cost Development Plan for the Grid, Hydropower Projects and other Energy Sources was elaborated for the Ministry of Energy and Mines by Hydro Québec International, in May 2005. It covers in detail the opportunities for electricity generation from hydro and thermal power plants in Madagascar. The possibilities for electricity generation from other renewable electricity sources, namely wind and solar electricity, are described very generally: Solar electricity is considered not to be economic. In the case of wind energy, the study mentions a potential wind park site in Antsiranana in Diego Province.

Outcome of Step 1b: Identified realistic and credible alternative scenarios to the project activity that are in compliance with mandatory legislation and regulations taking into account the enforcement in the region or country and EB decisions on national and/or sectoral policies and regulations.

Step 2: Investment analysis

Sub-step 2a: Determine appropriate analysis method

As the CDM project activity and the alternatives identified in Step 1 generate other financial/economic benefits than CDM related income, the benchmark analysis (Option III) is applied.

Sub-step 2b: Option III. Apply benchmark analysis

As prescribed by the Additionality Tool, the project developer has chosen to show the project Internal Rate of Return (IRR). This financial/economic indicator identified as most suitable for the project type and decision context is then compared afterwards with an appropriate benchmark.

Project IRR

The AfDB has been the main driver for setting the project financing for SHPP. Hence, the following calculations are based mainly on the AfDB financial model from August 2006 which is the latest before the construction of the SHPP started in April 2007. Hence and in accordance with the "Guidance on the Assessment of Investment Analysis" (Version 05), all input values were known before the investment decision and can therefore be considered realistic and appropriate values to be used in the financial calculation of the proposed project activity.

For the calculation of the financial indicators of the proposed hydropower project, we used the parameters listed in the table below which includes also the sources for these input values.

Table 7 – Parameters used in the investment analysis in 2006 (expected capacity of 15 MW)[4]

Item	Value	Unit	Source
Installed capacity	15	MW	AfDB calculation (10/08/2006)
Annual net power generation	80.65	GWh	AfDB calculation (10/08/2006) : for the first calendar year of operation only

[4] 15 MW is the installed capacity considered when investment decision has been taken. The capacity has been increased from 15MW to 16.5 MW for design requirements after investment decision.

			25% (20.2 GWh) are considered as operation starts only in October
Total investment (excl. VAT)	13.2 (nominal)	Million EUR	AfDB calculation (10/08/2006)
Value Added Tax for imports	2006: 4,300 2007 3,000 (nominal)	Million MGA[5]	AfDB calculation (10/08/2006): 20% for imported goods
Annual O&M costs	3,033 (2008 nominal)	Million MGA	AfDB calculation (10/08/2006) and based on EUR and MGA inflation rates. Salaries (693 million MGA in 2008) and social charges (173 million MGA in 2008) are additionally increased by 3% annually.
Political risk coverage[6]	1.6	% of total assests	AfDB calculation (10/08/2006)
Investment horizon[7]	25	Years	AfDB calculation (10/08/2006)
Expected power price	159 (2008 nominal)	MGA/kWh	AfDB calculation (10/08/2006): price in 2006, then annually adjusted based on national inflation rate and MGA/EUR exchange rate. 3% of this price is fixed for the recovery of the interconnection transmission line.[8]
Working Capital	(2008 nominal)	MGA	The WC takes into account changes in accounts receivable, (12% of sale revenues) accounts payable (17% of operating expenses) and minimum cash balance (10% of operating expenses)
Annual Depreciation[9]	5 to 15	years	AfDB calculation (10/08/2006): Preparatory works: 5 years, Civil work: 15 years, EM equipment: 10 years, Administration & engineering: 5 years, Transmission grid: 10 years,

[5] Malagasy Ariary or MGA: currency in Madagascar

[6] MIGA has issued a guarantee of 19.9 million USD to SHPP, covering its equity investment in and shareholder loans to HYDELEC. The coverage is for up to 15 years and covers the risks of breach of contract, war and civil disturbance, transfer restriction, and expropriation.

[7] The concession for SHPP was given for 30 years, but this was signed 5 years before hydro power plant started operation. Therefore, only 25 years of cash-flow were considered.

[8] All energy generated is purchased by JIRAMA. The 2006 sales price estimated in the AfDB financial model is MGA136/kWh for 2006 and varies annually according to the following formula: P=Po*(0.1+0.4 Ey/Eo+0,5Iy/Io) where Ey is the EUR/MGA exchange rate for the year y, Eo being the rate in the first month of production, and Iy/Io being inflation adjustment according to the same principle. This annual adjustment is a simplification done for the financial model, the final implementation of this formula will be on a monthly basis.

[9] In this PDD, the information on depreciation is used only to calculate income tax payments, which are determined on the basis of net income (i.e. after deduction of capital depreciation). According to Point 5 of the Guidance on the Assessment of Investment Analysis (Version 05), we do not deduct capital depreciation charges from gross cash flows for the calculation of the Project IRR.

			Environmental impact: 5 years
Project financing assumption[10]	16,900 8,000 11,935	Million MGA Million MGA Million MGA	AfDB calculation (10/08/2006) AfDB (equivalent to 6 Mio. EUR) Local banks Equity share
Income tax	30	% of earnings before taxes	AfDB calculation (10/08/2006)
Inflation rate EURO	2	%	AfDB calculation (10/08/2006)
Inflation rate MGA	10	%	AfDB calculation (10/08/2006)
Exchange rate MGA/EUR:	2,700	MGA for 1 MEUR	AfDB calculation (10/08/2006): 2006 value (for nominal value this is then multiplied with the relative inflation factor EUR/MGA)

The HPP Sahanivotry started operation in October 2008. Hence, the estimated AfDB generation and price figures used in the financial model 2006 can be compared with following generation and revenue figures reported by HYDELEC.

Table 8 – Comparison of projected and reported monthly generation, revenues and average price

		Projected generation (kWh)	Real generation 2008/09 (kWh)	Revenues excl. VAT 2008/2009 (MGA)	Average net price 2008/2009 (MGA/kWh)
2008	October	3.500.000	1.093.304	154.821.374	142
	November	3.000.000	7.128.556	1.014.488.323	142
	December	3.000.000	6.646.958	945.660.549	142
2009	January	10.800.000	6.113.596	897.894.219	147
	February	9.750.000	8.062.202	1.202.042.592	149
	March	10.800.000	10.667.887	1.597.251.631	150
	April	10.500.000	11.461.234	1.723.235.919	150
	May	10.800.000	7.606.604	1.173.874.504	154
	June	6.000.000	5.754.749	898.049.057	156
	July	5.000.000	5.504.071	852.692.977	155
	August	4.000.000	4.537.417	706.234.202	156
	September	3.500.000	2.692.499	421.695.864	157
	TOTAL:	**80.650.000**	**77.269.077**	**11.587.941.210**	**150**

Source: HYDELEC for real generation, revenues 2008/2009; AfDB (2006) for projected generation

The total reported electricity generation figure of 77 GWh for the first 12 months is below the estimated figure of 81 GWh in the investment analysis. As you can see, in seven months (2008: Oct; 2009: Jan-Mar, May-Jun, Sep) the reported monthly generation figure is below the projected, only in five months above (2008: Nov-Dec; 2009: Apr, Jul-Aug).

[10] This project financing distribution between AfDB, local banks and equity contribution is provided just for information. According to Point 9 of the Guidance on the Assessment of Investment Analysis (Version 05), we do not include cost of financing expenditures (e.g. loan repayments and interest) in the calculation of the Project IRR

According to Sahanivotry's production calculation details (provided to the DOE), the generation potential of 80.65 GWh was conservatively estimated from statistically-adjusted historical flows, accounting for a 5-year recurrent deficit period and 10 days of maintenance stoppage per annum, multiplied by the waterfall height and typical electro-mechanical equipment's efficiency. It relies on the overall generation potential from the river flow (provided it is realized), and not the precise electrical capacity of the equipments, thus the figure being independent from the subsequent upsizing of the turbines from 15 to 16.5 MW due to technico-environmental constraints.

At the time of the conversion of the PDD from small scale to large scale (i.e. after PDD registration) and over a 41 month period (from Oct 2008 to Feb 2012) real generation is 8% below the projected generation (251,288 MWh of real generation against 272,000 MWh of generation projected – monthly details is provided to the DOE).

Also the average net price of 150 MGA/kWh in nominal figures of 2008 and 2009 is significantly below the figures which AfDB projected in the 2006 financial model (160 MGA/kWh in 2008 and 173 MGA/kWh in 2009, see table below)[11]

Table 9 – Price development projected in AfDB financial model (10/08/2006)

Year	Projected electricity price (MGA/kWh)
2006	136
2007	147
2008	159
2009	173
2010	187
2015	282
2025	660
2030	1.018
2032	1.212

The comparison of these reported figures with the estimations done by AfDB clearly show that the assumptions taken by AfDB have been very optimistic which proves that the figures used for the investment analysis are conservative in terms of CDM.

Investment costs were finally 40,746 million MGA (accrued audited costs at 31-12-2011[12]) which exceeds the investment figures estimated in the AfDB financial model (10/08/2006).

One of biggest project risks is the weak financial situation of JIRAMA. Since 2003 JIRAMA has experienced difficulties, *"…mainly due to incompetent management. It made poor decisions on investments and committed errors in the choice of power generation technology, notably by opting for diesel-fired thermal plants instead of hydroelectricity. This option was selected because the initial investment cost of thermal plants is lower, but production costs in such plants are at the mercy of changing world oil prices…"*[13]

[11] Based on PPA amendment Nr. 3 signed on 16/08/2007, the tariff for 2007 was fixed with 142 MGA/kWh.
[12] Cumulative spreadsheet and audited reports provided to the DOE
[13] See OECD's African Economic Outlook 2005-2006, page 317

JIRAMA's financial situation deteriorated in 2005, with a negative value added in 2005 (mainly due to a late tariff adjustment in response to the hike in fuel prices), an accumulation of debts (MGA 255 billion as of 31/12/2005), a steady deterioration of the financial situation (budget deficit of MGA 93 billion) and net asset deficit (MGA 164 billion as of 31/12/2005).

In 2006, JIRAMA decided to set measures and restructure its company, but this was further delayed which resulted in additional financial problems of JIRAMA due to postponed electricity tariff increases. [14] JIRAMA's weak financial situation influenced significantly and delayed the project financing decision for SHPP. The risk of non-payment or payment delays by JIRAMA was an essential parameter of the project as all the revenues of the power plant come only from JIRAMA being the only purchaser of electricity.

Hence, all the key input figures used for the calculation of the project IRR can be assumed conservative in terms of CDM as it leads to an overestimation of the Project IRR using the AfDB 2006 assumptions.

Sub-step 2c: Calculation and comparison of financial indicators

These mostly nominal[15] input values are taken and modified to get the real cash-flows with base year 2006. The use of fixed input values is appropriate in case both the input values and the benchmark are defined in real terms (as opposed to nominal terms) and when there is no expectation that the change in the nominal value of the input parameters will differ significantly from the rate of inflation. The use of fixed real input values (such as power price and O&M cost) is common practice for the calculation of AfDB investment assessment. The IRR calculation compares the real IRR with a real benchmark which in both cases takes out the effects of general price increases due to inflation.

The project IRR has to be compared with an appropriate benchmark. This is difficult as the SHPP project is the first of its kind in Madagascar being an independent hydro power producer. There is no other operating power plant which can be compared with SHPP.

