GEF-6 PROJECT IDENTIFICATION FORM (PIF)

PROJECT TYPE: Full-sized Project
TYPE OF TRUST FUND: GEF Trust Fund

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PART I: Project Information

Project Title:	Conservation and improvement of ecosystem services for the Atsinanana region through agroecology[1] and the promotion of sustainable energy production		
Country(ies):	Madagascar	GEF Project ID:[2]	9793
GEF Agency(ies):	UNEP	GEF Agency Project ID:	01573
Other Executing Partner(s):	Ministry of Environment, Ecology and Forestry (General Directorate of Environment and General Directorate of Ecology) and the National Association of Environmental Action (ANAE)	Re-Submission Date:	August 28, 2017
GEF Focal Area(s):	Multi-focal Areas	Project Duration (Months)	48
Integrated Approach Pilot	IAP-Cities ☐ IAP-Commodities ☐ IAP-Food Security ☐	Corporate Program: SGP ☐	
Name of parent program:	N/A	Agency Fee ($)	360,045

A. INDICATIVE FOCAL AREA STRATEGY FRAMEWORK AND OTHER PROGRAM STRATEGIES[3]

Objectives/Programs (Focal Areas, Integrated Approach Pilot, Corporate Programs)	Trust Fund	(in $) GEF Project Financing	(in $) Co-financing
BD-4 Program 9	GEFTF	1,324,201	5,193,750
LD-1 Program 1	GEFTF	800,000	5,687,500
LD-2 Program 3	GEFTF	341,553	4,000,000
CCM-1 Program 1	GEFTF	1,324,201	5,193,750
Total Project Cost		3,789,955	20,075,000

B. INDICATIVE PROJECT DESCRIPTION SUMMARY

Project Objective: To optimise sustainable land use management, biodiversity conservation, renewable household energy security and climate change mitigation for the benefit of local communities in Madagascar

Project Components	Financing Type[4]	Project Outcomes	Project Outputs	Trust Fund	(in $) GEF Project Financing	(in $) Co-financing
1. Strengthen national policies and the legal and institutional framework for mainstreaming biodiversity and landscape	TA	*Enabling policy and institutional environment for integrating SLM, SFM, BD conservation and sustainable energy production within the national, regional and municipal frameworks*, resulting in:	1.1 Strengthen existing multi-stakeholder / inter-sectoral coordination mechanism for SFM, SLM, BD at Atsinanana district landscape level in accordance with local authorities and administrations. 1.2 Regulatory framework (1. Environment Code of Madagascar, 2. National Agroecology strategy	GEFTF	430,000	3,116,250

[1] *"Agroecology is based on the application of ecological concepts and principles to agricultural production for the optimization of agroecosystems, adding value to local resources with minimal reliance on external inputs. It aims at maintaining or mimicking natural balances while replacing the farmer at the core of the production process. Agroecosystem management relies on traditional knowledge through participatory approaches. According to Pretty (Pretty 1995 cited in Altieri 2002), the basic principles are: (i) enhancing biomass renewal and optimizing nutrient availability and balance of nutrient flows; (ii) ensuring favorable soil conditions for plant growth (organic matter management, soil cover, improvement of biological activity in the soil); (iii) minimizing losses in solar energy, air and water; (iv) promoting genetic diversification of species in time and space; (v) adding value to favorable biological interactions. Agroecology also includes social and economic principles: (i) social organization and local knowledge transmission; (ii) guarantee of decent revenue for farmers, their families. The agroecological approach is thus multidimensional and can be applied at several scales – the plot, the farm and the territory, always keeping in mind a holistic view"*. As cited in Coordination SUD, 2015. *Agroecological innovations in a context of climate change in Africa*.

[2] Project ID number will be assigned by GEFSEC and to be entered by Agency in subsequent document submissions.

[3] When completing Table A, refer to the excerpts on GEF 6 Results Frameworks for GETF, LDCF and SCCF and CBIT guidelines.

[4] Financing type can be either investment or technical assistance.

restoration		- Improved management of 293,000 ha [5] of forest and agricultural land in the Atsinanana district -Improvement in capacity development indicators as per Capacity Development Scorecard *[to be developed during PPG]*	and 3. National strategy for land management) is drafted/amended to strengthen SLM, SFM, BD mainstreaming 1.3 Stakeholders' knowledge on natural resources management at national, regional, district and municipal level are improved and data to support sustainable management of the biodiversity and forest resources of the Atsinanana Region is collected and available at the end of the project 1.4 Institutions' capacity is strengthened across sectors to collaborate and manage the Atsinanana region landscape sustainably by the end of the project 1.5 Two sectorial actions plans (agriculture, energy) developed that integrate biodiversity dimensions, sustainable energy and SLM 1.6 Municipal development plans developed for 4 municipalities in Atsinanana region integrating BD, sustainable energy, SLM and SFM and lessons learned to upscale to other municipalities			
2. Ensure scaling up of SLM practices and agroecology in a wider landscape	TA	Biodiversity management / ecosystem service provision mainstreamed in forest landscape management in two priority districts 43,044 tCo2-eq GHG emission avoided over a 10-year period due to active management of forests by communities 65,383 tCO_2-eq over a 10-year period sequestered as a result of enhancing carbon stocks through increasing of current vegetation cover 20% improvement in revenues of 7,000 local farmers due to the implementation of agroecology measures	2.1 Conservation agreements entered into by MEEF and local communities resulting in the conservation and active management of at least 3,500 ha of globally significant biodiversity habitat. 2.2 At least 500 ha of degraded land adjacent to or within identified High Conservation Value Forests restored using bamboo as pioneer species. 2.3 For production cultivated land (4,800 ha targeted): technologies developed, tested and appropriate infrastructure established to operationalize SLM in line with developed ILMPs, namely[6]: (i) incorporation of nitrogen-fixing trees into annual monocropping; (ii) improvement of planting methods and use of high yielding varieties; (iii) improved water management; (iv) increase in use of organic fertilizer and (v) integrated pest management. 2.4 Local communities are capacitated on decision making about ecosystem services management by the end of the project	GEFTF	1,918,337	10,726,250
3. Improving rural energy generation systems and wood services to reduce deforestation	TA / INV	Local community, local leaders and private sector aware and contribute to rural energy strategy for Atsinanana Region Reduction of 24,051 tCO2-equivalent emission from use of improved energy efficient cooking and installation	3.1 Report on Rural Energy Assessment-available for Atsinanana Region by the end of year 2 of project implementation 3.2 Development of private sector/community engagement strategy of transforming the energy sector in Atsinanana Region towards use of sustainable energy technologies 3.3 Training on *alternative fuel and improved stove* is provided for local communities and private	GEFTF	1,261,144	6,232,500

[5] Vohibinany District covers 605,685 ha and Vatomandry District 273,200 ha, including 293,000 ha under forest and agricultural land

[6] The list of examples of investment activities here is non-exhaustive; it may include other approaches and will be further defined during PPG.

		of bamboo gasification generator Sequestration of 39,170 tCO2-eq over a 10-year period as a result of sustainably managing a rehabilitated bamboo forest for biomass production	individuals 3.4 Demonstrate energy efficient and renewable energy technologies in the Vohibinany and Vatomandry Districts of Atsinanana Region: (i) 3,000 households adopt use of energy efficient cook stoves; (ii) one village electrified with one 25kW bamboo gasification generator 3.5 300 ha of shrub species and bamboo plantation established for energy use and wood services 3.6 Technologies transferred, adapted and produced locally as part of local enterprise activity			
			Subtotal		3,609,481	20,075,000
			Project Management Cost (PMC)[7]	GEFTF	180,474	0
			Total Project Cost		3,789,955	20,075,000

For multi-trust fund projects, provide the total amount of PMC in Table B, and indicate the split of PMC among the different trust funds here: NA

C. INDICATIVE SOURCES OF CO-FINANCING FOR THE PROJECT BY NAME AND BY TYPE, IF AVAILABLE

Sources of Co-financing	Name of Co-financier	Type of Co-financing	Amount ($)
CSO	International Network for Bamboo and Rattan (INBAR)	Grants	165,000
CSO	National Association of Environmental Action (ANAE)	In-kind	100,000
Recipient Government	Ministry of Environment, Ecology and Forests (MEEF)	In-kind	100,000
Donor Agency	IFAD - Programme de Soutien aux Pôles de Micro-Entreprises Rurales et aux Economies Régionales de Madagascar	Grants	410,000
Donor Agency	JICA - Projet d'Amélioration de la Productivité Rizicole sur les Hautes Terres Centrales (PAPRIZ)	Grants	9,650,000
Donor Agency	WB-IDA - Projet de filet de sécurité sociale	Grants	9,650,000
Total Co-financing			20,075,000

