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PROJECT IDENTIFICATION FORM (PIF)

PROJECT TYPE: FULL SIZE PROJECT
THE GEF TRUST FUND

Re-Submission Date: November 17, 2009

PART I: PROJECT IDENTIFICATION

GEF PROJECT ID: 4144 **PROJECT DURATION: 18** months
GEF AGENCY PROJECT ID:
COUNTRY(IES): Brazil
PROJECT TITLE: PILOT PROJECT FOR METHANE MITIGATION AND RECOVERY FROM HYDROELECTRIC POWER RESERVOIRS
GEF AGENCY(IES): IADB
OTHER EXECUTING PARTNER(S): FURNAS CENTRAIS ELÉTRICAS S/A
GEF FOCAL AREA (S): Climate Change
GEF-4 STRATEGIC PROGRAM(s): CC_SP3, CC_SP4, CC_SP6
NAME OF PARENT PROGRAM/UMBRELLA PROJECT (if applicable**):**

INDICATIVE CALENDAR*	
Milestones	**Expected Dates**
Work Program (for FSP)	March 2010
CEO Endorsement/Approval	June 2010
Agency Approval Date	July 2010
Implementation Start	August 2010
Mid-term Evaluation (if planned)	Abril 2011
Project Closing Date	February 2012

* See guidelines for definition of milestones.

A. PROJECT FRAMEWORK

Project Objective: The **general objective** of the project is to promote the adoption of Methane Gas (CH4) mitigation and recovery technologies in hydroelectric power reservoirs and facilities to promote Greenhouse Gas (GHG) emissions reduction. This objective will be attained through the: (i) assessment of CH4 concentration levels dissolved in water on the selected hydropower plant[3]; (ii) testing of different technologies and devices for CH4 mitigation and CH4 recovery from methane-rich reservoir waters and identify the most adequate one to be used in the selected hydropower; (iii) development of a pilot project for CH4 mitigation and recovery; (iv) conduct a technical and economical feasibility study for electricity generation using recovered CH4[4].

Project Components	Indicate whether Investment, TA, or STA[b]	Expected Outcomes	Expected Outputs	Indicative GEF Financing[a]		Indicative Co-Financing[a]		Total ($) c =a + b
				($) a	%	($) b	%	
1. Assessment of methane (CH4) recovery from hydroelectric power tropical reservoirs.	TA	- Increased understanding of CH4 recovery technologies and electricity generation potential. - Baseline of CH4 emissions in tropical hydropower reservoirs and facilities (particularly in the spillway or turbines) developed. - Data gathering on water quality in Furnas owned reservoirs over the past years - Environmental Impact Assessment (EIAs) of the ecosystems in Furnas reservoirs	- Technical reports including lab testing with preliminary results of CH4 measurements - Reports on CH4 concentration on water viable for CH4 recovery - Studies performed in 3 brazilian hydropower facilities and their reservoirs	0	0	6,200,000	100	6,200,000

3 The proposed GEF project may be implemented in the *Corumbá* hydroelectric power plant in the State of *Goias*. This plant is owned and operated by Furnas.

4 Economic/Financial feasibility studies may include potential revenues derived from carbon credits from the Clean Development Mechanism (CDM)

2. Mesuring CH4 emissions downstream the selected hydropower dam and CH4 grade dissolved on water along the reservoir	TA & Investment	High-quality, sound information on CH4 recovery potential in the selected hydropower dam	- Estimated CH4 emissions - Estimated CH4 concentration on water - Knowledge of the distribution of temperature and concentration of CH4 and CO2 in specific areas of the hydropower plant reservoir to be selected	358,460	28	280,000	72	638,460
3. Testing and selection of diverse CH4 mitigation and recovery technologies and devices.	STA	Selection of the most suitable devices and technologies for CH4 mitigation and recovery from hydropower reservoirs and facilities	- Technical assessments and cost-efficiency analysis on selected technologies, methods and devices undertaken.	511,137	45	841,500	65	1,352,637
4. Pilot project for CH4 mitigation and recovery in one hydropower plant reservoir owned and operated by Furnas	Investment	- Feasibility of selected technologies and devices for CH4 mitigation and recovery demonstrated - Detailed results of all the conducted tests and identification of the required improvements for replicating the pilot	- Experimental station for the recovery of CH4 in operation - Reduction on CH4 emisssions calculated - Extraction of CH4 per litre of water calculated - Detailed documentation of the assembly and manufacturing process of all the components of the pilot - Operational data for pilot is available for large scale replication - Minimum technical and operational conditions for large scale replication of CH4 recovery in hydropower plants determined	1,463,712	24	4,643,371	76	6,107,082