The investment costs are partly in EUR and in MGA. The involved exchange risks due to very different inflation rates (AfDB used annual values of 10% for MGA and only 2% for EUR) makes it difficult to decide on a representative benchmark for the project IRR to prove in the first step if the project is economically feasible.

We have decided to use the AfDB assumption for the required real return on private equity for the case of 100% equity investment. This figure of 15% is based on the high project-specific risks due to the difficult framework conditions described in this section B.5.

The results of the analysis for the proposed project activity are provided below.

Table 10 – Results of economic analysis (financial benchmark)

Scenario	IRR

[14] See Paragraph 7 in the Annual Progress Report from the International Monetary Fund (January 2009, http://www.imf.org/external/pubs/ft/scr/2009/cr0911.pdf).
[15] Nominal value refers to any price or value expressed in money of the day, as opposed to real value. The latter adjusts for the effect of inflation.

Project without revenues from the sale of CERs	12.45%
AfDB required real return on private equity	15.0%
Project with CER revenues (at 10 EUR / tCO_2)	14.56%

The results clearly indicate that the return on investment of the proposed project activity is below the 15% benchmark. With CDM revenues this 15% benchmark has become much closer. As discussed below, CDM was one of the main drivers to get access to debt financing in 2007.

In addition to the 15.0 % AfDB benchmark comparison above which was registered by the CDM-EB, an adequate project benchmark is determined below following the Weighted Average Cost of Capital (WACC) method, based on parameters that are standard in the market since the Greenfield project activity could be undertaken by other promoters.

The Weighted Average Cost of Capital (WACC) is calculated as follows:

$$r = w_d \cdot K_d \cdot (1 - T) + w_e \cdot K_e$$

Where:

r	=	WACC
w_d	=	Percentage of debt financing
w_e	=	Percentage of equity financing
k_d	=	Average cost of debt financing
k_e	=	Average cost of equity financing
T	=	Applicable corporate tax rate

As no typical debt/equity finance structure observed in the sector of the country is readily available, 50% debt and 50% equity financing is assumed as a default, therefore $w_d = w_e = 50\%$.

Cost of debt is assumed as the commercial lending rate in the country, since the benchmark is based on parameters that are standard in the market, and no documented cost of debt financing of comparable projects (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned) is available. The average commercial lending-debit rates from Madagascar Central Bank statistics is chosen, reflecting $K_d = 18.2\%$[16].

Cost of equity is determined among the default values for the expected return on equity provided in Appendix of the Guidelines on the Assessment of Investment Analysis (Madagascar – Group 1), thus $K_e = 13.75\%$.

The applicable corporate tax is taken as per the Project financing assumptions displayed in **Table 7** above, T = 30%.

➔ The calculated WACC results in **13.23%**, more conservative than the AfDB benchmark of 15% although still higher than the Project IRR in the absence of the CDM.

[16] Central Bank of Madagascar ante 2008 average debit interest rate over 2006 Q1 to Q4 period (source: http://www.banque-centrale.mg/index.php?id=m5_2_2_1). This estimate is deemed conservative as compared to the International Monetary Fund Financial Statistics on Lending interest rate for 2006 in Madagascar worth 29.5% (source: http://data.worldbank.org/indicator/FR.INR.LEND).

Sub-step 2d: Sensitivity analysis

In line with Point 21 of the Guidance on the Assessment of Investment Analysis (Version 05), we have considered variation of ±10% in the critical assumptions (i.e. total investment, annual O&M cost, and power sales revenues). The results are shown in the following table.

Table 11 – Sensitivity analysis; impact of variations in assumptions on the IRR without CDM revenues

Percentage Variation	-10%	-5%	0%	5%	10%
Total investment	14.21%	13.15%	12.45%	11.62%	11.03%
Annual O&M costs	12.85%	12.85%	12.45%	12.25%	12.04%
Power sales revenues (Power price x supply*)	10.58%	11.53%	12.45%	13.35%	14.23%

* The impact of a variation in power sale revenues is equivalent to a variation of either the grid price or the annual operation time and therefore only the product of these parameters (i.e. power sale revenues) has been included in the sensitivity analysis.

The sensitivity analysis confirms that the project's IRR without CDM revenues is unlikely to meet the required benchmark of 15%.

As already explained before, it is unrealistic that the power sales revenues are increased by far more than 10% to reach the benchmark. The main reason is the weak financial situation of JIRAMA. In addition, the comparison of the AfDB assumptions with the reported prices and electricity generation figures for the first 12 months of operation clearly shows that it is more realistic that the power sales revenues continue to be below the AfDB assumptions.

As mentioned before, the final investment costs are 13.2 million EUR which has also been proven to be in the same range of the AfDB assumption (13.2 million EUR). Finally and due to low influence of O&M costs in the IRR, the O&M costs have to be reduced by significantly more than 10% which is also unrealistic.

Post-registration comparison with the conservative WACC benchmark of 13.23% still proves the robustness of financial analysis conclusions to reasonable variations of critical assumptions, given the ex-post observations previously described in Sub-step 2.b:

- the total realized investment has not accrued below the expected level at the time of Project IRR analysis, and
- the power sales revenues do not exceed the projections (as real power supply is 8% below the projected generation, while base power fixed tariff only increased from 136 MGA/kWh in 2006 sales price assumption to 142 MGA/kWh in 2007 PPA amendment i.e. 4.4%).

Outcome of Step 2

Therefore, it can be stated that the proposed project activity is unlikely to be financially/economically attractive (project IRR being lower than the benchmark).

Furthermore, barrier analysis is conservatively applied as well to evidence that the proposed project activity faces barriers beyond financial unattractiveness, that do not prevent the continuation of the current practise from occurring.

Step 3: Barriers analysis

Step 3a: Identify barriers that would prevent the implementation of the proposed CDM project

The proposed project faces a combination of these barriers that prevents the implementation of this type of project activity, mainly:

- The main barrier is argued on the basis of difficulties to secure project financing due to the framework conditions and involved risks in Madagascar. The economic return on investment of HPP is not high enough to encourage and attract equity and/or international and local banks to participate in the project.
- The prevailing practice is that renewable sector suffers from traditional underinvestment in Madagascar, capacity development conducted mainly through the construction of thermal stations (in Annex 3 you can see that all new power plants built in the RI Tana grid since 1983 use fossil fuels). Although hydropower is an important source for the power grid in Madagascar, over the last 25 years the Sahanivotry HPP is the first of its kind. It took more than six years to finally get the final operating licenses for this independent small-scale hydro power project.

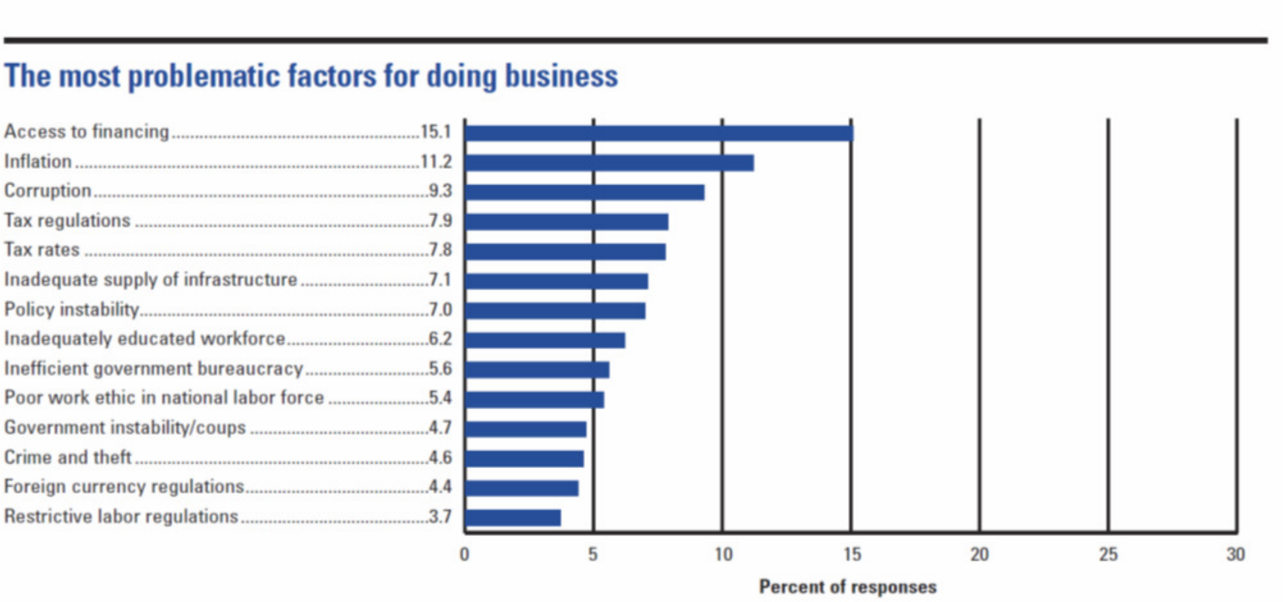
Thus, the project was proposed as a CDM project to overcome these barriers which was seriously considered when the project activity started.

Critical project financing

Doing business in Madagascar suffers from several problems which are typical for a least developed country. Based on the Global Competitiveness Index 2007 of the World Economic Forum Madagascar is ranked on position 113 out of 128 countries. The most problematic factors are access to financing, inflation and corruption (see table below).

Table 12 – The most problematic factors for doing business in Madagascar[17]

[17] Global Competitiveness Index 2007 of the World Economic Forum (http://www.weforum.org/pdf/gcr/africa/madagascar.pdf)



The Sahanivotry HPP has faced severe problems in getting the project financing based on the difficult political and economic situation in Madagascar.

The financing and construction phase of the proposed project is taking place during the period of a high inflation rate in Madagascar (Inflation eased to 9.2 per cent in 2008 from 10.3 per cent in 2007[18]). This could result in escalation in the project cost. The CDM revenues in “hard” currency (EUR) help in absorbing a part of this unforeseen additional cost burden.

In particular the weak financial situation of JIRAMA caused significant project risks as explained before. Revenues from the sale of CERs to a buyer with a good rating (e.g. KPC on behalf of the Austrian state) will guarantee a continuous income in the first years of operation, helping to cover financial gaps in case of non-payment by JIRAMA.

Project developer has looked for debt financing from the very beginning of the project development. In 2005 German bank Deutsche Investitions- und Entwicklungsgesellschaft mbH (DEG) had the intention to finance the power plant[19] together with the World Bank. DEG made a due diligence in August 2005, but finally decided not to participate in the project financing for HPP Sahanivotry.

After that, AfDB became the main driver for the project financing because AfDB identified that the project’s economic benefits for the development of the whole country is much bigger than its financial benefits. The consumers are the primary beneficiaries of the project due the low generation cost of hydro power in comparison with thermal power plants which will also support JIRAMA in its restructuring process.
Still in 2006, the potential for CDM was identified as additional revenue source. The internal AfDB project description from 2007 (confidential, but provided to the validator) clearly shows that CDM was identified as essential requirement for the economic feasibility of the project. CDM clearly helped AfDB

[18] http://www.africaneconomicoutlook.org/en/countries/southern-africa/madagascar/#/macro_economic_policy
[19] Evidence for the involvement of DEG can be found under http://www.tafatafa.eu.org/news_suite.php?id_news=329.

in the decision to take over the project risks. Based on the high risks due to the project risks of Madagascar and the weak financial situation of the JIRAMA the normal AfDB loan repayment period would be 10 to maximum 12 years. Due to the high economic benefits for the country and the additional CDM revenues, AfDB decided to accept an extended tenure of 15 years for the loan repayment.