D. INDICATIVE TRUST FUND RESOURCES REQUESTED BY AGENCY(IES), COUNTRY(IES), FOCAL AREA AND THE PROGRAMMING OF FUNDS [a)]

GEF Agency	Trust Fund	Country/ Regional/ Global	Focal Area	Programming of Funds	(in $)		
					GEF Project Financing (a)	Agency Fee (b)[b)]	Total (c)=a+b
UNEP	GEFTF	Madagascar	Biodiversity	NA	1,324,201	125,799	1,450,000
UNEP	GEFTF	Madagascar	Land Degradation	NA	1,141,553	108,447	1,250,000
UNEP	GEFTF	Madagascar	Climate Change	NA	1,324,201	125,799	1,450,000
Total GEF Resources					3,789,955	360,045	4,150,000

a) Refer to the Fee Policy for GEF Partner Agencies.

E. PROJECT PREPARATION GRANT (PPG)[8]

Is Project Preparation Grant requested? Yes ☒ No ☐ If no, skip item E.

PPG AMOUNT REQUESTED BY AGENCY(IES), TRUST FUND, COUNTRY(IES) AND THE PROGRAMMING OF FUNDS

Project Preparation Grant amount requested: $136,986					PPG Agency Fee: 13,014		
GEF Agency	Trust Fund	Country/ Regional/ Global	Focal Area	Programming of Funds	(in $)		
					PPG (a)	Agency Fee[9] (b)	Total (c)=a+b
UNEP	GEFTF	Madagascar	Biodiversity	NA	45,662	4,338	50,000

[7] For GEF Project Financing up to $2 million, PMC could be up to10% of the subtotal; above $2 million, PMC could be up to 5% of the subtotal. PMC should be charged proportionately to focal areas based on focal area project financing amount in Table D below.

[8] PPG requested amount is determined by the size of the GEF Project Financing (PF) as follows: Up to $50k for PF up to$2m (for MSP); up to $100k for PF up to $3m; $150k for PF up to $6m; $200k for PF up to $10m; and $300k for PF above $10m. On an exceptional basis, PPG amount may differ upon detailed discussion and justification with the GEFSEC.

[9] PPG fee percentage follows the percentage of the Agency fee over the GEF Project Financing amount requested.

UNEP	GEFTF	Madagascar	Land Degradation	NA	45,662	4,338	50,000
UNEP	GEFTF	Madagascar	Climate Change	NA	45,662	4,338	50,000
Total PPG Amount					136,986	13,014	150,000

F. PROJECT'S TARGET CONTRIBUTIONS TO GLOBAL ENVIRONMENTAL BENEFITS[10]

Provide the expected project targets as appropriate.

Corporate Results	Replenishment Targets	Project Targets
1. Maintain globally significant biodiversity and the ecosystem goods and services that it provides to society	Improved management of landscapes and seascapes covering 300 million hectares	*3,500 Hectares*
2. Sustainable land management in production systems (agriculture, rangelands, and forest landscapes)	120 million hectares under sustainable land management	*5,600 Hectares*
4. Support to transformational shifts towards a low-emission and resilient development path	750 million tons of CO_{2e} mitigated (include both direct and indirect)	*188,948 tCO_2-eq*[11]

PART II: PROJECT JUSTIFICATION

1. *Project Description*

1.1. The global environmental and/or adaptation problems, root causes and barriers that need to be addressed

Project Strategy Overview

By contributing to land degradation and the loss of biodiversity and ecosystem services, current patterns of agricultural development in Africa, including Madagascar, threaten opportunities for economic growth and food security. According to NEPAD, Africa currently accounts for approximately 27% of the world's land degradation, with roughly 500 million hectares of moderately or severely degraded land (totalling 67% of Africa's total land area). Agricultural croplands and pasture lands are frequently the most impacted, through anthropogenic activities that lead to deforestation and degradation of vegetative cover, soil erosion, declining soil fertility, salinization, soil compaction, and expanding desertification in dryland environments. Declines in soil fertility alone are a tremendous problem in Africa, as the amount of nutrients removed through harvesting on croplands is four times the amount being returned to the soil; this negative nutrient balance is an important factor contributing to food insecurity in Africa. Land degradation also contributes significantly to the loss of biodiversity and ecosystem services, in particular through destruction of natural terrestrial habitats due to agricultural expansion and desertification; degradation of aquatic and coastal habitats through sedimentation and agricultural chemicals and wastes; and changes in micro-climates and food and water availability due to habitat destruction and/or changes in soil fertility, runoff rates, etc. These losses of biodiversity and ecosystem services will produce negative impacts on food security, poverty reduction and sustainable development efforts on the continent.

At the same time, Madagascar and most other African countries are faced with the need to greatly increase productivity in order to produce sufficient food for their rapidly growing populations. In addition, the projected impacts of climate change on agriculture in the region suggest that yields could begin to decline at the very moment that burgeoning population creates increased demand for food. In this context, agriculture in Madagascar must go through an extraordinary transition so that it can sustainably meet output needs while avoiding additional land degradation and loss of ecosystem services and biodiversity, as well as reducing its contributions to greenhouse gas emissions. Therefore, it is critical that Madagascar begins to manage land, water and forest resources in an integrated manner that achieves multiple objectives, including agricultural production; continued provision of ecosystem services (water flow regulation and quality, pollination, climate change mitigation, tourism and cultural values); protection of biodiversity; and support for local livelihoods, human health and well-being.

Geographic & Socio-Economic Context

Located in the Indian Ocean and separated from the southeast coast of Africa by the Mozambique Channel, Madagascar is an island of 590,000 km^2 whose terrain is dominated by a mountainous Central Plateau ranging from 800-1,200 m in elevation,

[10] Provide those indicator values in this table to the extent applicable to your proposed project. Progress in programming against these targets for the projects per the *Corporate Results Framework* in the *GEF-6 Programming Directions*, will be aggregated and reported during mid-term and at the conclusion of the replenishment period.

[11] Please see Annex 2 for calculations

with the highest peaks rising to 3,000 m. Along its eastern side, the land drops steeply to a narrow coastal plain while in the west a more gradual slope descends to a larger coastal plain. Madagascar's climate is primarily tropical humid with mild temperatures, characterized by high precipitation distributed throughout the year in the eastern part of the country and consistent high temperatures with seasonal rains in the west. The southern part of the country is composed of arid and semi-arid areas that receive less than 400 mm of rain per year. Because of its geographical position, the country is subjected to frequent violent cyclones, which are exacerbated by climate change phenomena.

The Malagasy population is currently estimated at 20 million, with a relatively high population growth rate of 2.9%. The population is young and concentrated in the central highlands. 71% of the population is affected by poverty, with an average annual income of 167 Euros per inhabitant (National Institute of Statistics, 2014). Poverty is most widespread in rural areas (home to 70% of the population), where most inhabitants work in agriculture, primarily employing low-yielding traditional farming practices as access to agricultural inputs is quite limited. Because they cannot grow sufficient food supplies, rural residents suffer from high levels of malnutrition, poor health and low incomes, and as a result these populations rely heavily on natural resources (fruits, wild tubers, firewood and timber, medicinal plants, etc.) to supplement their livelihoods. Migration to and within rural areas in Madagascar puts additional pressure on natural resources, particularly as many migrants relocate to previously pristine areas, including protected areas, where soil fertility is still high and forest and other resources can be exploited. In many cases, these rural migrants are moving into areas with ecosystem conditions and functions quite different from their previous locations, which often leads to inappropriate and unsustainable resource use practices.