5. Feasibility studies for electricity generation using recovered CH4	TA	- Technical and economic feasibility study on the recovery and / or mitigation of CH4 in hydropower plants; - Estimate production costs, efficiency and Return on Investment (ROI) for a power plant using recovered CH4. - Estimated potential reduction on CH4 emissions based on pilot results	- Investment costs needed to build a generation plant using recovered CH4 determined - Estimated revenues (electricity sales and carbon credits) determined - Studies of economic feasibility and commercial use of CH4 as a source of Renewable Energy (RE) presented and disseminated	212,421	29	521,250	71	733,671
5. Project management				106,210	24	310,620	76	416,830
Total project costs				2,651,941	17	12,796,741	83	15,448,682

[a] List the $ by project components. The percentage is the share of GEF and Co-financing respectively of the total amount for the component.
[b] TA = Technical Assistance; STA = Scientific & Technical Analysis.

B. INDICATIVE Co-financing FOR THE PROJECT BY SOURCE and by NAME (in parenthesis) if available, ($)

Sources of Co-financing	Type of Co-financing	Project
Project Government Contribution (Furnas)	In kind	11,731,530
Project Government Contribution (Furnas)	Cash	265,211
Bilateral Aid Agency(ies)	--	--
Multilateral Agency(ies)	--	--
Private Sector[5] (HydroGHG)	In kind	800,000
NGO		
Others ()		
Total Co-financing		12,796,741

C. INDICATIVE FINANCING PLAN SUMMARY FOR THE PROJECT ($)

	Previous Project Preparation Amount (a)[6]	Project (b)	Total c = a + b	Agency Fee
GEF		2,651,941	2,651,941	265,194
Co-financing		12,796,741	12,796,741	

5 *HydroGHG Engenharia Ltda*. was established in 2007 as a Brazilian pioneer in the exploration and measurement of CH4 deposits dissolved in fresh water, as well as conducting feasibility studies for the mitigation or economic exploitation of this potential energy. *HydroGHG* is the result of successful work of a group of Brazilian researchers, and has been conducting studies for 5 years developing the technology of measurement, data analysis, recovery and mitigation of GHG. It has several patent applications and has vast experience in this area, with publications in Brazil and abroad.

6 Include project preparation funds that were previously approved but exclude PPGs that are awaiting for approval.

Total	15,448,682	15,448,682	265,194

D. GEF RESOURCES REQUESTED BY AGENCY (IES), FOCAL AREA(S) AND COUNTRY(IES)[1]

[1] No need to provide information for this table if it is a single focal area, single country and single GEF Agency project.

PART II: PROJECT JUSTIFICATION

A. STATE THE ISSUE, HOW THE PROJECT SEEKS TO ADDRESS IT, AND THE EXPECTED GLOBAL ENVIRONMENTAL BENEFITS TO BE DELIVERED:

Hydroelectric power represents 14% of the total energy supply in Brazil, and hydroelectricity alone accounts for more than 70% of the national electricity production.[7] While fossil fuel contribution to global warming is well known, the contribution of hydroelectric dams in terms of Greenhouse Gas (GHG) emissions, especially in tropical forest areas, is beginning to be unveiled. Several studies show that due to the decomposition of organic material, tropical reservoirs constitute an important source of Methane Gas (CH4), which has 21 times more global warming potential than the carbon dioxide (CO2) that gets released into the atmosphere. CH4 production varies considerably from one reservoir to another and from one season to another (dry season to rainy season), also, CH4 concentration in water fluctuates within a single reservoir. Since CH4 emitted comes from biological activity, emissions are especially high in large tropical reservoirs built over densely forested areas, where there is a large input of organic matter, the average temperature is high and there are large areas with anoxic conditions at the bottom of the water column.

Given that the water intake is located well below the surface and CH4 concentration strongly increases with depth, most of the CH4 dissolved in water is fast degassed after the water passes through the spillway or turbines due to the sudden pressure drop. As such, CH4 is released from water passing through the turbines or spillway, amounting up to 70% of the total reservoir emissions, like is the case for the the *Tucuruí* Dam in the Brazilian *Amazonia*.[8] Studies made in the Brazilian hydroelectric plants' reservoirs of *Serra da Mesa*, *Tucuruí* and *Itaipu* calculated a production of 8.6 Tera grams per year (Tg/y)[9] of CH4 for the three reservoirs. Considering that Brazil has more than 600 dams where the 95 largest reservoirs represent a total surface area of 35,500 km2 (96.5% of the surface area of all dams)[10], it is possible to extend these estimates to the entire Brazilian hydropower system. Assuming a conservative 60% of CH4 recovery efficiency, we arrive at a potential CH4 recovery in the range of 22–38 Tg/y.[11]