The loan awarded by the AfDB will be in EUR while project revenue will be in local currency, a situation that could induce a significant foreign exchange risk. However, this risk is partly mitigated by the fact that JIRAMA's sales price is partly pegged to the EUR and partly to the national price index and is adjusted every month. This exchange risk will also be reduced by the sale of CERs in EUR.

After confirmation of the PIN developer that the project is eligible for CDM (April 2007), AfDB decided in July 2007 to approve the loan to the project. The first disbursement of the necessary loan was made only by AfDB as commercial banks refused to take over the high project risks. Only then, it was possible to attract two co-financing local banks BFV, a subsidiary of Société Générale (France) and United Commercial Bank (UCB), a subsidiary of the Mauritian Commercial Bank (Mauritius). The AfDB's presence was the main precondition for the participation of these local banks in the financing, thus enabling them to share the risks of the project but also the Bank's experience in funding infrastructure projects. These local banks will therefore be better prepared to participate in future private energy production projects in the country.

Nevertheless, it took more than six years until the closure of the project financing. The project developer HYDELEC had to put significant efforts and equity to cover the development costs for more than six years in advance. The eligibility for CDM improved significantly the willingness of HYDELEC to continue with the SHPP project.

Summarizing, the clear CDM potential supported significantly the finalization of the project financing with the AfDB and local banks in 2007. CER revenues will help the financial sustainability of the project, as carbon credits will be paid in hard currency (EUR) which secures the repayment of the AfDB loan in foreign currency. Another benefit of an Emission Reduction Purchase Agreement (ERPA) for the SHPP project will be that CERs sales revenues will alleviate the financial pressure and supplement the tariff and to avoid/mitigate increases of electricity prices to the end customers. These revenues from the sale of CERs will help overcome the financial barriers also for other renewable projects as local banks will become more interested in funding such energy projects.

This is not the case of the continuation of the current practice alternative. According to the Madagascar Action Plan (MAP) 2007-2012, the current trend in the energy sector is the development of fossil fuel power plant. Simultaneously, there has been a decrease in the proportion of hydroelectric power generation leading to a greater reliance on thermal production. Thermal production accounted for 21% of total power generation in 1997 but rose to 35% by 2004. This situation is the result of the low investment capacity of the national energy company JIRAMA and the high investment cost required for developing hydroelectricity project compare to fossil fuel power plant.
In addition to the project financing barriers, also other barriers have been identified:

Policy barriers

Private investment in the energy sector does not have a long track record in Madagascar. Law No. 98-

032 of 20/01/1999 ended the monopoly of JIRAMA by opening up electric power generation, transmission and distribution to competition. This law authorizes the intervention of private operators through the award of concessions or permits (depending on installed power).

As already mentioned before, JIRAMA mainly opted for diesel-fired thermal plants instead of hydroelectricity.[20]There already exist several independent thermal power plants (all power plants put into operation since 2000 have been thermal power plants, see Annex 3).

In order to meet the increasing energy demand, the Ministry for Energy and the Mines, which is in charge of the development policy of the electricity sector, approved request/proposal of HYDELEC for the development and construction of four hydro power plants and one mini wind farm. Nevertheless, HPP Sahanivotry is the only one which has significantly advances and is already implemented.

HPP Sahanivotry is the first independent renewable power project facing therefore several challenges.
The bureaucratic process to get all the necessary permits and licenses for private hydropower projects take significantly longer than it typically does for thermal projects[21]. In the case of SHPP, it took six years for obtaining the final operation licence. JIRAMA does not have any policies in place to promote the development of hydropower plants, e.g. through preferential tariffs.

Institutionally, when SHPP becomes a registered CDM project, its importance will be enhanced locally and internationally, thus potentially reducing the bureaucratic process and the timeframes to get permits and licences and attracting more private investors. In 2007, it became clear that this hydro power project could become the first CDM project in Madagascar. This was an additional important driver to sign all the necessary agreements with the power grid operator JIRAMA in 2006 and 2007, more than five years after the first concession for Sahanivotry HPP had been issued (see also below the chronology of the project development).

Although the political willingness was shown by the government of Madagascar to support this project, it was due to the lack of experience and the political changes in Madagascar in 2008-2009 that the Letter of Approval from the DNA in Madagascar was only issued on 04/11/2009.[22]

This is not the case of the continuation of the current practice alternative. According to the Madagascar Action Plan (MAP) 2007-2012, the current trend in the energy sector is the development of fossil fuel power plant. Indeed, the last four power plants implemented since 2000 are of thermal energy and do not face the same policy barriers as hydroelectricity power plant project experience as described above.

Barriers due to prevailing practice

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[20] See OECD's African Economic Outlook 2005-2006, page 317

[21] E.g. the first two thermal IPPs started operation in 2000 and 2001, less than two years after Law No. 98-032 of 20/01/1999 was decided (see Annex 3: Loc Hydelec – Ambohimanambola, IPP HFF - Antsirabe).

[22] Starting in 2008 and mainly in 2009 the political system in Madagscar was paralyzed by the confrontations between the President Marc Ravalomanana against Andry Rajoelina, former mayor of the capital, Antananarivo. President Ravalomanana resigned on 17 March 2009. The military said that it would support Rajoelina as leader who had already declared himself the new leader assuming the role of acting President. Rajoelina announced that elections would be held in two years and that the constitution would be amended. The African Union proceeded to suspend Madagascar's membership on 20/03/2009 and the Southern Africa Development Community criticized the forced resignation of Ravalomanana.

SHPP is the first hydro power project for the last 25 years. The country has a lack of experience regarding the implementation of sustainable hydroelectric projects. Skills and capacity to implement such a project need to be imported from the engineering point and it requires specific local training for adequate construction and long term efficient usage.
Due to lack of preparatory studies, other small to medium-scale hydro power projects are not further advanced. Nor has there been sufficient technical investigation or pre-feasibility work done on the larger hydro sites (Lohavanana, Volobe and Antetezambato) that have been identified as the least-cost options for 2012 onwards.

SHPP has therefore a very special role for the future development of the electricity sector in Madagascar being a first mover in various senses. It is the first hydro power project implemented in Madagascar for 25 years and it is the first privately owned hydro power project at all. If SHPP gets CDM status, it will be the first project in Madagascar to be able to sell carbon credits.
Regarding technological and capacity barriers, CDM projects promote a business scenario where environmentally sound and safe technology is required, as well as local training for the project operation and future implementation of hydropower projects in Madagascar. The equipment, as well as associated training, is imported from countries which possess experience with environmentally sound technology and ensure a sustainable project implementation. These special requirements increase the cost of the project and hence the need to generate revenues from CERs.

This is not the case of the continuation of the current practice alternative. According to the Madagascar Action Plan (MAP) 2007-2012, the current trend in the energy sector is the development of fossil fuel power plant. Indeed, the thermal energy sector does not experiment a lack of experiences as it is the case in the hydroelectricity sector.

Step 3b: Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

As described above, the identified barrier would not prevent the implementation of alternative 4 (continuation of the current practice), since it represents the common practice and the main trend of development of thermal power stations since two decades in Madagascar.

Madagascar being a Least Developed Country[23], guideline 7 (§10) of the *Guidelines for objective demonstration and assessment of barriers Version 01 (EB50 Annex13)* is applicable: *"for projects <u>in Least Developed Countries it is sufficient to transparently describe the relevant barriers</u>, as less stringency is needed with regards to data availability in the actual demonstration of barrier, as compared to the projects in other countries"*.

Step 4: Common practice analysis

The latest version of the *"Guidelines on common practice"* available on the UNFCCC website is applied:

Step 1: Calculate applicable capacity or output range as +/-50% of the design output or capacity of the proposed project activity.

[23] Accessible at http://www.unohrlls.org/en/ldc/25/

From a project activity capacity of 16.5 MW, the applicable output range is calculated as 8.25 to 24.75 MW of power generation capacity.

Step 2: Identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:

(a) The projects are located in the applicable geographical area;

(b) The projects apply the same measure as the proposed project activity;

(c) The projects use the same energy source/fuel and feedstock as the proposed project activity, if a technology switch measure is implemented by the proposed project activity;

(d) The plants in which the projects are implemented produce goods or services with comparable quality, properties and applications areas (e.g. clinker) as the proposed project plant;

(e) The capacity or output of the projects is within the applicable capacity or output range calculated in Step 1;

(f) The projects started commercial operation before the project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

In the host country of Madagascar, the power plants operating before the start date of the project and belonging to the 8.25 - 24.75 MW output range are:

Power plant[24]	Installed capacity	Commissioning date	Technology
Mandraka	24 MW	1956	Hydro
Hydelec - Ambohimanambola	13.4 MW	2000	Thermal
IPP HFF - Ambohimanambola	24.46 MW	2005	Thermal

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

All of the projects identified in Step 2 are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation.

Therefore $\underline{N_{all} = 3}$.

Step 4: within similar projects identified in Step 3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

The technology used in the project activity is different from **all but one** of the projects identified above (**Mandraka**) with regard to its energy source/fuel which is hydraulic.Therefore $\underline{N_{diff} = 2}$.

[24] Please refer to Annex 3.

Step 5: Calculate factor $F=1- N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

$F=1- N_{diff}/N_{all} = 0.33$

The proposed project activity is a "common practice" within a sector in the applicable geographical area if the factor F is greater than 0.2 and N_{all}-N_{diff} is greater than 3.

➔ Since F = 0.33 and N_{all}-N_{diff} = 1, it can be concluded that **the project activity is not common practice** i.e. that its technology has not diffused in the relevant sector and region.

The Mandraka project identified as similar was implemented more than 50 years ago. The experience of implementing such a project is lacking nowadays; moreover the context (economic and technological context) in which it was developed was totally different.

Outcome of Step 4:
Step 4 is satisfied, i.e. vthe proposed project activity is not regarded as "common practice;

therefore, the proposed project activity is additional.

Prior Consideration of the CDM before the start of the project activity

The company HYDELEC Madagascar, which specializes in energy generation projects, started developing the Sahanivotry site since 2001. A concession was awarded to the company by the Government and a first energy purchase contract was signed with JIRAMA. However, the project was suspended following the political strife that rocked the country in 2002 onwards.

Table 13 – Serious CDM consideration and the start of the project activity

Milestones	**Key dates**
Concession for the installation and operation of SHPP with an installed capacity 10 MW Issuing Authority: Ministry of Energy and Mines (MEM)	17/02/2001
Approbation of the concession contract for the production of energy at HPP with an installed capacity of 10 MW Issuing Authority: (MEM)	05/03/2001
Signature of Power Purchase Agreement (PPA) PPA amendment Nr. 1	17/02/2001 27/06/2001
Discussions with CDM consultant and first proposals for CDM project development	05/2006
PPA amendment Nr. 2	12/10/2006
Draft PIN delivered to HYDELEC and confirmation that the HPP Sahanivotry fulfils CDM eligibility criteria	10/04/2007
Start of construction	**19/03/2007**
Loan Agreement with African Development Bank (AfDB)	05/07/2007
Finalization of Project Idea Note	09/07/2007
PPA amendment Nr. 3	16/08/2007
Loan Agreement with BFV-Société Générale and Mauritius Commercial Bank (Madagascar) S.A.	06/09/2007
PIN eligibility letter issued for HYDELEC Sahanivotry hydropower project by the DNA	18/09/2007

Authorization for the increase of capacity by 5 MW at SHPP. Issuing authority: MEM	28/11/2007
Contract on reimbursement of CDM project related immaterial services between HYDELEC and KPC (both CDM project participants)	02/2008
PDD publication at the UNFCCC website for stakeholder consultation	17/05/2008-15/06/2008
Procurement and installation of HPP	05/09/2008
Start of operation of Sahanivotry HPP	**10/2008**
Emission Reduction Purchase Agreement (ERPA) signed between HYDELEC and KPC	08/2009

As evident from the above, since 2006 the project developer was aware of the CDM benefits and the CDM benefits were the decisive factor in the decision to go ahead with the project because they played a crucial role in overcoming prohibitive barriers preventing implementation. The chronology of events given above reveals that the project developer had taken parallel action to implement the project and to get the project registered as a CDM activity; the two conditions stipulated by EB41 Annex 46 related to the serious consideration of CDM benefits are fulfilled.