The Atsinanana region (site of project activities) is located in the east of Madagascar and covers a surface area of 22,382 km^2, which represents 3.78% of the country's total area. The region has a population of around 1.27 million people (INSTAT, 2014) residing in seven districts; of these, the Vohibinany and Vatomandry districts are the focus of the proposed project. The Atsinanana region produces a diversity of food crops (rice, cassava, maize, sweet potato), cash crops (coffee, pepper, clove, cinnamon, banana, lychee) and industrial crops (sugar cane, oil palm). Livestock and fishing are also widely practiced by the local population, and mining, tourism and handicrafts constitute other important economic sectors. At present, about 8,000 rural households in Vohibinany and Vatomandry Districts earn at least part of their income from the harvesting and production of NTFPs, including baskets of fruits and vegetables, storage containers, fishing gear, musical instruments and furniture.

Primary Economic Sectors in Madagascar

Agriculture: The agriculture sector accounts for approximately 35% of Madagascar's GDP. A wide-range of food crops, livestock and fisheries have been developed to provide the population's food supply and for regional and international trade (50% of export values consist of agricultural and fishery products). Although 8 million ha are available for agriculture in the country, most farming households cultivate less than 1 ha, and plot sizes continue to decrease with high population growth and a tradition of dividing land equally among offspring. Agriculture is typically practiced with traditional techniques, rudimentary tools, and low levels of use of inputs such as fertilizers. Most food crop production (rice and other cereals, tubers, leguminous, etc.) is for self-consumption, although some surplus products are sold in local markets to get money for the purchase of essential items. Vegetable and fruit farming is carried out by some farmers to provide additional income, while most export-oriented farming (coffee, clove, pepper, vanilla, etc.) is carried out by or overseen and controlled by larger farming operations.

Forestry: Legally exported forest products include wood and various raw materials used in handicrafts and other industries (fibre baskets, medicinal plants, etc.). Official exports of raw wood declined from 5,520 tons in 2010 to 622 tons in 2011 and 5 tons in 2012 (Madagascar export, 2005-2012, INSTAT), due in part to new restrictions on the exportation of precious wood. However, illegal wood harvesting remains common; in August 2014, a cargo of 34 containers containing rosewood from Madagascar valued at USD 12.3 million was intercepted in Mombasa, Kenya. Bamboo is an indigenous resource that is highly underutilized in Madagascar and throughout Africa; despite having an estimate 12% of the world's known bamboo resources (FAO 2010), sub-Saharan Africa accounts for only 1% of international export trade in bamboo products (INBAR 2014).

Tourism: Foreign visitors are attracted to Madagascar primarily for its natural beauty and unique ecosystems, flora and fauna, with almost 2/3 of visitors stating that the reason for their trip was to visit natural areas and/or for seaside vacations. In 2012, the number of visitors was estimated to be 180,000 (National Office of Tourism, 2013), and the National Tourism Office (ONTM) reported a 7% increase in the first four months of 2014 from the same period a year earlier.

Mining: Madagascar has significant mining resources (many of which are found under existing natural forests), which are exploited at different scales, including several local companies engaged in industrial scale mining, a number of Chinese companies engaged in medium scale mining, and numerous local communities / operators engaged in small scale mining.

Biodiversity and Ecosystem Services in Madagascar

Madagascar is a mega-biodiversity country with a high concentration of endemic species. Malagasy ecosystems are believed to be home to approximately 12,000 species of plants, 370 species of reptiles, 244 species of amphibians, 154 species of fish and 99 species / sub-species of lemurs. It is estimated that 83% of floral species in Madagascar are endemic. Malagasy biodiversity provides significant economic, sociocultural, ecological and scientific values. Valuable ecological services are provided by diverse species and habitats, including soil protection and restoration, preservation of water resources and hydrological systems, and atmospheric carbon sequestration by vegetation. Animals play significant roles in habitat functioning, such as performing pollination and seed dispersal and germination, which benefits both natural and productive ecosystems. In economic terms, biodiversity and ecosystem services benefit the livelihoods of more than 18 million people, as an estimated 80% of the population depends primarily on natural resources for their livelihoods. Native flora and fauna provide local, regional and national uses; for example, a number of amphibians and reptiles and plant species (ornamental and precious woods) generate products that are exported internationally following quota authorised by the government, while many other species are important for use and consumption domestically. Socially, biodiversity plays a significant role as a source of food, domestic energy, building materials and traditional medicines, and species are important for Malagasy cultural traditions, including various tree species (baobabs, tamarinds) and animals (lemurs) that are regarded as sacred. Madagascar is home to 43 species of bamboo, of which more than two thirds are endemic to the country (Bystriakova et al, 2004) and provide habitat for some of the most iconic and threatened species in Madagascar, including various lemurs, several reptiles and the critically endangered Angonoko Tortoise (*Geochelone yniphora*).

Environmental Context in the Atsinanana Region

The climate of the Atsinanana region is hot and humid with abundant rainfall ranging from 2,800-3,500 mm / year and spread over most of the year, resulting in a lush and diverse vegetative cover; the region also is frequently affected by cyclones and flooding. Data on biodiversity in the Atsinanana region is rather incomplete, as few studies have been undertaken, but the area is regarded as one of the biodiversity hotspots of Madagascar. The Environmental Dashboard maintained by the National Environment Office classifies the biodiversity in Atsinanana as exceptional and of high ecological value, and lists 106 endemic species of mammals and birds and 10 endemic species of flora. There are six protected areas totalling 216,648 hectares in the region, all of which are under pressure from agricultural expansion and various forms of trafficking in native flora and fauna. The landscape in Atsinanana is characterized by a succession of mountains covered with forests and *savoka* (herbaceous areas frequently subject to fires), leaving narrow valleys that are favourable for food crops and coffee production. Forests cover 349,719 ha or 15.6% of the total area of Atsinanana; in Vohibinany and Vatomandry districts, most of remaining natural forests are protected. According to the National Office for the Environment (ONE), the rate of deforestation in the Atsinanana Region is approximately 0.56%/year (close to the national average). Most of the deforestation is due to land clearance by small farmers, driven by limited availability of arable land, high rates of population growth, and the scarcity of economic alternatives. In many cases, the forest soils in newly cleared areas are not able to support sustained cultivation of crops, and farmers frequently abandon their fields after two or three years.

In the Vohibinany and Vatomandry districts, ferralitic soils predominate and are prone to erosion in areas with slopes greater than 15%. 7 of the 17 towns in Vohibinany and 6 of the 17 towns in Vatomandry are subject to significant erosion, and 12 of the towns in each district have seen reductions in areas of *tanety* (space made up of succession of slopes, hills and plateaus). In these districts, soil losses may exceed 200,000 t / ha, resulting in widespread siltation of rice and other agricultural fields in lowland areas and greatly reduced agricultural production. Soil fertility is another major issue in these districts; 10 towns in Vohibinany and 11 towns in Vatomandry have seen significant reduction in the soil fertility in their rice fields. Bamboo is considered to be a highly promising opportunity for poor rural households in these two districts due to the fact that it grows very rapidly, it does not require any inputs such as fertilizers and pesticides, and it can be sold as a raw material or made into various products. The list of value-added products made from bamboo is extensive, including non-commercial products such as mats, baskets, canoes, fishing kits, fences, etc., as well as commercial products including furniture, building and roofing materials such as fencing poles, veneer, floor tiles, panels for walls and ceilings, scaffolding material, door and window frames, various pulp and paper products such as newsprint, toilet paper and cardboard, and others. Bamboo is also a potential source of bio-energy in the form of charcoal briquettes and wood for domestic and industrial use, and serves as an excellent large-scale carbon sink, with each plant taking in almost double the carbon dioxide of a tree.