Even if CH4 emissions decrease as the reservoir grows older, they stabilize at a high level due to the continuous inflow of organic matter through hydrographic drainage and the generation of new photosynthetic-based biomass. Therefore, CH4 could be recovered during the life of the hydroelectric power plant. The application of the recovered CH4 will depend on its quantity and quality. The recovered CH4 could be pumped to large consuming centers, stored locally or burned in gas turbines to generate electricity during high-demand periods, or even purified for transport applications. The thermal power plant production could use the transmission facilities already in place to deliver the power to consumer centers.

Given the large participation of hydroelectric power generation in Brazil, it is of upmost importance to better estimate the amount of CH4 and how they evolve over time, to mitigate and recover the CH4 generated on large land-covered areas in order to reduce the potential for GHG emissions and to transform the CH4 in the reservoirs and facilities into a new renewable source of energy.

The proposed GEF project aims to:

[7] Brazil, Agência Nacional de Energia Elétrica (ANEEL): 2005, "Atlas de energia elétrica do Brasil (2ª edição)", Brasília, Brazil.

[8] Fearnside PM. Greenhouse gas emissions from a hydroelectric reservoir (Brazil's Tucuruí dam) and the energy policy implications. Water Air Soil Pollut 2002;133:69–96.

[9] Tera grams = 10^{12}grams = 1,000,000 tons

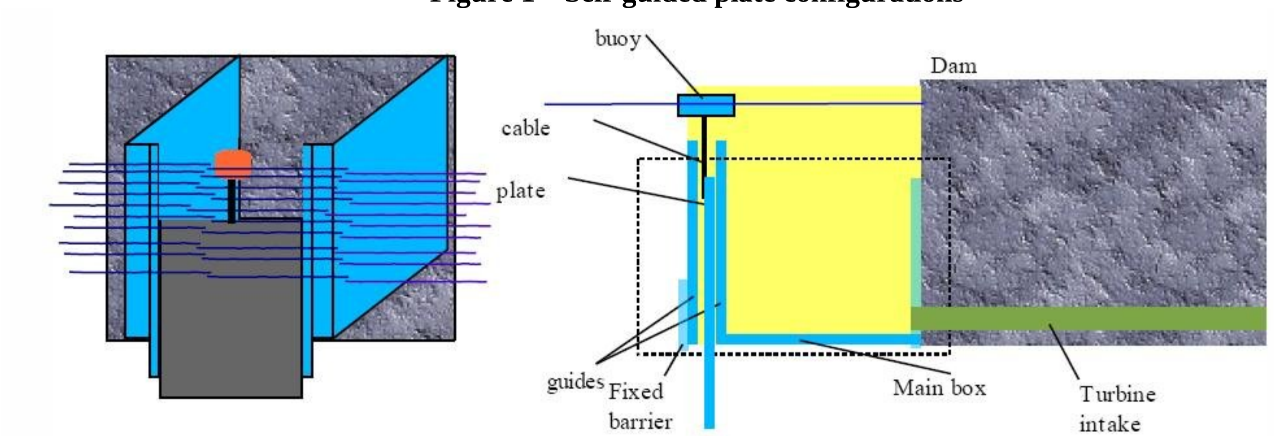
[10] The International Commission on Large Dams. World Register of Dams. Paris: International Commission on Large Dams, 2003, see also /http://www.icold-cigb.orgS.

[11] As per A.W. Bambace, F.M. Ramo, I.B.T. Lima, R.R. Rosa. Mitigation and recovery of methane emissions from tropical hydroelectric dams, these figures represent two to four times the current Brazilian consumption of natural gas, and are equivalent to a production of 690,000 – 1,100,000 bbl/day of crude oil (or 38-62% of the current 1,800,000 bbl/day oil Brazilian consumption).