Conclusion

The project activity is not the most attractive alternative for a power project in Madagascar and is not the business-as-usual scenario in a country where the last hydro power plant started operation 25 years ago. In case of non-registration of SHPP as CDM project, there will be further delays on planned hydro power projects, where the schedule is already far behind schedule.

The project activity will reduce the reliance of RI TANA on fossil fuels for power generation and is not associated with any leakage. The implementation of SHPP will therefore result in emission reduction and the registration of the project as a CDM project will help overcome the barriers presented above. The SHPP is additional and meets the CDM requirements of additionality.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

According to the approved methodology ACM0002 (Version 13.0.0), Emission reductions are calculated as:

$$ER_y = BE_y - PE_y \quad \textbf{(1)}$$

Where:

ER_y = Emission reductions in year *y* (tCO_2e)
BE_y = Baseline emissions in year *y* (tCO_2/yr)
PE_y = Project emission in year *y* (tCO_2/yr)

Project emissions

Fossil fuel combustion ($PE_{FF,y}$)

No project emissions are expected as the project activity only involves renewable electricity generation from the run-of-river hydroelectricity power plant (no reservoir) without fossil fuel consumption, hence PEy = 0.

Emissions from water reservoirs of hydro power plants ($PE_{HP,y}$)

For hydro power project activities that result in new single or multiple reservoirs and hydro power project activities that result in the increase of single or multiple existing reservoirs, project proponents shall account for CH_4 and CO_2 emissions from the reservoirs.

As mentioned in Table 4 (Applicability conditions of the methodology ACM0002), the project consists in the installation of a new run-off-river hydro power plant and does not involve any reservoir.
Therefore this source of project emission is not applicable.

Baseline Emissions

Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by existing grid-connected power plants and the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$BE_y = EG_{pj,y} \times EF_{grid,CM,y} \quad \textbf{(2)}$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using the latest version of the "*Tool to calculate the emission factor for an electricity system*" (tCO_2/MWh).

Calculation of $EG_{PJ,y}$

Since the project activity is *the installation of a new grid-connected renewable power plant at a site where no renewable power plant was operated prior to the implementation of the project activity*, it verifies the case of a Greenfield renewable energy power plant of the ACM0002 methodology Version 13.0.0 whereby:

$$EG_{PJ,y} = EG_{facility,y} \quad \textbf{(3)}$$

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/yr)

$EG_{facility,y}$ is therefore the quantity of net electricity supplied by the project plant to the Malagasy electricity grid . It is determined as a difference between (i) quantity of electricity supplied by the project

plant to the grid and (ii) quantity of electricity delivered to the project plant from the grid (please refer to section B.7 for monitoring details). The methodology ACM0002 Version 13.0.0 assumes that all project electricity generation above baseline levels would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources, as reflected in $EF_{grid,CM,y}$.

Calculation of $EF_{grid,CM,y}$

According to the "*Tool to calculate the emission factor for an electricity system*" Version 03.0.0, the combined margin (CM) emission factor shall be calculated by applying the following six steps:

STEP 1: Identify the relevant electric power system;
STEP 2: Choose whether to include off-grid power plants in the project electricity system (optional);
STEP 3: Select a method to determine the operating margin (OM);
STEP 4: Calculate the operating margin emission factor according to the selected method;.
STEP 5: Calculate the build margin (BM) emission factor;
STEP 6: Calculate the combined margin (CM) emission factor.

Step 1: Identify the relevant electric power system

The project activity will sell electricity to the regional grid of Antananarivo. The regional grid of Antananarivo consists of 16 power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints. Madagascar has no single power grid; instead, population centres are served by regional grids currently not interconnected. Electricity imports are not possible.

Step 2: Choose whether to include off-grid power plants in the project electricity system (optional)

"Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.
Option II: Both grid power plants and off-grid power plants are included in the calculation.

Option I is chosen.

Step 3: Select a method to determine the operating margin (OM)

The "Tool to calculate the emission factor for an electricity system" (version 03.0.0) mentions four options for calculating the operating margin emission factor ($EF_{grid,OM,y}$):
a) Simple OM, or
b) Simple adjusted OM, or
c) Dispatched data analysis OM, or
d) Average OM.

For the proposed project, Option (b) Simple Adjusted OM has been selected. According to the methodology the simple adjusted OM is suitable where there is not enough data to use dispatch data analysis to calculate the operating margin and low-cost/must run resources constitute more than 50% of

total generation. Table below shows that installed capacity of the low-cost/must run resources in RI TANA constitutes more than 50%.

Table 14 – Constitution of low-cost/must run resource in RI TANA for the period 2003-2006

Year	2003	2004	2005	2006
Percentage (%)	88%	83%	82%	79%

Source: JIRAMA

The emission factor can be calculated using either of the two following data vintages:

1. Ex ante option: A 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation, without requirement to monitor and recalculate the emission factor during the crediting period, or

2. Ex post option: The year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1, y-2) should be used throughout all crediting periods.

For the Project, ex-ante data will be used for calculating the OM emission factor ($EF_{grid, OM\text{-}adj,y}$) based on data from the years 2004 - 2006.

Step 4: Calculate the operating margin emission factor according to the selected method

According to the "Tool to calculate the emission factor for an electricity system" (version 03.0.0), the Simple adjusted OM emission factor ($EF_{grid,OM\text{-}adj,y}$) is a variation of the Simple OM, where the power plants / units (including imports) are separated in low-cost/must-run power sources (*k*) and other power sources (*m*).
As under Option A of the simple OM, it is calculated based on the net electricity generation of each power unit and an emission factor for each power unit, as follows:

$$EF_{grid,OM-adj,y} = (1-\lambda_y) \times \frac{\sum_m EG_{m,y} \times EF_{EL,m,,y}}{\sum_m EG_{m,y}} + \lambda_y \times \frac{\sum_k EG_{k,y} \times EF_{EL,iky}}{\sum_k EG_{k,y}}$$

Where:

$FF_{grid,OM\text{-}adj,y}$	Simple adjusted operating margin CO_2 emission factor in year *y* (tCO_2/MWh),
λ_y	Factor expressing the percentage of time when low-cost/must-run power units are on the margin in year *y*
$EG_{m,,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year *y* (MWh)
$EG_{k,y}$	Net quantity of electricity generated and delivered to the grid by power unit *k* in year *y* (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$EF_{EL,k,y}$	CO_2 emission factor of power unit *k* in year *y* (tCO_2/MWh)

m	All grid power units serving the grid in year *y* except low-cost/must-run power units
k	All low-cost/must run grid power units serving the grid in year *y*
y	The relevant year as per the data vintage chosen in Step 3

$EF_{EL,m,y}$, $EF_{EL,k,y}$, $EG_{m,y}$ and $EG_{k,y}$ should be determined using the same procedures as those for the parameters $EF_{EL,m,y}$ and $EG_{m,y}$ in Option A of the simple OM method.

Determination of $EF_{EL,m,y}$

Since data on fuel consumption and electricity generation is available, the emission factor ($EF_{EL,m,y}$) should be determined as follows (**option A1** of the tool):

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$EF_{EL,m,y}$	CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
$FC_{i,m,y}$	Amount of fuel type *i* consumed by power unit m in year *y* (Mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fuel type *i* in year *y* (tCO_2/GJ)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m	All power units serving the grid in year y except low-cost/must-run power units
i	All fuel types combusted in power unit m in year y
y	The relevant year as per the data vintage chosen in Step 3

λ_y is defined as follows:

$$\lambda_y(\%) = \frac{\text{Number of hours low} - \text{cost / must} - \text{run sources are on the margin in year y}}{\text{8760 hours per year}}$$

Lambda (λ_y) should be calculated as follows:

Step i)	Plot a load duration curve. Collection of chronological load data (typically in MW) for each hour of the year *y,* and sort the load data from highest to lowest MW level. Plot MW against 8,760 hours in the year, in descending order.
Step ii)	Collection of power generation data from each power plant / unit. Calculate the annual generation (in MWh) from low-cost/must-run power plants / units (i.e. $\Sigma_k EG_{k,y}$)
Step iii)	Fill Load Duration Curve. A horizontal line across load duration curve was plotted such that the area under horizontal line and the curve right from the intersection point (MW times hours) equals the total generation (in MWh) from low cost/must-run resources (i.e. $\Sigma_k EG_{k,y}$)
Step iv)	Determine the "*Number of hours per year for which low-cost/must-run sources are on the margin*". First, the intersection of the horizontal line plotted in step 3 and the load duration curve plotted in step 1 was located. The number of hours (out of the total of 8,760 hours) to the right of the intersection is the number of hours for which low-cost/must-run sources are on the margin. Lambda (λ_y) is the calculated number of hours divided by 8,760.

$EF_{grid,OM-adj,y} = 0.518$ t CO_2/MWh

Step 5: Calculate the build margin (BM) emission factor

In terms of vintage of data, one of the following two options can be chosen:

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available on units already built for sample group *m* at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewable of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emission factor shall be calculated ex-ante, as described in option 1. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

For the purposed project, option 1 is chosen to calculate the Build Margin emission factor.

The build margin is calculated according to the "Tool to calculate the emission for an electricity system" (version 03.0.0).

The sample group of power units *m* to calculate the build margin should be determined as per the procedure, consistent with the data vintage selected:

a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-units}}$);

- The set of five power units that started to supply electricity to the grid most recently is listed in Table below. In year 2006, this sample group $\mathbf{AEG_{SET\text{-}5\text{-units}}}$ comprises a net electricity production of 120,298 MWh.

Table 15 – The five most recently built power plants in RI TANA

Name of power plant	Fuel	Commissioning date	Installed capacity (MW)	Gross Generation 2006 (GWh)
LOC HFF-Ambohimananbola	Diesel	2007	5	19.9
LOC EDM-Antsirabe	HFO	2006	5	0.0
IPP HFF-Ambohimanambola	Diesel	2005	24.5	24.7
IPP HFF-Antsirabe	Diesel	2001	4.55	25.5
Loc Hydelec Ambohimanambola	Diesel	2000	13.4	50.2
Total			**52.45**	**120.3**

b) Determine the annual electricity generation of the project electricity system, excluding power units registered as CDM project activities (AEG_{total}). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET-\geq 20\%}$);

- AEG_{total} = 723,205 MWh and the set of power power capacity additions in the electricity system that comprise 20% of the system (i.e. 144,641 MWh in 2006) and that started to supply electricity to the grid most recently corresponds to a total set of **$AEG_{SET-\geq 20\%}$ = 610,131 MWh**.

c) From $SET_{5\text{-}units}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

- The set of power units that comprises the larger annual generation is **$SET_{sample} = SET_{\geq 20\%}$**.