Threats and Issues in Madagascar and the Atsinanana Region

Deforestation and Forest Degradation

Madagascar has experienced severe deforestation and fragmentation. Overall forest cover in the country decreased by over 40% between 1950-2000 (Harper et al, 2011) and by an additional 4.3% from 2000 to 2010 (FAO, 2010). Slash and burn farming

(*tavy* in local terms), logging for timber, land conversion for agriculture, fire, fuel wood and charcoal production, and overgrazing are all major sources of deforestation and land degradation in Madagascar. Because agriculture is the mainstay of the rural economy, one of the largest drivers of forest clearance is the demand for additional agricultural land, driven primarily by population growth and the declining productivity of existing croplands. Another important factor is the demand for wood products for energy generation; one study estimated that wood energy (firewood and charcoal) accounts for 93% of energy supplies in Madagascar and is used by 82% of Malagasy Households (EPM, 2010 INSTAT study). Natural forests provide an estimated 20% of the wood energy supply; this part of the wood energy sector consists of many thousands of small producers and is characterized by uncontrolled and sometimes illegal exploitation of forest resources. To further compound this problem, communities in Madagascar rely predominantly on slow-growth woods to produce the majority of their firewood and charcoal. In addition, the use of energy efficient stoves in homes in Madagascar is still extremely low, and the vast majority of Malagasy smallholders still use inefficient charcoal-making processes and cook stove technologies that typically have biomass conversion rates as low as 10% and energy efficiency rates of just 10-17%. The resulting inefficient burning of solid biomass both puts more pressure on forest resources and also is a major cause of health problems. While national baseline figures for greenhouse gas emissions resulting from the use of inefficient charcoal cook stove technology will need to be fully quantified during the project preparation phase, the potential for reduced emissions through this project are enormous. For example, using business-as-usual scenarios for household energy generation and use in Africa, one study (Bailis et al., 2005) estimated that cumulative emissions will reach 6.7 trillion tons of carbon by 2050, or 5.6% of Africa's total emissions; the same study also showed that emissions could be reduced by somewhere between 5-19% if African households intensively adopted efficient cook stoves and if SMEs used efficient charcoal production technologies.

Overall, loss of natural habitat in the country is estimated at 0.55% per year; given that more than 80% of plants, mammals, and amphibians in reptiles are endemic in Madagascar, this rapid destruction and degradation of natural habitats is of immense global significance (Harper et al, 2007). A recent assessment of 2,300 floral species in Madagascar determined that 78% of the species were under threat of extinction, and according to the WB Data Portal, 540 plant species, 119 mammal species and 87 fish species are threatened in the country. The primary threats to biodiversity are the destruction and degradation of natural habitats, over-exploitation of natural resources, mining and climate change. Information on the condition of biodiversity in the Atsinanana region is limited, including the levels of degradation of natural habitats. However, some data on existing species is available, which shows that the region harbours 16 endemic floral species (of 310 endemic species in the country) and 7 endemic terrestrial fauna (of 106 endemic species in the country). The region is also known to harbour 20 species of freshwater fish, as well as 15 species of marine algae and 112 species of marine fish (TBE ONE, 2009). In Atsinanana, significant land degradation and rapid deforestation continues to take place, including very high levels of slash and burn agriculture (which is prevalent in 75 of the 84 municipalities in the Region). Between 2005 - 2013, 22,892 hectares or 7% of the forest area was cleared (ONE 2013), which has contributed to the high rates of soil erosion and declining agricultural productivity prevalent in the area. Fires from human or natural causes are also an important contributor to deforestation in Atsinanana; in 2007, an estimated 1,556 hectares of forest were burnt.

Land Degradation in the Agricultural Landscape

Much of the agricultural sector in Madagascar is characterized by agricultural production that fails to provide households with sufficient resources / incomes to meet their daily needs, while also contributing to unsustainable rates of exploitation of natural resources and productive bases (i.e. soil, water, forests) that further exacerbate rural poverty by degrading the ability of the resource base over the long-term. Unsustainable agricultural practices, together with deforestation, have led to enormous levels of soil erosion in Madagascar, where deep gullies and sediment-filled rivers are a common feature. One study (EPM, 1999) estimated that 200-400 tons / ha of soil is removed as run off annually, against a global average of 11 tons / ha. Because Madagascar is highly reliant on agriculture for its economy and food security, this loss of topsoil is disastrous economically and socially, threatening the lives of millions of people and severely impacting the ability of poor rural populations to sustain their livelihoods. Overall, agricultural output has stagnated in recent years in large part due to declines in soil fertility and loss of topsoil; as a result, additional agricultural output has depended on geographical expansion rather than improved productivity. Poor agricultural practices, notably monocultures that are not suitable to local conditions (in terms of soil types, rainfall patterns, and slope steepness), are a major contributor to land degradation problems. Other unsustainable practices include the inappropriate use of agricultural machinery (which damages the land) and over-reliance on the use of burning on croplands.

In the Atsinanana region, soil erosion is common and widespread, in particular after heavy rainfalls and in areas with slopes of at least 15%. Valuable topsoil is being lost, leaving fragile and less productive soils and leading to the creation of gullies and other forms of land degradation. Erosion in upland areas is causing significant sedimentation and siltation in lower lying wetlands and rice growing areas (affecting over 60% of rice fields), as well as the drying up of watering points and other disturbances to aquatic ecosystems and to water provision for households and agriculture.

Barriers

Weak legal, policy and institutional framework for mainstreaming biodiversity conservation, sustainable land management and sustainable energy production: Land tenure is very problematic in Madagascar and many rural populations who exploit the land legally are vulnerable to the illegal appropriation of their lands by political actors or economic operators, which greatly reduces their motivation to conserve natural resources. At the institutional level, coordination structures such as environmental committees were established as far back as 2003 to support the mainstreaming of environmental dimensions across sectors. However, despite the presence of these structures, the lack of experience and technical capacities to develop tools and approaches for integrating the conservation of biodiversity and ecosystem services into productive sectors, and to develop and disseminate critical information and knowledge management tools, has greatly limited the country's efforts to mainstream biodiversity conservation, sustainable land management, and other environmental priorities into the activities of planners and productive sectors. For example, although the updated 2014 NBSAP supports the integration of biodiversity into sectorial policies and strategic frameworks for poverty reduction, to date the integration of biodiversity and forest protection issues into other sectorial and cross-sectorial policies remains very limited. Furthermore, an association of NGOs, Agricultural Research Centre and agricultural private operators called *Madagascar Direct Sowing Group (GSDM),* with financial support from the French Government and technical support from CIRAD, IFAD and the World Bank, has implemented a number of projects focused on agricultural conservation and the development of integrated agriculture / livestock raising / silviculture production systems. Starting in the 1990s, these projects have identified a wide array of potential cropping systems suitable for various ecological zones in Madagascar with varying agro-ecological and socio-economic conditions and different levels of intensification and risk (Seguy, 2005). GSDM has proposed various forms of Conservation Agriculture to increase soil nutrients and preserve mycorrhizal associations between fungi and cultivated plants, with benefits for reducing erosion and increasing soil biological activity. However, although these projects demonstrated their high agronomic, environmental and economic performance, as well as their sustainability, their adoption has remained limited due to limited human and financial resources, the lack of an approach for expansion of these intensive knowledge systems, and the prevalence of smallholders with extremely limited capacities to invest in new production approaches. In terms of energy policy, Madagascar's existing energy policies do not focus on biomass and environmental management aspects and do not include appropriate measures to address rural biomass and energy demand that depends on forest resources. Furthermore, the country's law for Ethanol Production (2003) and related government policies constitute a significant risk of promoting land clearance for sugar cane cultivation, including within protected areas.

Existing land management systems do not integrate sustainable ecological production and restoration processes to benefit rural smallholders: The ability of agricultural producers in the project target area and the country in general to generate sufficient production and incomes is constrained by many factors, including an already degraded resource base and limited availability of raw materials, which often results in over-exploitation and land degradation. However, these fundamental problems are compounded by the absence of any integrated vision and related solutions that take into account the entire array of problems in rural areas, such as land degradation, loss of biodiversity and resources, limited energy producing options, and food insecurity that together compel rural households to carry out activities that are unsustainable. Existing land management systems are a combination of modern and traditional systems, and while the national government, through regional and local affiliates, promotes measures and projects to improve productivity, these are not always adapted to respect local needs and available resources. Furthermore, even where the Government of Madagascar has begun to enact integrated sustainable land management and restoration projects, these frequently rely on the planting of exotic, fast growing tree species such as eucalyptus, which are known to have negative biochemical impacts on native species, as well as negative influences on water, biodiversity, and soil nutrients and loss. As a result, rural communities in Madagascar do not have the policy and institutional support or training and information necessary to develop resource management systems that integrate agriculture, forestry, fisheries, water and livestock management; are adaptive for potential future impacts, including climate change; and focus on both increasing levels of output and productivity while also maintaining the ecological integrity of the land.