i. **Assess CH4 concentration levels dissolved on water on the selected hydropower plant**: There are two ways for measuring CH4 concentration on water to trace a vertical profile[12]: (i) collecting water from different depths using Van Dorn bottles; and (ii) using buoys with sensors placed on appropriate depths. For the purpose of this GEF project, the Van Dorn bottles will be used for CH4 measurement. Van Dorn bottles collect the water on site and are maintained pressurized until measures are made on lab. Once on the lab, the water is degassed, at atmospheric pressure, and the CH4 concentration is measured on a chromatograph. The Van Dorn bottles are widely used on marine and inland water studies[13]. It is a cheap and reliable device to collect water samples and transport them to be analyzed on a lab. Using the buoys with the sensors, measures are taken automatically on a programmable time and the data is stored and transmitted to a central unit locally placed (hydropower dam operational center). The buoy with sensors is still being developed and has two basic advantages: allows for continuous monitoring of CH4 concentration tracing how it varies along the days and seasons, and does not demand a measuring team to take water samples and bring them to lab. These sensors (hardware and software) are still being developed by the project team.[14]

ii. **Test different technologies and devices for mitigation of CH4 and identification of the most adequate one to be used in the selected hydropower**: There are two technologies for mitigating methane emissions on hydropower reservoir that are going to be tested: (i) membranes system; and (ii) self-guided plate system. Both have the same principle: prevent deep rich methane waters to reach spillways or turbine intakes by blocking them. The membrane system is placed to block the whole channel, properly anchored to the reservoir bottom, and placed far enough from the inlets to allow maintenance and minimization of accidents. The membrane induces a recirculation near the bottom, and it makes possible to collect CH4-rich water under it. The self-guided plates system has a control buoy that ensures the relative position between the water surface, one or more sliding plates placed before the turbine intakes or spillways. With the help of real-time measurements, it is possible to evaluate directly the CH4 concentration inside the device. Figure 1 presents two self-guided plate configurations that show a cross section of a self-guided plate system. When the turbine intake is too close to the reservoir bottom, a telescopic system with self-guided plates is needed.

Figure 1 – Self-guided plate configurations



Both mitigation devices help to reduce turbine or spillway CH4 emissions, so the gas concentration in the main channel, before the barriers, tends to increase. Consequently, the adoption of mitigation strategies result in a portion of the CH4 that was previously degassed by the turbines or spillways, to be oxidized by methanotrophic bacteria before reaching the atmosphere or transformed into new reservoir surface emissions.

12 Methane gas dissolved on water concentration measuring technology.

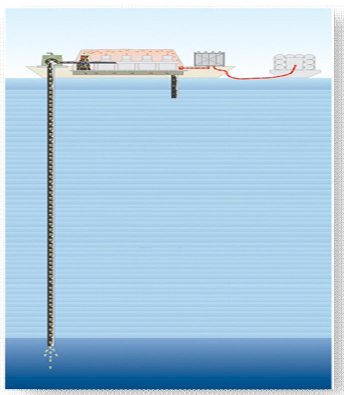
13 Inland water studies include the study of lakes and ponds, rivers, springs, streams and wetlands.

14 Some prototypes of the sensors are being tested on site (Brazilian *Pantanal* environmental monitoring system). The tests will continue until March/2010. If approved, the sensors could be used as part of the GEF project. The sensors development costs are part of the counterpart (HydroGHG and *MB Instrumentação Eletrônica*). Therefore, there is no GEF resources allocated to sensors development. The GEF resources will be used for the acquisition of a measuring system (instruments, equipments, computer, software, etc.).

Membrane or sliding plates barriers are commonly used on dams to block or control water flux. Normally, the objective is to prevent plants and fishes for achieving turbine intakes, or to route them away towards a biological path.

iii. **Develop a pilot project for CH4 recovery**: The proposed CH4 recovery strategy is based on the transport of CH4-rich, pressurized, deep waters to surface ambient conditions, where the dissolved CH4 can be extracted into a sealed vessel.[15] Based on the selected separation technology, a floating experimental pilot recovery station will be built. Mounted on a floating raft (see figure 1), the experimental station will allow for the CH4-rich water pass through different degasification devices. Light and scalable, the recovery boat may be moved from one site to another whenever an exploitation zone becomes poor in CH4. The experimental station will be designed and built on a smaller scale to demonstrate the effectiveness, efficiency, productivity and profitability on the recovery of CH4.

Methane degassing and separation from water can be done with existing and patented separation technologies[16] such as: (i) bubbling system; and (ii) water jet and spray systems. Both technologies will be tested to select the most appropriate one for the conditions of the Brazilian reservoirs. In the bubbling system, an upward hose leads water to a horizontal tube, in which the residence time is long enough to allow a high degassing level. A hydrophilic filter retains and directs CH4 bubbles to an upper gas outlet. A submerged pump is used to force upstream flow, and as the water goes up, the bubbling starts, and the two phase flows causes a reduction in column density that enhances the upward flow. In the water jet and spray systems, a nozzle is used to create a water jet or spray forming a cloud of droplets. The small droplets offer a high surface area and small internal diffusion lengths to the dissolved gas that escapes to the vessel, and is pumped out by a blower. The gas mix passes inside batch absorbers that collect CH4.



iv. **Conduct a technical and financial feasibility study for electricity generation using recovered CH4:** The proposed pilot project will assess the composition, concentration and efficiency of the recovered CH4 and the estimated revenues, production costs, efficiency and return on investment (ROI) to determine the financial feasibility for electricity generation. The proposed pilot will also estimate the potential reduction of CH4 emissions to identify potential revenues derived from carbon credits.