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin.

Otherwise:

d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activities, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample\text{-}CDM}$) the annual electricity generation ($AEG_{SET\text{-}sample\text{-}CDM}$, in MWh);

- Some of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago (Andekaleka);
- No power units are registered as CDM project activities in RI TANA electricity system;

If the annual electricity generation of that set is comprises at least 20% of the annual electricity generation of the project electricity system (i.e. $AEG_{SET\text{-}sample\text{-}CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample\text{-}CDM}$ to calculate the build margin. Ignore steps (e) and (f).

- $AEG_{SET\text{-}sample\text{-}CDM}$ is not valid therefore steps (e) and (f) are applied.

Otherwise,

e) Include in the sample group $SET_{sample\text{-}CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation); The sample

group of power units m used to calculate the build margin is the resulting set $\mathbf{SET_{sample\text{-}CDM\text{-}>10yrs}}$ = $\mathbf{SET_{sample}}$ = $\mathbf{SET_{\geq 20\%}}$.

- **$AEG_{sample\text{-}CDM\text{-}>10yrs}$ = 610,131 MWh.**

Calculation of the build emission factor:

The build margin emission factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units *m* during the most recent year *y* for which power generation data is available, is calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

Where:

$EG_{m,y}$ is the net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
$EF_{EL,m,y}$ is the CO_2 emission factor of power unit *m* in year *y* (tCO_2/MWh)
m are the power units included in the build margin
y is the most recent historical year for which power generation data is available.

According to the "Tool to calculate the emission factor for an electricity system" (version 03.0.0), the CO_2 emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in step 4 (a) section 6.4.1 for the simple OM, using options A1, A2 or A3, using for y the most recent historical year for which electricity generation data is available, and using for *m* the power units included in the build margin.

For the proposed project, option A1 is chosen to calculate the CO_2 emission factor. The emission factor is determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \times NCV_{i,y} \times EF_{CO2,i,y}}{EG_{m,y}}$$

Where:

$FC_{i,m,y}$ is the amount of fossil fuel type i consumed by power unit *m* in year *y* (Mass or volume unit)
$NCV_{i,y}$ is the net calorific value (energy content) of fossil fuel type *i* in year *y* (GJ/ mass or volume unit)
$EF_{CO2,i,y}$ is the CO_2 emission factor of fossil fuel type *i* in year y (tCO_2/GJ)
$EG_{m,y}$ is the net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)
m are all power units serving the grid in year *y* except low-cost / must-run power units
i are all fossil fuel types combusted in power unit *m* in year *y*
y is either the three most recent years for which data is available at the time of submission of the CDM-PDD (ex-ante option) or the applicable year during monitoring (ex-post option)

$EF_{EL,m,y}$: 0.579 t CO_2/MWh

Step 6: Calculate the combined margin emissions factor

According to the "Tool to calculate the emission factor for an electricity system" (version 03.0.0) the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or
(b) Simplified CM.

The weighted average CM method (option a) is used as the preferred option.

Therefore the combined margin emission factor ($EF_{grid,CM,y}$) is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times \omega_{OM} + EF_{grid,BM,y} \times \omega_{BM}$$

Where:

W_{OM} is the weighting of operating margin emissions factor (%)
W_{BM} is the weighting of the build margin emissions factor (%)
$EF_{grid,BM,y}$ is the Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$ is the Operating margin CO_2 emission factor in year y (tCO_2/MWh)

Where the weights W_{OM} and W_{BM}, by default, are 50 % (i.e. $w_{OM} = w_{BM} = 0.5$) as mentioned in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0).

$EF_{grid,CM,y}$ = 0.548 tCO_2/MWh

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	***$FC_{i,m,y}$***
Data unit:	g/kWh
Description:	Amount of fossil fuel type *i* consumed by power plant / unit *m* in year *y* within RI TANA
Source of data used:	JIRAMA (2007) Ministry of Energy and Mines, Least Cost Generation Masterplan[25] (2005)
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The choice of the data satisfies the guidance in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0). RI TANA is the project boundary of the project. • Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, once *ex ante* following the guidance included in Step 5.

[25] Ministère de l'énergie et des mines; Plan d'expansion au moindre coût des réseaux, Projets hydroélectriques et autres sources d'énergie, Rapport Final, Hydro Québec International, Montréal (Québec), Canada, Août 2005

Any comment:	The data is from the national utility JIRAMA resp. Ministry of Energy and Mines. The uncertainty of the data is low.

Data / Parameter:	$EG_{m,y}$ and $EG_{k,y}$
Data unit:	MWh
Description:	Net electricity generated and delivered to the RI TANA by power plant / unit *m* resp. *k* in year *y*
Source of data used:	JIRAMA (2004, 2005, 2006)
Value applied:	See Annex 3
Justification of the choice of data or description of measurement methods and procedures actually applied :	The choice of the data satisfies the guidance in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0). RI TANA is the project boundary of the project. • Simple OM: once for each crediting period using the most recent three historical years for which data is available at the time of submission of the CDM-PDD to the DOE for validation (*ex ante* option); • BM: For the first crediting period, once *ex ante* following the guidance included in Step 5.
Any comment:	The data is from the national utility JIRAMA resp. Ministry of Energy and Mines. The uncertainty of the data is low.

Data / Parameter:	$NCV_{i,y}$
Data unit:	GJ/ton
Description:	Net calorific value (energy content) of fossil fuel type *i* in year *y*
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	Fuel oil: 44.44 Diesel: 40.19
Justification of the choice of data or description of measurement methods and procedures actually applied :	The choice of the data satisfies the guidance in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0). The data is used to calculate the emission coefficient of the fuel.
Any comment:	2006 IPCC Guidelines for National Greenhouse Gas Inventories are considered to be authoritative.

Data / Parameter:	$EF_{CO2,i,j,y}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of fossil fuel type *i* in year *y*
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Workbook Vol.2.
Value applied:	Fuel oil: 77.37 Diesel: 74.06
Justification of the choice of data or description of measurement methods	The choice of the data satisfies the guidance in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0). The data is used to calculate the emission coefficient of the fuel.

and procedures actually applied :	
Any comment:	IPCC Guidelines for National Greenhouse Gas Inventories are considered to be authoritative.

Data / Parameter:	λ_y
Data unit:	%
Description:	Fraction of time when the low-cost must-run resources are on the margin in year *y*
Source of data used:	JIRAMA (2007)
Value applied:	74
Justification of the choice of data or description of measurement methods and procedures actually applied :	The choice of the data satisfies the guidance in the "Tool to calculate the emission factor for an electricity system" (version 03.0.0). This data was calculated as the crossing point of the load duration curve and the low-cost must-run resources curve.
Any comment:	The data is from the national utility JIRAMA. The uncertainty of the data is low.

Data / Parameter:	EF_{CO2} for the diesel consumed by the emergency back-up diesel generator
Data unit:	tCO_2/kg of diesel
Description:	CO_2 emission factor of diesel used for the emergency back-up diesel generator at SHPP
Source of data used:	Footnote of Table I.D.1 in AMS I.D. ver.13 mentions this conversion factor following revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied:	3.2t CO_2/kg of diesel
Justification of the choice of data or description of measurement methods and procedures actually applied :	The Footnote in AMS I.D ver.13 sets this conversion factor for small diesel generators like the emergency unit at SHPP (275 kW). This value of 3.2 $kgCO_2$/kg diesel for the calculation of project emissions is more conservative than the 2.96$kgCO_2$/kg diesel calculated for the power plants using diesel in Madagascar (see Annex 3, last column).
Any comment:	-

Data / Parameter:	CAP_{BL}
Data unit:	W
Description:	Installed capacity of the hydro power plant before the implementation of the project activity.
Source of data used:	Project site
Value applied:	-
Justification of the choice of data or description of measurement methods and procedures actually	For new hydro power plants, this value is zero.

applied :	
Any comment:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity (no reservoir).

Data / Parameter:	**A_{BL}**
Data unit:	m^2
Description:	Area of the reservoir measured in the surface of the water before the implementation of the project activity, when the reservoir is full
Source of data used:	Project site
Value applied:	-
Justification of the choice of data or description of measurement methods and procedures actually applied :	For new reservoirs, this value is zero.
Any comment:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity (no reservoir).

B.6.3. Ex-ante calculation of emission reductions:

The ex-ante emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - L_y$$

Where:
ER_y is the emission reduction in year *y* (tCO_2)
BE_y is the baseline emission in year *y* (tCO_2)
PE_y is the project emission in year *y* (tCO_2)
L_y is the leakage emission in year *y* (tCO_2)

Project Emissions

The proposed project is a run-of-river hydro project. The only fossil CO_2 emissions from the project activity could come from the 275 kW diesel emergency unit installed at the plant. This unit will only operate in unplanned emergency situations as the hydropower plant operates during 12 months per year. The hydropower plant has three turbines; therefore the maintenance is done during the dry season; where only one or two turbines are running. That means the maintenance is done easily without any need of the diesel generator. The Emergency system is to be used to serve the plant in case the power in the plant is not available.

Due to the low probability and the small size of the unit, we have not considered any CO_2 emissions from the diesel generator. Hence, the project emission (PE_y) is zero, or $PE_y = 0$

Leakage

As newly built hydropower plant, there is no energy generating equipment transferred from another activity and no existing equipment transferred to another activity. There is no need to consider leakage (L_y) for the proposed project, thus $L_y = 0$.

As a result:
$ER_y = BE_y$

Therefore,
$ER_y (tCO_2) = BE_y (tCO_2) = 80,650 * 0.548 = 44,196$ t CO_{2e}

B.6.4 Summary of the ex-ante estimation of emission reductions:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of overall emission reductions (tonnes of CO_2e)
01/05/2010 – 31/12/2010	-	29,464	-	29,464
01/01/2011 – 31/12/2011	-	44,196	-	44,196
01/01/2012 – 31/12/2012	-	44,196	-	44,196
01/01/2013 – 31/12/2013	-	44,196	-	44,196
01/01/2014 – 31/12/2014	-	44,196	-	44,196
01/01/2015 – 31/12/2015	-	44,196	-	44,196
01/01/2016 – 31/12/2016	-	44,196	-	44,196
01/01/2017 – 31/12/2017	-	44,196	-	44,196
01/01/2018 – 31/12/2018	-	44,196	-	44,196
01/01/2019 – 31/12/2019	-	44,196	-	44,196
01/01/2020 – 30/04/2020	-	14,732	-	14,732
Total (t CO_2e)	**-**	**441,960**	**-**	**441,960**

B.7. Application of the monitoring methodology and description of the monitoring plan:

B.7.1 Data and parameters monitored:

Data / Parameter:	$EG_{facility,y}$
Data unit:	MWh/yr
Description:	Quantity of net electricity generation supplied by the project plant to the grid in year *y*
Source of data to be used:	Electricity meter(s)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	80,65 MWh
Description of measurement methods and	Two bi-directional energy meters M1 and M2 are used to monitor the net electricity generated (ACTARIS SL 7000; Type: SL 761 B 060; Serial number: 33055428 and, 36050447; Manufacturer: ACTARIS France with a respective

procedures to be applied:	accuracy of 0.5% and 1%) M1 and M2 are installed on the 63 kV substation of the hydro power plant to measure directly and continuously the electricity generation and the net electricity supply to the grid. The metering instruments will be calibrated annually in accordance with the national standard set by JIRAMA.
QA/QC procedures to be applied:	The data will be cross-checked against electricity sales receipt from JIRAMA and/or records from the grid for quality control. Since the electricity generated will be the revenue meters which measure the quantity of electricity that the project will be paid for, the Power Purchase Agreement between JIRAMA and HYDELEC can be used as reference. Moreover a third power meter M3 is used by JIRAMA at the substation of Antsirabe, together with a fourth end-user power meter M4 at HOLCIM cement factory of Ibity, to cross checked the net electricity generated by the project.
Any comment:	The information will be provided monthly by HYDELEC to JIRAMA.