Existing practices for rural energy production are inefficient and do not utilize sustainable locally-produced biomass: Lack of access to electricity among rural inhabitants in Madagascar, combined with the inability of most rural inhabitants to pay for generators, renewable energy generation, and other options, produces a high level of demand for wood products from a very degraded forest landscape. Development of sustainable and profitable wood resource production systems, such as bamboo, could reduce the pressure on the natural forest landscape significantly, but is constrained by a lack of experience and capacities among resource management agencies and local communities in bamboo cultivation or the production of additional economic benefits from bamboo products that would make it more competitive with harvesting of natural wood or other energy supply options. The level of demand for wood resources also can be reduced by the use of more efficient wood energy production processes, including more efficient charcoal production and more efficient wood burning stoves. However, in Madagascar rural inhabitants as well as micro and small businesses that might serve them do not have the experience or technical and financial resources to adopt these technologies and improved practices, and in many cases, simply are not aware that such alternatives

exist. In addition, adoption of more efficient energy production and use technologies is constrained by the lack of financing mechanisms that can make the adoption of these technologies financially feasible.

1. 2) The baseline scenario or any associated baseline projects

Faced with the challenges described above, the Government of Madagascar has begun to undertake various programs to improve agricultural and forest management and resource use. However, in the area of forest management and wood energy production, many programs to date have relied on planting exotic species of fast-growing trees such as eucalyptus, which are known to have allelopathic effects (Davidson, 1985; FAO, 1988; Demel 2000, Amare 2002; Nduwamungu et al, 2007) and potentially negative impacts on water table, biodiversity and soil nutrients. As a result, many communities still need options for the ecologically sustainable and economically feasible production of woody biomass for household energy use and livelihoods development.

Baseline projects in energy sector:

With support from IFAD, INBAR implemented a project from 2010-13 entitled *"Integration of livelihoods of the poor and addressing environmental degradation with bamboo in eastern and southern Africa"*, which represented the first major attempt to formalize a market for an NTFP (bamboo) in Madagascar by improving cooking stove technologies and production of charcoal, coupled with development of a value chain for bamboo resources intended to help provide sustainable renewable energy, improve rural and urban livelihoods, and support landscape restoration and mitigation of climate change and adaptation. In partnership with the Ministry of Environment, Ecology, the Sea and Forests and the IFAD projects on Promotion Program for Rural Knowledge (PPRR) and Support Programme for rural Micro-enterprises and Regional Economies (PROSPERER) (see below), INBAR established four mother nurseries and 67 village nurseries, introduced the use of five species of bamboo from India that produce high biomass yields and offer significant potential for value added products, trained 1,500 youth in various value chain activities, and established two bamboo charcoal production centres. The proposed project will benefit greatly from the models and lessons learned in this INBAR project (INBAR is a key project co-financing partner). During the project period INBAR will continue educating and sensitizing communities and civil society on options for the use of bamboo in household energy initiatives. The IFAD Support Programme for the Rural Microenterprise and Regional Economies (PROSPERER) focuses in increasing the incomes of poor rural people. It works towards creating efficient business development services that respond to the needs of small and micro rural enterprises, and builds the capacity of these enterprises to identify their individual requirements. During the project period, the PROSPERER project will continue supporting bamboo agroforestry systems for fuelwood purposes.

A *project for the distribution of improved stoves (kopadroa) and alternative fuels (bozaka coal)* is designed to improve household access to domestic energy and minimize dependence on forest resources in four towns in the Bongolava area in the district of Tsiroanomandidy. The TanyMeva Foundation is providing funding for this project executed by ANAE for the period 2014-2017. The proposed project will benefit from the lessons learned from the implementation of this project.

The national ethanol fuel program (2016-2030) is a state program to facilitate ownership of household ethanol fireplaces. The program is an initiative of the Government of Madagascar and partnerships will be developed progressively, but the World Bank is already supporting various studies to design the program implementation phase. The program cost is estimated at $15 million for the first ten years, primarily for coordination and implementation of production areas and small industrial units. The pilot site for this program is the Atsinanana region.

The Ministry of Energy, with support from the International Centre for Cooperation in Agricultural Research (CIRAD), is implementing a *Rural Household Energy Project* designed to introduce efficient charcoal processing equipment and cooking stoves in order to reduce pressure on forests from firewood collecting.

Finally, WWF's *Energy Programme for 2050 Horizon* is assisting the Government of Madagascar in adjusting the country's regulatory framework for the energy sector in order to support the development of research on alternative energy sources that are low cost and facilitate households' access to cleaner energy.

Baseline Projects in Agricultural sector:

The *Social Safety Net project for Madagascar (FSS project),* supported by the World Bank / International Development Association, is a three-year project (2016-2018) designed to strengthen social safety nets for the poorest population in rural areas, including support for the improvement of productive bases and the environment in general through productive safety nets. The project operates in five regions of Madagascar, including the Atsinanana region, where it carries out activities relevant to

environmental protection, ecosystem restoration, agriculture, livestock, and fishing, with an emphasis on agroecology. The results of this project will provide significant lessons learned for the design of the implementation strategies of the proposed project.

The *Government of JICA – WFP Food-for-work project: Project for the amelioration of Rice Production in Central High lands (PAPRIZ)* includes reforestation as well as the construction or rehabilitation of community assets such as irrigation and drainage canals, rural roads and water catchment systems. In the cyclone- and flood-prone southeast of Madagascar, food-for-work helps empower female heads of households through training in so-called 'short-cycle farming' using improved agricultural techniques. This helps women increase crop production, raise revenues and strengthen their households' ability to withstand future shocks. Food-for-work activities are principally for households headed by women, alongside those with elderly, ill or disabled people, as well as families with many members and malnourished children.

The *World Bank Emergency Food Security and Social Protection project* is designed to strengthen the immediate capacity of recipients to respond to the food security and locust crises, by: (i) increasing agricultural production capacity in project areas, while enabling extremely poor households, in the project areas, to access cash transfers and cash for work activities; and (ii) improving the capacity of recipients to respond promptly and efficiently to an eligible crisis or emergency.

USAID/Madagascar announced two programs related to food security in Madagascar: *Asotry (the name of the cropping season in Malagasy)*, implemented by the Adventist Development and Relief Agency; and *Fararano*, carried out by Catholic Relief Services. Together, these two programs will receive US$ 75 million in support to reduce food insecurity and increase the resilience of vulnerable households to shocks in five regions: Amoron'I Mania, Atsimo Andrefana, Atsinanana, Haute Matsiatra and Vatovavy-Fitovinany.

1.3) The proposed alternative scenario, GEF focal area[12] strategies, with a brief description of expected outcomes and components of the project

To achieve this alternative scenario the project will have the following key elements and expected results:

Component 1: Strengthen national policies and the legal and institutional framework for mainstreaming biodiversity and landscape restoration: In 2003, an environmental unit has been created in each sectorial Department, with the target to mainstream the environmental dimension. The activities related to mainstreaming environment dimension (biodiversity, sustainable energy and SLM) are developed by these structures in the Ministries in charge of agriculture and energy. As indicated in the baseline section, the lack of experience and technical capacities to develop tools and approaches for integrating the conservation of biodiversity and ecosystem services into productive sectors, and to develop and disseminate critical information and knowledge management tools, has greatly limited the country's efforts to mainstream biodiversity conservation, sustainable land management, and other environmental priorities into the activities of planners and productive sectors. The proposed project will assist in removing the main barriers to mainstreaming biodiversity conservation, sustainable forest management, sustainable land management and sustainable energy production by strengthening national policy, regulations and capacities for SLM and SFM to integrate bio energy, biodiversity and livelihood considerations; demonstrating integrated land and forest management at a landscape level, and promoting wider adoption of efficient renewable energy technologies by households to reduce demands on natural forests. The project will enable stakeholders to produce an enabling legal, policy, planning and institutional environment for integrating sustainable land and forest management principles within the national, regional, district and municipal level frameworks. At the national level, the project will strengthen the efforts of the Ministry of Environment, Ecology and Forests by assisting in the drafting/redrafting of related Chapters to the Code of the Malagasy Environment, the development of a National Agroecology strategy, and the dissemination of policy recommendations on SLM and BD mainstreaming. The project will ensure stronger inter-sectoral coordination and capacity building on integrated natural resource management, with a specific focus on intensifying agriculture through SLM and SFM. Capacity strengthening and knowledge management at the grassroots and higher governmental levels through peer-to-peer learning, systematic capacity building, and information dissemination will be carried out, focusing on critical issues of SLM practices, forest rehabilitation, promotion and financing of bioenergy, community-based natural resource management and monitoring of threats to biodiversity. Further, to address the threats of land degradation and biodiversity loss related to the agricultural and energy sectors, sectorial action plans will be developed on how these sectors can be actively engaged and how their practices can be adapted to provide support to produce environmental as well as developmental benefits. In order to increase funding and mainstreaming of biodiversity, sustainable energy, sustainable land and forest management into existing development plans at a local level or support development of these plans where they do not exist in order to influence biodiversity, SLM and SFM

[12] For biodiversity projects, in addition to explaining the project's consistency with the biodiversity focal area strategy, objectives and programs, please also describe which Aichi Target(s) the project will directly contribute to achieving.

considerations. The project assistance will be provided on the development or review of four municipal development plans that fall within the Vohibinany and Vatomandry districts. Lessons will be drawn from the process and a methodology developed to ensure upscaling of this integration into other municipalities in the Atsinanana region and Madagascar. The involvement of local communities in all of the aforementioned activities will strengthen their knowledge and confidence to defend their interests and to seek political and social support regarding land and resource use rights.