Generation of electricity depends on the concentration of CH4 in the water. Recent studies have shown that if the water is collected at depths greater than 50 meters within the CH4 saturation zone, the gas recovered will have a partial CH4 pressure in the range of 36 to 80% (the rest being mainly N2 and CO2), suitable for stationary applications. It is estimated that the H2S/CH4 ratio for the pilot will range from 15 to 20 parts per million (ppm), which means that the gas can be directly used in any combustion engine. Graph 1 presents the global efficiency of the proposed CH4-extraction system, defined as the ratio between the net CH4 output mass (i.e. the extracted gas minus the methane used to run the extraction system, considering a 23% engine efficiency) and the total CH4 mass available in the water, as a function of the CH4 concentration. A CH4 concentration above 6 grams per cubic meter (g/m3) yields a global efficiency higher than 40%. On the other hand, for concentrations levels below 3 g/m3, the net energy output is negative and, thus, the operation is unfeasible. The composition, concentration and efficiency of the recovered CH4 will be tested during the pilot project to determine the financial feasibility for electricity generation.

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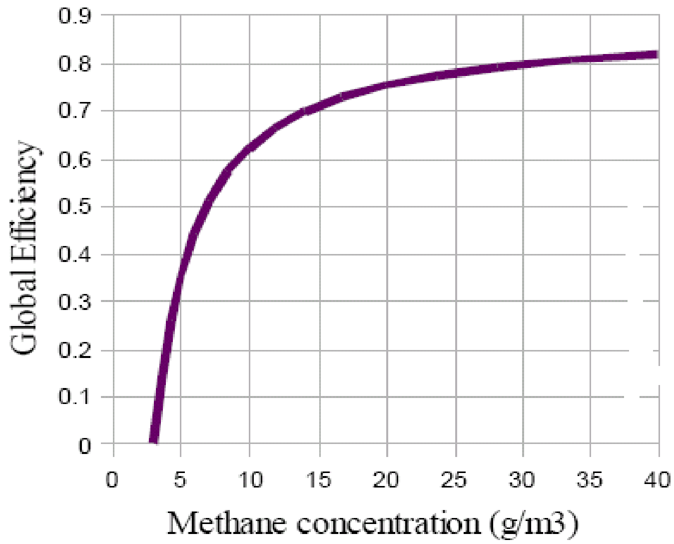
15 A similar approach has already been successfully implemented for degassing CO2 from lakes *Nyos* and *Monoun* (the so-called ''killer lakes'') in Cameroon.

16 Gas-liquid separators are commonly used on a variety of industries, such as: oil and gas production, chemical plants, power generation, petroleum and petrochemical industry. Their application varies since gas recovery, filtering and dehumidification until distillation and air cleaning through removing pollutants.

Graph 1 – Global efficiency of the CH4 extraction system as a function of the CH4 concentration



Replicability. Although the technology to be tested in this project has been used and proved for several years in the oil and gas industry, its application to mitigate and recover CH4 is new. As such, finding the means to finance this kind of projects is a challenge. It is considered that the main barriers to be overcome are: (i) technological; and (ii) financial. The specific GEF support will provide experience in the application of the technology under certain characteristics of a hydropower plant and a positive outcome will provide an important demonstration effect helping to replicate the same approaches in other countries. At the same time, a positive outcome of the feasibility studies for electricity generation using recovered CH4 (i.e., positive return on investment) will help to overcome funding difficulties for these types of projects. Replication will ensure overall cost-effectiveness of the project as other projects could expand cumulative global environmental benefits. Given the large number of tropical reservoirs in Brazil and around the world, the replication potential for this project is large. A dissemination plan will be put in place with the following key elements:

i. A comprehensive monitoring and evaluation system will accompany the GEF intervention. This will help to identify what works, what doesn't and why;
ii. Closely follow the implementation of the activities under components 1 to 4 and identify the necessary elements for up-scaling these activities in Brazil and beyond. The pilot project will improve the understanding (i.e. learning) about practicalities about CH4 recovery followed by the dissemination of experience to promote rapid implementation throughout Brazil and other countries. The implementation of components 1 to 4 will be closely followed and lessons learned will be actively looked for to develop an improved understanding on what conditions have to be in place for larger scale dissemination of CH4 recovery;
iii. Prepare publications on the lessons learned and results of the project;
iv. Organize site visits for Government agencies and private sponsors interested in implementing the developed technologies in Brazil and other countries;
v. Engage with other projects in the country, region and world to exchange lessons, experiences, and solutions encountered to perceived challenges in CH4 recovery;
vi. Present the results achieved in the implementation of the pilot project through presentations at national and regional seminars/workshops.

B. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH NATIONAL/REGIONAL PRIORITIES/PLANS:

The future evolution and strategy of the Brazilian energy sector is contained in the National Energy Plan 2030 (PNE), which proposes that increases in electricity demand will be met mainly by: (i) large hydroelectric plants (some already under construction); (ii) renewable energy (RE) (e.g., wind, ethanol, biodiesel, natural gas) to diversify the energy matrix; and (iii) implementation of energy efficient programs.

At the same time, the first Inventory of Anthropic GHG Emissions, published by the Brazilian Science and Technology Ministry, has compiled data that points out the fact that hydropower plants may have a significant impact in terms of CH4 emissions. Under the National Plan on Climate Change, the Brazilian government has stressed the national objective of reducing GHG emissions mainly from land use and land use change and stresses that Brazil intends to keep a high share of RE in the energy matrix. As such, it is increasingly important for the Brazil to mitigate, recover and produce a renewable CH4 source that will allow not only to reduce CH4 emissions, but also, to replace a fossil fuels source by a renewable one. The proposed project addresses all the priorities described in the PNE and in the National Plan for Climate Change. This, in addition to the country's firm commitment to promote RE resources and to reduce GHG emissions, ensures that the GEF project is firmly embedded within the country's national priorities.

C. DESCRIBE THE CONSISTENCY OF THE PROJECT WITH GEF STRATEGIES AND STRATEGIC PROGRAMS:

The proposed Project is consistent with three GEF Strategic (mitigation) Objectives in the Climate Change (CC) Focal Area. The proposed project supports the utilization of RE energy (recovered CH4), and reduction of GHG emissions.

This Project is consistent with GEF Strategic Program 3 "Promote Market Approaches for RE" and long-term objective 4, because energy generated from recovered CH4 is reliable, secure and environmentally-friendly and thus increase the basket of potential non-conventional clean energy sources while diversifying the country's generation mix (i.e., reducing the country's dependence on hydroelectricity).

This Project is consistent with GEF Strategic Program 4 "promoting sustainable energy production from biomass" and long term objective 6, because it may help in the development of new sources of RE from biomass.

This Project is also consistent with GEF Strategic Program 6 because it reduces CH4 emissions from land use. As such, the Project will support the Government in its efforts to mitigate and recover the CH4 from tropical hydropower plants. The development of CH4 mitigation and recovery procedures will significantly reduce GHG generation.

D. JUSTIFY THE TYPE OF FINANCING SUPPORT PROVIDED WITH THE GEF RESOURCES:

The GEF funding will contribute to: (i) develop a national CH4 recovery technology by reducing technical and financial barriers that prevent the development of this type of technology in developing countries; (ii) promote a market approach and encourage the participation of the private sector in the development of this technology that will help meet the growing demand for power generation; (iii) support productive uses and sustainable socio-economic growth; and (iv) contribute with the development of high skilled technological processes and transfer of technology to local firms and human talent.

GEF financing will provide the necessary financial support to demonstrate the viability of CH4 mitigation and recovery from tropical reservoirs. The demonstration effect will be significant in helping to remove technological and financial barriers currently preventing local Governments, private sector and local power companies from implementing these new and promising approaches.

The proposed project is innovative for Brazil, for the GEF and for the regional community because it will promote the application of technology and devices under an innovative approach for CH4 recovery. The project will contribute to development of a cost-effective RE source for Brazil, and it's expected to have an important demonstrative effect in other countries that have large hydropower development. In terms of GHG mitigation, the project will both reduce GHG emissions through the methane recover, and displace the demand for fossil fuels since it will replace other fossil energy sources within Brazil's energy matrix.

The innovative nature of this proposal consists on testing and developing a technology that will both reduce GHG emissions and develop sources of RE, taking advantage of the country's existing geographical, technological and infrastructure capacity and promoting the growth of the Brazilian industrial structure.