Data / Parameter:	$\mathbf{FC_{diesel}}$
Data unit:	kg
Description:	The quantity of diesel fuel consumed by the diesel generator during any emergency situation
Source of data to be used:	The emergency records and log book
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable, since the project has not yet experienced any emergency and there is only a very low probability for any emergency situation
Description of measurement methods and procedures to be applied:	This data is measured and recorded in a log book during emergency period
QA/QC procedures to be applied:	This will be cross checked with the purchase receipts of diesel fuel and measurement conducted in the diesel storage tank
Any comment:	The diesel generator will only operate in unplanned emergency situations. The hydropower plant has three turbines; therefore the maintenance is done during the dry season; where only one or two turbines are running. That means the maintenance of SHPP is done without any need of the diesel generator.

Data / Parameter:	$\mathbf{NCV_{diesel,y}}$
Data unit:	GJ per mass or volume unit (e.g. GJ/m³, GJ/ton)
Description:	Weighted average net calorific value of diesel fuel in year *y*
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as neither local nor national values available.

Value of data applied for the purpose of calculating expected emission reductions in section B.5	43.3
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	Any future revision of the IPCC Guidelines should be taken into account.

Data / Parameter:	**$EF_{CO2, diesel,y}$**
Data unit:	tCO_2/GJ
Description:	Weighted average CO_2 emission factor of diesel fuel in year *y*
Source of data to be used:	IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories, as neither local nor national values available.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.0748
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	Applicable since Option B of the Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion is used. Any future revision of the IPCC Guidelines should be taken into account.

Data / Parameter:	**CAP_{PJ}**
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data to be used:	Project site

Value of data applied for the purpose of calculating expected emission reductions in section B.5	16,500,000
Description of measurement methods and procedures to be applied:	Determined based on recognized standards. Monitored yearly.
QA/QC procedures to be applied:	-
Any comment:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity. As mentioned in Table 4 (Applicability conditions of the methodology ACM0002), the project is the installation of a new run-off-river hydro power plant and does not involve any reservoir.

Data / Parameter:	$\mathbf{A_{PJ}}$
Data unit:	m^2
Description:	Surface area of the reservoir measured at full supply level after the implementation of the project activity.
Source of data to be used:	-
Value of data applied for the purpose of calculating expected emission reductions in section B.5	Not applicable.
Description of measurement methods and procedures to be applied:	-
QA/QC procedures to be applied:	-
Any comment:	This parameter is used to calculate the power density. However calculation of power density is not required for this proposed project activity. As mentioned in Table 4 (Applicability conditions of the methodology ACM0002), the project is the installation of a new run-off-river hydro power plant and does not involve any reservoir.

B.7.2. Description of the monitoring plan:

This monitoring plan outlines the principles which shall be followed in monitoring the parameters listed in section B.7.1. A monitoring manual with detailed procedures will be prepared on the basis of the principles outlined below. The monitoring manual may be updated to reflect that the actual implementation of the project will not deviate from the monitoring plan as presented in this section.

1. Monitoring of net electricity supplied by the project to the grid

The proposed project activity is connected via a transformer and a 63 kV transmission line to the regional grid of Antananarivo via Antsipolitra. The data to be monitored is the net electricity supplied to the grid.

The monitoring is based on real-time transmission of generation conditions of SHPP by means of a fully automatic metering system.

The electricity delivered from SHPP to RI TANA will be continuously monitored through metering equipments installed in the project sites. The monitoring is based on real-time transmission of the generation data by means of a fully automatic data acquisition system.

To monitor the electricity supplied by the project, two bi-directional electricity meters M1 and M2 are used, on the project plant site of Sahanivotry. Two additional meters M3 and M4 are used by JIRAMA as a cross-check at Antsirabe's substation and Ibity end-user connection (see Table 16 and Figure 4 below).

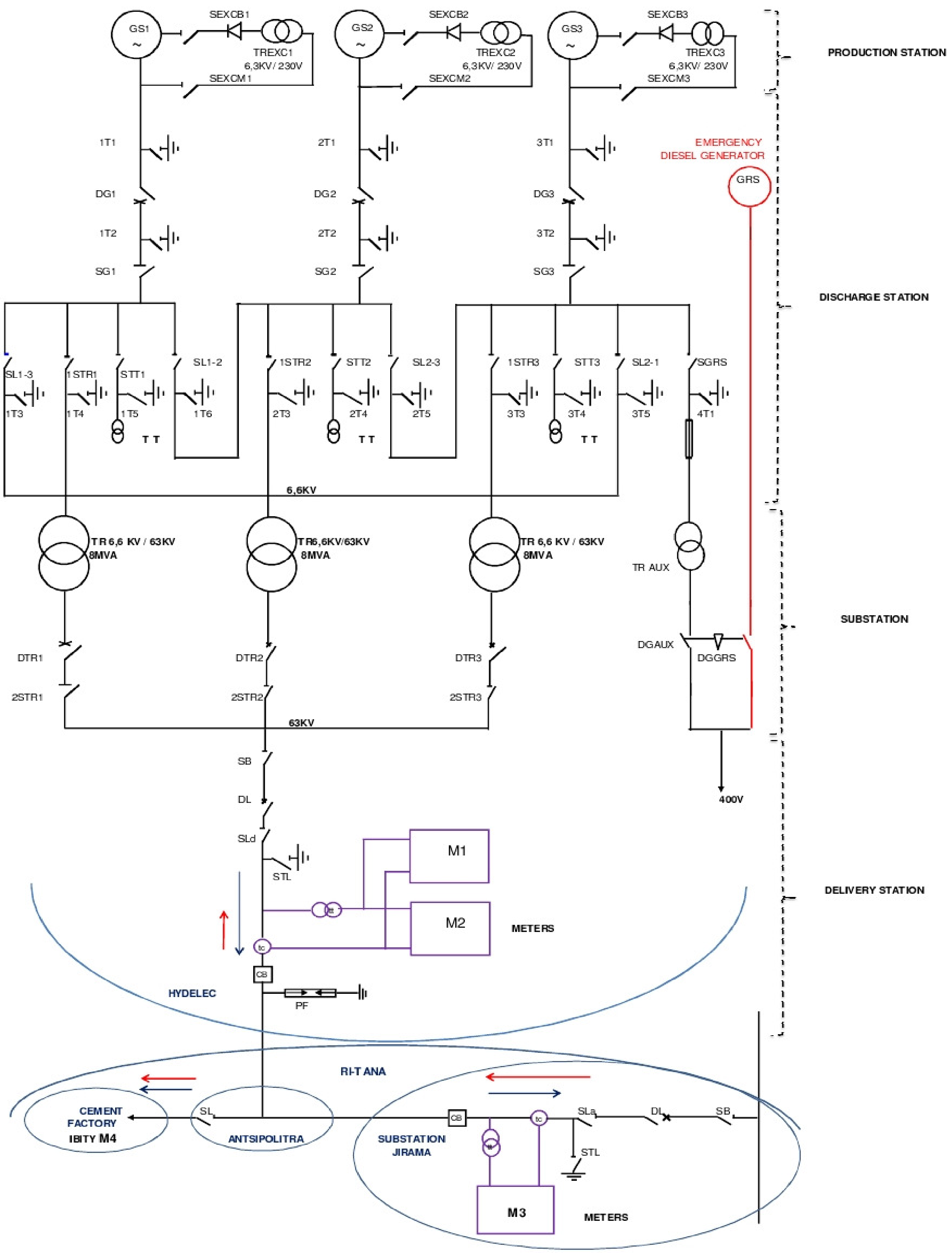
Electric meters	**Meters label**	**Serial Number**	**Characteristics**	**Use**
Sahanivotry's substation	M1 ***(main)***	33055428	bi-directional	Monitoring of net electricity supplied by the project
	M 2 ***(back-up)***	36050447	bi-directional	Use in case of failure of M1
JIRAMA : Antsirabe	M3	36050437	bi-directional	Use by JIRAMA to control the electricity supplied by Hydelec
HOLCIM : Ibity	M4	73305393	bi-directional	

Table 16: Electricity meters characteristics

M1 (and M2 backup) readings are net measurements, deducting SHPP's eventual power import from the grid for its auxiliary consumption when not operational (and alternatively to its emergency diesel generator).

The following grid connection diagram indicates the principles of positioning of metering instruments M1, M2 M3 and M4 that will be used in the monitoring of the emission reductions.
Staff will watch the operation status of metering equipments daily on site. Furthermore, designated staff will collect the measured electricity monthly and complete the corresponding record. These records will be checked by the company administrator or supervisor.

Figure 3 – Grid connection and meters diagram


GS1
SEXCB1
TREXC1
6,3KV/ 230V
SEXCM1
GS2
SEXCB2
TREXC2
6,3KV/ 230V
SEXCM2
GS3
SEXCB3
TREXC3
6,3KV/ 230V
SEXCM3
PRODUCTION STATION
1T1
2T1
3T1
EMERGENCY
DIESEL GENERATOR
GRS
DG1
DG2
DG3
1T2
2T2
3T2
SG1
SG2
SG3
DISCHARGE STATION
SL1-3
1STR1
STT1
SL1-2
1STR2
STT2
SL2-3
1STR3
STT3
SL2-1
SGRS
1T3
1T4
1T5
1T6
2T3
2T4
2T5
3T3
3T4
3T5
4T1
T T
6,6KV
TR 6,6 KV / 63KV
8MVA
TR6,6KV/63KV
8MVA
TR 6,6 KV / 63KV
8MVA
TR AUX
SUBSTATION
DTR1
DTR2
DTR3
DGAUX
DGGRS
2STR1
2STR2
2STR3
63KV
SB
DL
400V
SLd
STL
M1
M2
METERS
DELIVERY STATION
CB
PF
HYDELEC
RI-T ANA
CEMENT
FACTORY
IBITY M4
SL
ANTSIPOLITRA
SUBSTATION
JIRAMA
SLa
DL
SB
STL
M3
METERS

Caption:

SEXCB :low voltage excitation disconnector
SEXCM :Medium voltage excitation disconnector
TREXC :excitation transformer
DG :generator's circuit breaker
SG :generator's disconnector
CB :tank circuit
STR: transformer's disconnector
DTR: transformer's circuit breaker
STT: voltage transformer's disconnector
SL: link disconnector
ST: earthing switch
TRAUX : auxiliary transformer
DGAUX:auxiliary circuit breaker
DGGRS: emergency generator circuit breaker
TT:voltage transformer

SB: bus bar disconnector
DL: line's circuit breaker
GS: generator
SGRS: emergency diesel generator's disconnector
STL: line's earthing switch
Sla: line's disconnector
SLd: line's disconnector
M1,M2,M3, M4: kilowatt-hour meters
tc: current transformer
tt: voltage transformer
PF: surge arrester