Component 2: Ensure scaling up of SLM practices and agroecology in a wider landscape: In order to relieve the pressures from local communities on forest resources and the continued loss of soil fertility on arable lands, partnerships and agreements will be established between the Ministry of Environment, Ecology and Forests (MEEF), the Ministry of Agriculture, and local communities on what areas to conserve and restore and what areas should be supported to increase agricultural production using agroecological principles. Agricultural support will be provided to local villages at selected sites within the districts of Vohibinany and Vatomandry, on the basis of the implementation of forest conservation strategies mutually agreed by MEEF and the communities and stipulated in signed Conservation Agreements between the parties. The efficacy of such a scheme has been confirmed by national stakeholders, but a detailed feasibility analysis for the agreement scheme will be undertaken during the PPG. Based on the agreements, at least 3,500 ha of High Conservation Value Forests (HCVFs) will be conserved. The project also will restore/rehabilitate 500 ha of degraded land in areas adjacent to and within the HCVFs through the planting of bamboo. In order to address continued land degradation (loss of soil fertility) on the arable land, as well as address the contribution of the agriculture sector to deforestation and forest degradation, the demonstration of agroecological (SLM) technologies will be implemented in the areas covering the agreements. The practices to be tested on these degraded lands covering at least 4,800 ha will include the incorporation of nitrogen-fixing trees in annual monocropping fields, the improvement of planting methods and use of high yielding varieties, the improvement of water management, integrated pest management, and use of organic materials that are available to improve soil structure, water and nutrient holding capacity and soil fertility. The exact measures will be established during the PPG. A capacity building programme will be developed and implemented to assist local community members to make informed and wise decisions concerning the management of ecosystems and the maximization of the services that these ecosystems provided to the communities.

Component 3: Improving rural energy generation systems and wood services to reduce deforestation: Around 3 billion people in developing countries rely on wood fuels for their daily cooking needs with profound negative implications for their workload, health, and budget as well as the environment. The island nation of Madagascar has a serious energy shortfall, especially as fuel becomes more scarce and expensive, both locally and worldwide. In its developing economy, Madagascar's rural populations remain disconnected from electricity networks, relying instead on charcoal and firewood for basic needs such as cooking. Demand for wood to burn and for making charcoal is driving deforestation on the biodiverse jungle island – especially as the population increases. Furthermore, deforestation and burning of biomass is contributing to climate change. According to Polly Seplowitz (August 2009) in Building Energy-Efficient Stoves in a Madagascar Village, "*throughout the villages of Madagascar, food is traditionally cooked on open fires, a method that leads not only to respiratory problems within household members, but also requires nearly twice the amount of firewood as does cooking with the energy-efficient stoves. The excessive use of wood for both cooking and building has led to serious deforestation throughout Madagascar, and an attendant loss of the island's precious biodiversity"*. Improved cook stove (ICS) technologies in many cases appear to be an obvious solution. Despite continuous efforts of the international community to disseminate ICS, take up rates in most developing countries are strikingly low. In urban Burkina Faso for example, ICS users save between 20 and 30 percent of fuels compared to traditional stoves making the investment very profitable one. Nonetheless, adoption rates are low at a mere 10 percent. It turns out that the major deterrent of adoption are the upfront investment costs – which are much more important than access to information, taste preferences, or the woman's role in the household. These findings suggest that more direct promotion strategies such as subsidies would help the household to overcome its liquidity constraints and hence improve adoption rates[13]. Selection of appropriate and popular ICS depends largely on availability of fuels, energy savings, and reduction in smoke emission. However, an effective laboratory test of selected ICS models is needed to find out the appropriate one that may be replicated countrywide after successful pilot intervention[14]. In rural Mexico, the use of the Patsari *stove* was significantly associated with a reduction of symptoms and of lung function decline[15]. ADES[16], is making women leaders distributing solar and efficient cook stoves. ADES trains women to host solar stove cooking demonstrations, animating others to spread knowledge and use of solar box stoves, e-solar stoves including photovoltaic cells and solar parabolic stoves. The project, which represents a partnership between the international Climate Protection Partnership and the Swiss-Madagascan nonprofit ADES, even includes distribution of easy-to-understand solar cookbooks. The project – which includes input and feedback from the communities to develop and enhance products oriented toward them – not only taps the key role of women in adopting and

[13] Why Do Households Forego High Returns from Technology Adoption Evidence from Improved Cook Stoves in Burkina Faso by Gunther Bensch et al. 2014

[14] Assessment of Existing Improved Cook Stove in Bangladesh, Mizanur Rahman et al. 2006

[15] Isabelle Romieu et al, American journal of respiratory and critical care…2009.

[16] "ADES solar and efficient stoves in Madagascar,"

spreading use of solar and efficient cook stoves, but also aims for long-term change in building sustainable Madagascan societies.

The project will capitalize on the aforementioned international experiences and will undertake a Rural Energy Assessment in the Atsinanana Region in order to analyse the energy needs of the region as well as to ensure that recommended solutions appropriate to local conditions are identified and validated and will be implemented during the project phase. The recommendations/solutions options will reconcile economic development, sustainability, environmental protection and resilience in the face of future climate changes – it is therefore important to undertake a careful local analysis of current and future energy needs, as well as potential production sources. Once the assessment has been undertaken and adequate options retain, the project will support the development of sustainable mechanisms to establish and implement the dissemination and upscaling of new technologies, to identify which sectors are best suited to take forward the technology, and to determine how government can best use limited funds to entice partners to address the energy needs of the region. An initial cost-effectiveness assessment was completed in order to provide some structure to the proposed activities (see annex 3), this will be updated and improved during the PPG in order to decide on the choice of the most appropriate and cost-effective energy solutions for the region. The efficient cook stoves that we will be promote should respect the criteria related to: (i) All of the raw materials are provided locally; (ii) Stoves are personalized to the household needs in terms of sizes; and (iii) Innovation is also seen on manufacturing methods since it will directly involve beneficiaries. Training will be provided to the rural families who will manufacture themselves the improved cook stove. The project will also assist as well in installation of a gasification generator. Unlike the cook stoves, the gasification generator will not be produced in Madagascar but purchase from India. The generator comprises of two units of 25 kW which are simplified and designed to be easily maintained at rural areas. The two units include a standard generator which is traditionally used except the combustible gas will be coming from the second unit which is a combination of a burner of biomass and a gas filter system. The gas produced is passed on to the first unit. The two units will be designed and manufactured in India with a simplified maintenance system. The local communities will appoint technicians who will be trained at the Common Production and Training Center (CPTC) based in the Capital Antananarivo.The generator will be installed in appropriate facility/building holding facility and local cooperative will be established to manage it. In sum, 3,000 energy efficient cook stoves will be produced by rural families in the districts of Vohibinany and Vatomandry, as well as electrifying one village with a 25kW bamboo gasification generator. Government of Madagascar will be providing 300ha of lands to the project demonstration. During the PPG, the most appropriate ownership of the 300 Ha will be discussed with all the stakeholders and the relevant legal status will be provided.