E. OUTLINE THE COORDINATION WITH OTHER RELATED INITIATIVES:

Furnas is the second largest energy generation company in Brazil, with ten operational hydroelectric power plants with an installed capacity of 8,662 MW. The Inter-American Development Bank (IDB) is currently working in a potential project to rehabilitate and modernize three of Furnas' hydroelectric power plants (with an installed capacity of approximately 3,000 MW). The project will renew obsolete electromechanical equipment and switchyards with the objective of recovering their generation capacity and increase their reliability and operational flexibility with an important impact in energy efficiency and in GHG emissions. The proposed pilot project will complement, in terms of reduction of GHG emissions, the investments in rehabilitation of the hydroelectric plants.

F. DISCUSS THE VALUE-ADDED OF GEF INVOLVEMENT IN THE PROJECT DEMONSTRATED THROUGH INCREMENTAL REASONING :

For years, engineers in Brazil have been studying the issues related to the mitigation and recovery of CH_4 emissionsin hydroelectric dams. They have adapted and developed technological solutions to face this challenge, but due to the lack of adecuate financial resources, the large scale implementation of those GHG mitigation and recovery strategies could take several years.

In particular, the full potential of recovered CH_4 from reservoirs could not be assessed and therefore, the potential for electricity generation through this RE source (CH_4) could not be developed. With the proposed GEF project, important amounts of GHG emissions could be recovered and used as RE source of electricity. The generation of electricity with recovered CH_4 will become a second product in the operation of hydro facilities with the potential of obtaining carbon credits under the Clean Development Mechanism (CDM).

GEF support for the proposed project is critical for the following reasons: (i) the financial and technical/operational risks of applying technologies in an innovative area that have not been widely proven and tested are high, especially in a developing country context; (ii) the success of the proposed project is a critical step for developing a local CH_4 recovery technology, which will enhance the Brazilian industry and competitiveness in the hydropower sector with it's replication potential; (iii) the GEF project will help accelerate the dissemination of the technology and achieve substantial reduction in GHG emissions; (iv) the development of this technology may increase the energy supply in Brazil, reducing the need for building new reservoirs, protecting important natural resources such as the Amazon Rainforest, and avoiding the resettlement of villages and damage to indigenous reserves.

G. INDICATE RISKS, INCLUDING CLIMATE CHANGE RISKS, THAT MIGHT PREVENT THE PROJECT OBJECTIVE(S) FROM BEING ACHIEVED, AND IF POSSIBLE INCLUDING RISK MITIGATION MEASURES THAT WILL BE TAKEN:

Key main risks include:

Risks	Likelihood	Mitigation Measures
Qualified labor risk - Lack of human resource talent with the technical expertise to successfully develop the CH_4 recovery technology.	Low	This risk is mitigated by the country's extensive expertise in hydraulic, mechanical, electronic, and electrical engineering, which could be tapped for design, test and construction of the pilot project.
Market risks - Investments in RE based on CH_4 recovery do not provide an attractive ROI	Medium	This risk is mitigated by the potential diversification of revenues derived from sales of electricity and carbon credits.
Economical/Financial Risk. The main economical/financial risk is the CH_4 price. If CH_4 international price drops below US$ 4,00 per ton/BTU, it will be difficult to commercially exploit the CH_4 as competitive energy source.	Medium	This risk is mitigated by the potential to obtain carbon credits, in addition to the revenues generated by the sale of electricity.
Country risk - Lack of the country's commitment for development and implementation of RE.	Medium	This risk is mitigated by the Brazilian PNE and the National Plan on Climate Change that promote RE to diversify the energy matrix and the reduction of GHG emissions.

Risks	Likelihood	Mitigation Measures
Market risks - Lack of funding for replicating the pilot projects	Medium	Mobilize stakeholders' participation, especially private sector of Government institutions, at an early stage and in the project implementation process.
Technical risk - CH4 recovery technology. There are different technologies for gas-liquid separators. Each technology has specific operational parameters such as: gas recovery efficiency, acquisition and operational costs, particulate tolerance, maintenance circle, bottlenecks in adsorption material supply chain, etc. A wrong choice can compromise a large scale use.	Low	This risk is mitigated by the technical personnel that will test in field all devices and recovery technologies before building and operating a pilot CH4 recovery unit.
Technical risk – CH4 mitigation technology. There are two types of mitigation devices that prevent deep rich CH4 waters to flow through turbine intake or spillways: a membrane separator and a movable plate device. Depending on operational conditions of the hydropower plant (water flow velocity, water volume, bottom dam surface topography, etc.) neither technology could be used or would be feasible.	Low	This risk is mitigated by the fact that both the membrane system and the plates system are proven technologies and could be adapted to new conditions found in the selected hydropower plant.