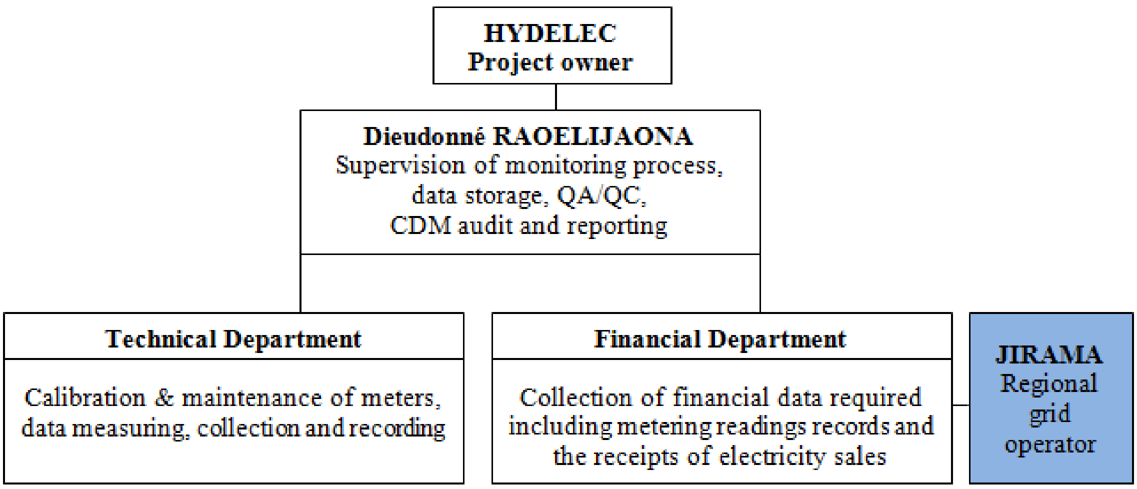
→ (blue) current direction when the plant is operational
→ (red) current direction when the plant is shutdown

2. Monitoring Organisation

The project owner HYDELEC will take the responsibility of the monitoring plan implementation; HYDELEC will appoint a CDM manager, who will be responsible for the supervision of the monitoring process, the data measuring, collection and recording, QA/QC, audit and reporting.

The staff from technical and financial departments will undertake the monitoring tasks including watching metering equipments periodically, collecting electricity data and completing records, checking and analyzing the data, archiving relevant records, reporting to the CDM manager Mr Dieudonné RAOELIJAONA.

Figure 4 – Monitoring and management structure



Energy meters

Two bi-directional energy meters (ACTARIS SL 7000; Type: SL 761 B 060; Serial number: 33055428 and 36050447; Manufacturer: ACTARIS France with a respective accuracy of 0.5% and 1%) will be installed for monitoring the generated power, according to the national standard set by JIRAMA.

The meters will register the following information:

1. Active power
2. Reactive power
3. Apparent power
4. Voltage
5. Phase's current
6. Active energy
7. Frequency
8. Event record
9. Harmonies

Quality assurance and quality control

The electricity delivered by SHPP to RI TANA will be monitored trough metering equipment at the project site. The data will be cross-checked against electricity sales receipt from JIRAMA and/or records from the grid for quality control. Since the electricity meters will be the revenue meters which measure the quantity of electricity that the project will be paid for, the Power Purchase Agreement between JIRAMA and HYDELEC can be used as reference.

Calibration of meters will occur annually according to the national standards set by JIRAMA.
All relevant data records obtained from the monitoring will be kept by the project owner during the crediting period and for at least two years after for DOE's verification.

Verification

It is expected that the verification of the emission reductions generated from the project will be conducted annually.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

Completion date: 23/10/2009

Elvira Lutter
Email: elvira.lutter@poyry.com

Christian Steinreiber
Email: Christian.steinreiber@poyry.com

Pöyry Energy GmbH
Laaer-Berg-Strasse 43, 1100 Vienna, Austria

Changes from registered PDD (conversion from small-scale to large-scale): 11/06/2012

Alexandre Dunod
Email : a.dunod@ecosurafrique.com

Christophe Roche

Email : c.roche@ecosurafrique.com

ecosur afrique - www.ecosurafrique.com

The persons/entities of determining baseline are not project participants

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

The starting date of the project activity is 19/03/2007, the start of construction.

C.1.2. Expected operational lifetime of the project activity:

25 years after start of operation (01/10/2008)

C.2. Choice of the crediting period and related information:

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

Not applicable

C.2.1.2. Length of the first crediting period:

Not applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

The crediting period will start on 01/05/2010, or on the day after the registration of the CDM project activity, which is later.

C.2.2.2. Length:

10 years

SECTION D. Environmental impacts

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

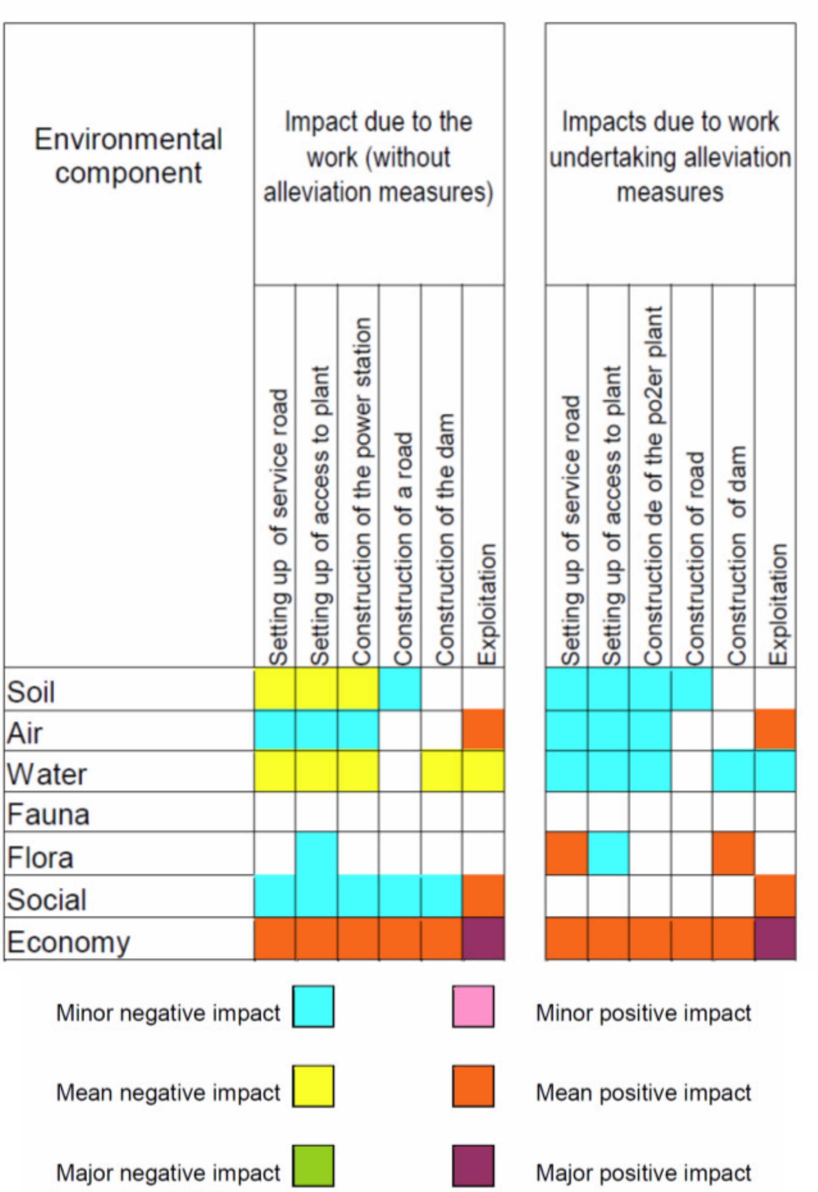
The "Charter of Environment" (Law 90-033 amended by the Law 97.016 dated 6 June 1997) imposes the principles for the environmental management in general and Environmental Impact assessment (EIA) in general.

The decree on the "Compatibility of Investments and Environment" (Decree 99.954 dated 15 December 1999) determines which type of projects must execute an EIA and the necessary procedures. According to this decree two types of activities are subject to an EIA:

1. Investments likely to have a negative impact on the environment. According to Annex I hydropower projects with an installed capacity higher 50 MW are subject of an obligatory EIA. Annex II stipulates that hydro power projects with an installed capacity between 25 and 50 MW are subject to a Programme of Environmental Commitment.
2. Investments situated in sensible zones.

According to the national legislation, SHPP is not subject to an EIA. Nevertheless, HYDELEC assigned SAGETEC in 2001 with an EIA. The results of the EIA were used in order to undertake reasonable and applicable measures able to reduce, mitigate, and control any potential negative impacts and maximize the effects of any potential positive impacts. The definitive EIA has been submitted to the DOE.
The matrix below presents the environmental impacts identified.

Figure 5 – Matrix on environmental impact



Source: SAGETEC

Impacts on the physical components

The main impacts are related to the disturbance of surface soil as well as increased dust, noise and emissions during the construction of the project.

Impacts on the surface water resource are minimal, and only during the construction period due to the increment of suspended solids. During the operation period, a minimum water flow of $0.6 m^3/s$ will be guaranteed for irrigation issues. The project design does not include a water reservoir.
Flora and fauna will be mainly affected during the construction period due to the loss of vegetation within the area of infrastructure and access roads, and due to the increment of noise levels. These impacts are of

minor importance due to the characteristics of the construction design. These impacts will be mitigated trough afforestation measures.

Impacts on the socio-economic component

The main negative socio-economic components are related to conflicts regarding land use and purchase and health and security of the construction workers.

In order to decrease the impact regarding the use and purchase of arable land, the project developer implemented a decompensation initiative. Regarding security and health at the construction site, the project developer provided training on security issues and medical assistance at the construction site.
The environmental impacts of the project are considered minimal and insignificant as mentioned above, and are more evident during the construction phase of the project. The project will have major positive socio-economic impacts related to development, employment, infrastructure etc.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

Not applicable.

SECTION E. Stakeholders' comments

E.1. Brief description how comments by local stakeholders have been invited and compiled:

Identification of stakeholders

Stakeholder	Description of involvement
Local communities	Inhabitants, local authorities and politicians of the following communities situated in the area of influence of the project: - Rural community of Sahanivotry (10,269 inhabitants) - Rural community of Manandona (10,631 inhabitants) - Urban community of Antsirabe (175,343 inhabitants)
JIRAMA	JIRAMA is the national utility for electricity and water in Madagascar. JIRAMA serves more than 100 localities in the whole country and it is the monopolistic owner of the electricity grid.
Ministry of Energy and Mines (MEM)	The MEM is in charge of the elaboration, implementation and administration of the national energy and mining policy taking into consideration the objectives of the MAP.
Ministry of Environment, Water and Forestry (MINENVEF)	The MINENVEF is in charge of sustainable management of natural resources such as air, water and forest. The MINENVEF is the Designated Local Authority (DNA).
National Authority of Water and Sanitation (ANDEA)	ANDEA is the authority responsible for the integrated administration of water resources in Madagascar and the sustainable development of the water and sanitation sector.

The public consultation comprised meetings with stakeholders on site, interviews and newspaper publications (evidence has been provided to the validator).

JIRAMA

JIRAMA has signed the Power Purchase Agreement (PPA) with HYDELEC on 17/02/2001, resp. amendment 1 dated 27/6/2001, amendment 2 dated 12 /10/2006 and amendment 3 dated 16/08/2007.