Lessons learnt from other project involving gasification generators worldwide will be considered before the installation of the generator commences (see Annex 1 for information on Biomass Gasification and lessons learnt from projects in India). At least 300 ha of degraded land provided by the Government of Madagascar, will be replanted with shrub species and bamboo plantations and sustainably managed in order to provide biomass for the cook stoves and gasification generator. Other technologies and opportunities for local enterprises to participate in the energy strategy will be promoted. It is expected that 3000 rural households will benefit from GEF resources via the cooperatives in order to be self-sufficient in terms of energy production and management. GEF resources will be invested to establish the cooperatives activities (manufacturing of cook stoves, purchase and establishment of local management structure of the gasification generators) and design of mechanism which will ensure sustainability and scaling up of such activities.

The use of cook stoves and gasification generators is believed, based on the initial cost-effective assessment (annex 3) to more cost-effective. However, during the PPG, a more detailed cost effectiveness analysis will be conducted both in ecological and socioeconomic terms. The outcome will help to bring more appropriate options in terms of Global Environmental and Socio-Benefits.

The description of the project components above indicates that the project is aligned to a number of *GEF focal area strategies.* Biodiversity Objective 4: Mainstream Biodiversity Conservation and Sustainable Use into Production Landscapes/Seascapes and Sectors, specifically Program 9: Managing the Human-Biodiversity Interface, through land use planning, developing policy and regulatory frameworks, and development of incentives for the conservation of high conservation value forests through the testing of conservation agreement schemes. Climate Change Objective 1: Promote Innovation, Technology Transfer, and Supportive Policies and Strategies, specifically Program 1: Promote the timely development, demonstration, and financing of low-carbon technologies and mitigation options, through promoting energy-efficient cook stove and bamboo gasification generator technologies. Land Degradation Objective 1: Maintain or improve flow of agro-ecosystem services to sustain food production and livelihoods, specifically Program 1 Agro-ecological Intensification, through testing/showcasing agro-ecological methods and approaches and strengthening community-based agricultural management. Land Degradation Objective 2: Forest Landscapes: Generate sustainable flows of forest ecosystem services, including sustaining livelihoods of forest dependent people, specifically Program 3: Landscape Management and Restoration, through restoration of forest ecosystems in areas within and adjacent to High Conservation Value Forests.

The project supports the objectives of the UNCBD, and in particular will contribute to the achieving the following *Aichi Targets:* Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably; Target 7: By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity; Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity; Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification; Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

4 Incremental/additional cost reasoning **and expected contributions from the baseline, the GEFTF, LDCF, SCCF, CBIT and** co-financing

This project is based on the promotion of agroecological approaches and the use of sustainable energy in the rural environment of Madagascar. These two complementary approaches will support the socio-economic development of the project area, the restoration / conservation of natural resources and ecosystems, and improvements in human nutrition and health.

Scenario without GEF Resources: Without the contribution of this GEF project, the population in the Atsinanana region will continue to become poorer, to unsustainably exploit the region's natural resource base and to carry out agricultural practices that damage soils and degrade ecosystem services. Agricultural expansion will continue to destroy large areas of natural forest, and intense demand for wood energy resources will further degrade forest areas. Without the interventions proposed by this project, the rate of annual deforestation in the region over the next five years (36 000 ha per year at present) is expected to double. In addition, forest degradation will impact areas of critical biodiversity habitat, with severe negative impacts on globally significant biodiversity, including a number of endemic floral and faunal species.

Scenario with GEF Resources: This GEF project will build on the above-mentioned baseline projects to mainstream agroecology and conservation agriculture as well as improved renewable energy technologies into existing national and regional programs and initiatives. Madagascar is investing in sustainable land management activities, but because of the lack of experience with bamboo cultivation in traditional forestry programs in the region, resource management agencies and local communities lack the awareness, technical capacities, infrastructure and finance to incorporate bamboo into existing initiatives. The GEF project will provide a platform to overcome these challenges and successfully implement bamboo cultivation and agroecology practices so that by the end of the project pressure on native forests will have been reduced, land degradation will have been halted and even reversed through ecological restoration activities, and greenhouse gas emissions will have been reduced through the adoption of more efficient energy production / use technologies. In addition, project activities to share and transfer relevant experiences to other programs in Madagascar and to other INBAR member countries in Asia (including countries such as China and India where bamboo cultivation is already widespread) will support the long term up-scaling of these sustainable practices and result in similar global benefits on a wider scale.

5 Global environmental benefits **(GEFTF) and/or** adaptation benefits **(LDCF/SCCF)**

The Global Environmental Benefits that will be generated from the project implementation include the sustainable management of natural resources and critical habitats in an integrated manner providing development and environmental benefits. The promotion of bamboo as a strategic resource to address land degradation and climate change will deliver numerous ecosystem services and benefits, including enhanced carbon sequestration, reduced soil erosion and improved nutrient cycling, protection of vulnerable and marginal rainfed farming systems, and avoided deforestation. More specifically, the following GEB will be generated from the project implementation:

1. The conservation of biodiversity across 3,500 ha of high conservation value forests and the restoration of 500 ha of forest adjacent or within these forests;
2. Improved management of 800 ha of forests ecosystems ensuring that the ecosystems provided by these forests are maximized for human benefit (i.e. through wood energy services)
3. Over a 10-year period, potential avoided GHG emissions of 84,495 tons of CO_{2e} and the sequestration of 104,453 tons of CO_{2e} [17]
4. Arresting land degradation through good SLM and SFM practices within at least 5,600 ha.

[17] See annex 2

Among the key biodiversity hotspots, the project will support conservation through the local land use plans include:

i) The Zahamena National Park is located on the Eastern coast of Madagascar within the tropical rainforest. The ZNP is home to many endangered species that are specific to its environment. It typically rains year round, it has a moist and warm climate which is favorable to the plants and animals within the ecosystem. The 423 km² national park is divided in an eastern and a western forest, in the corridor in between is villages. In 2007, Zahamena was declared UNESCO World Nature Heritage site. Thirteen species of lemurs live inside Zahamena's rainforest, among them the largest lemur, the Indri (*Indri indri*), as well as diademed sifakas (*Propithecus diadema*) and black-and-white ruffed lemurs (*Varecia variegata*). Besides these, there is a secret nocturnal and little researched inhabitant of Zahamena: The hairy-eared dwarf lemur (*Allocebus trichotis*). Much easier to find are mouse lemurs and fat tailed lemurs. But Zahamena is especially famous for its bird kingdom: 112 species of birds, more than the half being endemic and occurring nowhere else than on Madagascar;

ii) Mangerivola Special Reserve was created in 1958 and covers 11,900 ha and is located in Atsinanana Region. It is home of 100 species of birds with high level of endemism. It host 6 species of lemurs, 3 species of carnivores, 13 species of small mammals, 19 species of reptiles, 45 species of amphibians. The reserve is rich in flora with 325 species from 66 families; 52% of the species are endemic;

iii) The Marolambo National Park covers 95,063ha and has a temporary protection status by decree taken by the Government in 2013. The Park lies between several regions including Atsinanana, Vatovavy-Fitovinany, Vakinanka and Amoron'i Mania. It is home of 10 species of lemurs, 4 species of carnivores, 7 species of rodents, 13 species of birds, 2 species of reptiles, 3 amphibians and 4 local endemic fish species. In term of flora, it has 324 species among which 2 endemic species of Sarcolaenaceae family; and;

iv) The classified forest of Vohibola which is the home of important species of lemurs which are in critical condition due to the fragmentation of the forest.

6 Innovation, sustainability and potential for scaling up

Innovation: Several aspects of the project design are innovative for Madagascar – the project will combine scientific and participatory approaches in ways that have not been attempted before in the country; it will implement a multi-level approach, strategically targeting decision-makers at household, community, district and regional levels; and it will promote an adaptive management approach that strengthens the capacities of farmers to adapt to new challenges and opportunities in the future, including climate change. The project's focus on agroecology and the integration of bamboo, which could provide fast returns on investment for landscape restoration initiatives and address the current shortage in biomass for household energy as a sustainable energy source, is innovative for Madagascar. Following several years of baseline pilot and proof of concept projects, this GEF project will represent the first effort in Madagascar to integrate bamboo production into a program for combined sustainable land management and climate change mitigation objectives. Most rural development programs focus on agriculture and livestock improvements. The proposed project will include production strategies, but also will identify important habitats within the landscape that are providing ecosystem services that people depend on, and will plan for their protection and/or restoration.