H. DESCRIBE, IF POSSIBLE, THE EXPECTED COST-EFFECTIVENESS OF THE PROJECT:

The project is considered to be a cost-effective intervention for the GEF due to the CO2 emission reduction due to: (i) CH4 recovery; (ii) CH4 emissions' mitigation; and (iii) potential of electricity generation with recovered CH4. Studies made in the Brazilian hydroelectric plants' reservoirs of *Serra da Mesa*, *Tucuruí* and *Itaipu* estimated that by using the proposed mitigation and recovery technologies, emissions could be reduced by 25%, specifically 0.569 Tg/y of CH4 for the three reservoirs[17]. Since CH4 is 21 times more harmful than CO2, in terms of its global warming potential, the estimated annual reduction emission for the 3 reservoirs could be 11.38 Tg/y of CO2e.

The pilot project activities may be implemented at the *Corumbá* hydroelectric plant in the State of *Goias*. The CO2 emissions of this reservoir are estimated at 0.9 Tg/y of CO2e due to the proximity of the hydroelectric plant to the city of *Corumbá* and the existence of relevant wastewater effluents. Therefore, the expected GHG emissions reductions of the pilot project are approximately 0.012 Tg/y of CH4 or 0.225 Tg/y of CO2e.[18]

The proposed project intends to confirm these estimates. If this potential is realized and the project replicated, there will be a considerable reduction in CO2e emissions in Brazil. A more detailed analysis of the environmental benefits derived from this project will be made and documented during the next phase of project preparation. The project team will evaluate the project savings from baseline using the estimated energy savings and US$/tCO2 method and will demonstrate that the interventions chosen are the most cost effective against other alternatives.

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17 A.W. Bambace, F.M. Ramo, I.B.T. Lima, R.R. Rosa. Mitigation and recovery of methane emissions from tropical hydroelectric dams. Instituto Nacional de Pesquisas Espaciais (INPE), São José dos Campos, Brasil.

18 Information provided by Furnas.

I. JUSTIFY THE COMPARATIVE ADVANTAGE OF GEF AGENCY:

The Inter-American Development Bank (IDB) is a major lending institution in Latin America and the Caribbean (LAC) supporting both the public and private sector. During the last decade, IDB has been involved in investment (public and private) including the construction of large hydroelectric and bioenergy projects in Brazil[19] and technical assistance supporting climate change mitigation programs, particularly in EE and RE projects[20]. The proposed GEF project is consistent with the IDB Sustainable Energy and Climate Change Initiative (SECCI), because it promotes the development of RE and access to carbon markets and supports the development of new technologies or methods that can provide replication throughout the LAC region. Therefore the IDB is well positioned to provide maximum value added in this field.

The project fits within the comparative advantage of IDB for GEF projects in three main aspects:

a. Development impact. The program targets technological development and innovation with a positive impact on climate change and energy use in LAC, all core themes of the IDB.

b. Private sector focus. Many initiatives in LAC have been focused on non-profit institutions, based in the region. However, since innovations often come from the private sector,[21] this TC explicitly encourages the participation of the local private sector.

c. Future business opportunities for the IDB through scaling up. One of the main pillars of the project will be the potential for scaling up, creating new opportunities for the IDB to engage with public and private sectors in LAC.

PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT(S) AND GEF AGENCY(IES)

A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT (S) ON BEHALF OF THE GOVERNMENT(S):

(Please attach the country endorsement letter(s) or regional endorsement letter(s) with this template).

NAME	POSITION	MINISTRY	DATE
Carlos Eduardo Lampert	GEF Operational Focal Point	Ministry of Planning, Budget and Management	September 30 2009

B. GEF AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF policies and procedures and meets the GEF criteria for project identification and preparation.

Agency Coordinator, Agency name	Signature	Date	Project Contact Person	Telephone	Email Address
Ricardo Quiroga GEF Coordinator IDB		September 30 2009	Sylvia Larrea	202-623-2088	sylvial@iadb.org

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[19] *Segredo* Hydroelectric, *Campos Novos* Hydroelectric, *Dona Francisca* Hydroelectric, *Itumbiara* Bioenergy, *Ituiutaba* Bioenergy, *Moema* Bioenergy.

[20] Feasibility studies for small hydropower projects, biofuels, biomass, solar energy, and EE programs in the States of *Minas Gerais* and *Sao Paulo*.

[21] In 2000, the private sector in the US performed 75% of research and development and financed 68% of it (Source: National Science Boar, 2002. Cited by: Scotcher, S. (2004). Innovation and Incentives. MIT Press.