Ministry of Energy and Mines

The project obtained from MEM

3. the "concession for the installation and operation of SHPP with an installed capacity of 10 MW", dated 17/02/2001
4. the "approbation of the concession contract for the production of energy at SHPP with an installed capacity of 10 MW", Decree Nr. 2001-182 dated 05/03/2001
5. the "authorisation nr. 40 ME/SG/DG/DEN for starting construction and increasing of capacity from 10 MW to 15 MW", dated 07/03/2007
6. the "authorisation for the increase of capacity by 5 MW at SHPP", Order Nr. 21016/2007 dated 28/11/2007

Ministry of Environment, Water and Forestry

The project obtained the Letter of No Objection (LoNO) for the Project Idea Note (PIN) concerning the SHPP of HYDELEC (dated 18/09/2007). The Letter of Approval from Madagascar was issued on 04/11/2009.

National Authority of Water and Sanitation

ANDEA granted water usage rights for the Sahanivotry Hydro Power Plant at the Sahanivotry river on 21/05/2007.

Municipalities

Public consultation of local population took place in the framework of the EIA executed in November 2001. A list of the participants in the public consultation meetings has been provided to the validator. The contacts with the municipalities were positive, as the project contributes to sustainable local development, job creation and welfare of the local population.

Newspaper publications

Evidence from various newspaper publications informing about the Sahanivotry project has been provided to the validator.

E.2. Summary of the comments received:

The stakeholders welcomed the SHPP project development and mentioned that it would definitely improve the socio-economic situation of the affected local communities such as job creation,

development of the region, promotion of social activities such as rehabilitation of existing infrastructure (routes, schools, medical centre, water irrigation etc.), social welfare and increasing living standard etc.

The stakeholders raised concerns regarding the use of arable land as well as risk for health and security at the construction site.

Evidence has been provided to the validator which confirms the absence of negative impacts deriving from the proposed activity.

E.3. Report on how due account was taken of any comments received:

As response to the concerns raised by the local population regarding the use of arable land, HYDELEC decompensate the use of arable land for the project by refunding at a double or triple price the missed income from agriculture and the acquisition of the territory and the right to reuse the arable land for agriculture.

Regarding security at the construction site, the project developer implemented the following measures:
1. Training of employees for security at work
2. Implementation of national and international security norms
3. Provision of medical assistance.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	HYDELEC
Street/P.O.Box:	15, Avenue de l'Independance Analakely
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State/Region:	
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E-Mail:	pdg@hydelec.mg
URL:	
Represented by:	
Title:	President Directeur Géneral
Salutation:	Mr.
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Middle name:	
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URL:	www.publicconsulting.at, www.ji-cdm-austria.at
Represented by:	Martin Gauss
Title:	Consultant
Salutation:	Mr.
Last name:	Gauss
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Personal e-mail:	m.gaus@kommunalkredit.at

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There is no deviation of public ODA funding. All information regarding the AfDB financing is contained in section a.4.4.

Annex 3

BASELINE INFORMATION

CO2 Emission Coefficient	Date of commissioning	Fuel	Installed capacity	NCV	Emission factor	Carbon Emission Factor	Oxidation Rate	Emission factor	Emission factor
	[year]	[-]	[MW]	[TJ/10³ tonnes]	[t C/TJ]	[kg C/t]	[%]	[kg C/t]	[kg CO2/t]
Antelomita 1	1930	Hydro	4.08	-	-	-	-	-	-
Antelomita 2	1950	Hydro	4.08	-	-	-	-	-	-
Manandona	1930	Hydro	1.40	-	-	-	-	-	-
Mandroseza	1955	HFO	3.28	44.33	21.10	0.935	0.995	0.931	3.41
Mandraka	1956	Hydro	24.00	-	-	-	-	-	-
Antsirabe 1015	1964	HFO	1.20	44.33	21.10	0.935	0.995	0.931	3.41
Antsirabe 1016	1967	HFO	1.20	44.33	21.10	0.935	0.995	0.931	3.41
Antsirabe 1017	1968	HFO	1.80	44.33	21.10	0.935	0.995	0.931	3.41
Antsirabe 1309	1982	Diesel	7.00	40.19	20.20	0.812	0.995	0.808	2.96
Ambohimanambola 1306	1972	Diesel	6.00	40.19	20.20	0.812	0.995	0.808	2.96
Ambohimanambola 1307	1973	Diesel	6.00	40.19	20.20	0.812	0.995	0.808	2.96
Ambohimanambola 1308	1981	Diesel	6.00	40.19	20.20	0.812	0.995	0.808	2.96
Andekaleka G1 & G2	1982	Hydro	62.00	-	20.20	-	-	-	-
Loc Hydelec - Ambohimanambola	2000	Diesel	13.40	40.19	20.20	0.812	0.995	0.808	2.96
IPP HFF Antsirabe	2001	Diesel	4.55	40.19	20.20	0.812	0.995	0.808	2.96
IPP HFF - Ambohimanambola	2005	Diesel	24.46	40.19	20.20	0.812	0.995	0.808	2.96
Loc EDM - Antsirabe	2006	HFO	5.00	44.33	21.10	0.935	0.995	0.931	3.41
Loc HFF - Ambohimanambola	2007	Diesel	5.00	40.19	20.20	0.812	0.995	0.808	2.96
of which hydro									
of which thermal									
Total									

	Fuel	Specific Fuel Consumption	Generation 2004	Generation 2005	Generation 2006	Fuel Consumption 2004	Fuel Consumption 2005	Fuel Consumption 2006	Emissions per anno 2004	Emissions per anno 2005	Emissions per anno 2006
	[-]	[g/kWh]	[MWh]	[MWh]	[MWh]	[t/a]	[t/a]	[t/a]	[t CO2/a]	[t CO2/a]	[t CO2/a]
Antelomita 1	*Hydro*	-	*23,754.78*	*39,365.77*	*25,144.62*	-	-	-	-	-	-
Antelomita 2	*Hydro*	-				-	-	-	-	-	-
Manandona	*Hydro*	-	*5,017.72*	*3,586.62*	*4,756.42*	-	-	-	-	-	-
Mandroseza	*HFO*	*327.00*	*1,530.97*	*197.03*	*3.86*	*500.63*	*64.43*	*1.26*	*1,708*	*220*	*4*
Mandraka	*Hydro*	-	*96,204.21*	*78,191.48*	*54,490.47*	-	-	-	-	-	-
Antsirabe 1015	*HFO*	*250.00*									
Antsirabe 1016	*HFO*	*259.00*	*24,956.56*	*15,727.26*	*8,530.94*	*6,257.86*	*3,943.61*	*2,139.13*	*20,650*	*13,013*	*7,059*
Antsirabe 1017	*HFO*	*274.00*									
Antsirabe 1309	*Diesel*	*220.00*									
Ambohimanambola 1306	*Diesel*	*220.00*									
Ambohimanambola 1307	*Diesel*	*220.00*	*43,805.68*	*27,595.20*	*20,148.03*	*9,637.25*	*6,070.94*	*4,432.57*	*28,544*	*17,981*	*13,129*
Ambohimanambola 1308	*Diesel*	*220.00*									
Andekaleka G1 & G2	*Hydro*	-	*453,967.10*	*467,184.60*	*489,832.90*	-	-	-	-	-	-
Loc Hydelec - Ambohimanambola	*Diesel*	*232.00*	*16,732.87*	*18,081.43*	*19,954.69*	*3,882.03*	*4,194.89*	*4,629.49*	*11,498*	*12,425*	*13,712*
IPP HFF Antsirabe	*Diesel*	*220.00*	*7,658.57*	*1,440.82*	*0.00*	*1,684.89*	*316.98*	-	*4,990*	*939*	-
IPP HFF - Ambohimanambola	*Diesel*	*220.00*	*25,165.22*	*24,436.13*	*24,683.81*	*5,536.35*	*5,375.95*	*5,430.44*	*16,398*	*15,923*	*16,084*
Loc EDM - Antsirabe	*HFO*	*236.00*	*0.00*	*17,765.24*	*25,500.70*	-	*4,192.60*	*6,018.16*	-	*14,307*	*20,537*
Loc HFF - Ambohimanambola	*Diesel*	*225.00*	*0.00*	*24,760.72*	*50,158.68*	-	*5,571.16*	*11,285.70*	-	*16,501*	*33,427*
of which hydro			*578,943.81*	*588,328.47*	*574,224.41*						
of which thermal			*119,849.87*	*130,003.82*	*148,980.70*						
Total			698,793.68	718,332.29	723,205.11				83,788.79	91,309.02	103,951.50

OPERATING MARGIN	t CO2/MWh	*0.70*	*0.70*	*0.70*
	1-Lampda	0.74		
	Operating Margin	**0.5178**	**t CO2/MWh**	
BUILD MARGIN 2006	**Building Margin**	**0.5790**	**t CO2/MWh**	

Annex 4

MONITORING INFORMATION

All monitoring information is contained in section B.7.

HYDELEC
MADAGASCAR S.A.

Centrales hydroélectriques. Centrales thermiqu

Etudes – Réalisation- Exploitati

Members of the CDM Executive Board

Antananarivo, 25th May 2011

N/ref : L/001/HYD/LM/CDM/11
Object : Carbone credit CDM N° 3558

Dear Sirs/Madam,

We kindly want to draw your attention to our Hydropower Project Sahanivotry, which has been successfully registered under CDM in August 2010 (number: 3558), being the first CDM project and the first hydro power project since 25 years in Madagascar

The project was developed using the small-scale CDM methodology AMS I.D. (version 13) and the project was projected to be below the threshold of 15 MW. The maximum capacity of the hydroelectric power station in Sahanivotry, which is mentioned in all official appropriate documents (permits issued by the national ministries, feasibility studies, energy purchase contract with the JIRAMA…), is 15 MW.

As a result, with the natural data/information on the site (hydrology, topography, waterfall height), the maximum power plant with three generators is 15 WM. However, if only one generator works, case which arises every year because it is hydroplant run of the river, the loss of charge in the water intake and penstock reduce with an increase of the net head

This operating generator allows to generate about 10% of the power compared with the rated one.

It is the reason why we asked the manufacturer to size the generators to 6 875 kVA or 5,5 MW in order to protect the machine , secure the operation and to fulfill the environmental condition. But, the maximum capacity of the three generators while working simultaneously remains 15 MW.

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S.A au capital de 2 750 000 000 Ar - RC Antananarivo n° 2000 B 41
NIF : 105005252 du 09 Août 2005 - Stat n° 40 100 11 2000 0 00333 du 24/01/2006
CP 0115502 du 21/01/08 - QUIT 268858 D DU 5/11/07

MINISTERE DE L'ENVIRONNEMENT, DE
REPOBLIKAN'I MADAGASIKARA

We would emphasize that the maximum capacity gone by all official documents is 15 MW.

The actual generation prove that the capacity is under 15 MW and lower than the capacity planned in the PDD.

As a conclusion, we would underline that the project will meet the methodology of ACM0002 large-scale, given that in EB50, the directive 10.7 of the appendix 13, it is stipulated that, for projects (small or large-scale) in less developed countries, there should be more flexibility in the availability of the data / information in the actual demonstration of the barrier, compared to the projects in other countries.

Faced with this difference in interpretation, we would ask you recommendations to deal with the situation because this small-scale power plant of Sahanivotry is under the threshold of small-scale of CDM of 15 MW.

Remaining at your disposal for further information regarding this project of Sahanivotry, and looking forward to hearing from you soon.

Yours Faithfully,

André FILLET

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