Sustainability: The project design will include a number of strategies and activities to ensure sustainability. At the institutional level, the project will include significant capacity building activities, working directly with local and national governments, local communities, civil society and the private sector. To ensure long-term sustainability, an exit strategy will transfer all project responsibilities to local institutions by the end of the project. MEEF will work to ensure that a favourable policy environment is put in place that promotes bamboo resource development, investment and dissemination of improved renewable technologies. In social terms, the project will adopt a participatory approach to ensure the full involvement of local people, and it will involve and influence decision-makers at various levels in order to optimize the chances of sustainable follow-up programs. The project will engage and work with all sectors of society - community, civil, public and private – to identify current barriers, as well as opportunities, so as to build social buy-in to the project. Demonstrating the sustainable economic benefits of project activities, in particular bamboo cultivation and product development, will be critical components to ensuring the sustainability of the project objectives. The proposed technologies for improved cook stoves and bamboo charcoal products are well validated and have been shown to provide increased savings / incomes to households and Micro and Small Enterprises (MSEs). Improved cook stoves can provide annual fuel savings for households worth as much as US$ 60-80 per year, while companies producing bamboo charcoal briquettes at an INBAR project site in Ethiopia are achieving internal rates of return on investment as high as 30-40%. In addition, although biomass gasification technology for off-grid electricity generation has yet to be widely applied in Africa, INBAR experiences in India have found that the technology can produce electricity competitively at a base rate of US$ 0.08 / kWh, well below the base rate in Madagascar. While the initial costs of establishing bamboo plantations are often as high as other forestry interventions, positive returns on investment can be achieved more rapidly, in some cases as quickly as 3-8 years after planting. In addition, there are many existing stands of bamboo in

Madagascar that typically have no management regimes in place and are subject to overexploitation, poor yields and low profits. However, with low-cost training and adoption of best practices resource management, farmers in INBAR projects in Madagascar have managed to increase dry biomass yields from existing bamboo plantations several times over. The project team also will leverage the private sector and financial mechanisms to lock-in economic benefits and widen access to a greater number of community and household beneficiaries, many of whom currently are unable to realized the full potential of their bamboo for want of financial resources. The project will scale up and adapt several existing models of financing for cook stove users and providers, as well as charcoal producers, and develop similar models for micro and small enterprises. To ensure sustainable environmental outcomes from the project, the project will provide communities, civil society, government, and the private sector with clear guidelines on best practices for bamboo management and cultivation. For example, the project will ensure that bamboo does not replace existing forest vegetation, and to avoid risk to the wider landscape, the project will use only tropical, non-invasive sympodial (clumping) bamboos. At present, information on the potential benefits of bamboo for Madagascar is limited, and the quantification of the benefits through monitoring and evaluation under this project will play a major role in mainstreaming the use of bamboo into national development plans and policies, as well as in regional (e.g. TerrAfrica) and international (e.g. Bonn Challenge) initiatives.

Scaling Up: Scaling-up agroecology measures including SFM, SLM and CCM interventions to other areas will be possible through the information generated through by project activities in the Atsinanana region. Evaluations of the effectiveness of these activities and their potential for upscaling will include rankings provided by farmers, analyses of the likelihood of adoption based on costs, labour and input requirements and technical challenges, and social equity concerns such as the potential to benefit women and other vulnerable groups and compatibility with local cultural practices. In addition, practices that address unique risks are particularly innovative and merit further exploration, or are gender-specific will also be highlighted. The project's focus on sustainability and the establishment of platforms for knowledge management and sharing will provide the required framework to upscale results within Madagascar (including within all 84 communes in the two target districts), as well as regionally. As bamboo grows widely throughout Madagascar, which has more endemic bamboo species than the rest of Africa combined, the project's solutions that address common biodiversity, climate change and land degradation challenges have enormous scope for replication and up-scaling in the region. In comparison to other forestry initiatives, bamboo cultivation provides smallholder farmers with fast returns on investment and significant opportunities for value addition at the farm level, which provides strong economic incentives for additional farmers to participate in bamboo cultivation. In addition, the project will link to broader regional initiatives (e.g. TerrAfrica and the Bonn Challenge) that can scale and replicate activities in other countries (especially INBAR member countries) such as: adoption of national bamboo frameworks for multilateral environmental agreements (e.g. UNFCCC & UNCCD); increased biomass gasification electricity generation; restoration of degraded lands; and widespread adoption of improved cook stoves.

2. *Stakeholders.* Will project design include the participation of relevant stakeholders from civil society organizations (yes ☒ /no☐) and indigenous peoples (yes ☒ /no☐)? If yes, identify key stakeholders and briefly describe how they will be engaged in project preparation.

In partnership with the Ministry of Environment, Ecology and Forests, the project will work with civil society and local community groups and residents to design and implement activities for landscape restoration, sustainable land management, development of bamboo value chains, and strategies for domestic energy. To ensure the full participation of these groups, the project team will focus on the need for consultation, dialogue and participatory approaches with civil society and communities in the design and implementation of the project.

Stakeholders	**Roles and Responsibly in the project**
Ministry of Environment, Ecology and Forests (MEEF)	Within MEEF, the Directorate of Environment will act as the lead project executing agency, while the Directorate of Forest and Ecology will play a strong role in providing technical support and guidance to the project.
Regional Directorate of Atsinanana (MEEF)	The regional directorate on environment works under the leadership of MEEF. The directorate will play a strong role in landscape restoration and sustainable management of bamboo resources in the selected project sites.
National Association for Environmental Action (ANAE)	ANAE is one of the project executing agencies, and will participate in the coordination and implementation of agroecology, agroforestry, conservation agriculture and other activities related to agricultural production and natural resources preservation. ANAE has extensive experience in water and soil conservation and rural development in Madagascar, and is a leading proponent of agroecological approaches for combatting poverty and malnutrition and preventing environmental degradation
International Network for Bamboo and Rattan (INBAR)	INBAR will have the role to educate and sensitize communities and civil society on options for the use of bamboo in sustainable land management, production livelihoods and household energy initiatives

PROSPERER	The team implementing PROSPERER (Programme de Soutien aux Pôles de Micro-Entreprises Rurales et aux Economies Régionales de Madagascar) will co-implement landscape restoration of bamboo and bamboo agro-forestry systems in the Atsinanana area
FORMAPROD	The team implementing FORMAPROD (Vocational Training and Agricultural Productivity Improvement Programme) will carry out training programs on the development of bamboo value-chains and enterprise development.
Ministry of Energy	The Ministry of Energy will act as the leading agency for developing strategies for bamboo biomass energy and renewable energy - gasification.
Ministry of Agriculture	The Ministry of Agriculture will be responsible for strategic policy making for integrating bamboo and agroecology concepts in agriculture, livestock and fisheries
Local Leaders	Mayors, village chiefs and other local leaders will identify and allocate land for bamboo restoration and sustainable harvesting activities, and will help to mobilize local community participation in project activities
Civil society organizations	The REDONA cooperative of over 100 producers in the Antananarivo region who specialize in the production of musical instruments and furniture will provide support to provide a master trainer for capacity building, and support in the development of prototypes and new technologies. Maté and VolobeAvotra are NGOs working in the Diana and Atsinanana region that will facilitate the dissemination of information, community mobilization, and sustainable resource development and management activities relating to bamboo / charcoal production. The Saint Gabriel NGOs working in the Toamasina region will facilitate community organizing by providing training centres, microfinance and marketing support for bamboo, bamboo charcoal and briquettes, and bamboo furniture to create employment opportunities for the rural poor
Local Communities, including indigenous groups	Local communities will be involved through participatory planning and implementation process for project activities, including: building dialogue and consultation; understanding local community capacities, needs and constraints; increasing awareness and sensitization; and participating in landscape restoration, sustainable management of bamboo forests, and value-chain development.
Private Sector	A company formed during Phase II of the INBAR project, CIBART Madagascar will provide trade and marketing support to households, micro, small and medium enterprises. In addition, several private contractors have expressed interest in establishing bamboo groves, in the production of bamboo charcoal wood, briquettes and charcoal, and in other business opportunities along the bamboo value chain.
CRAM members and other agroecology stakeholders	CRAM is a consortium focused on agroecology created in 2015 and consisting of many bodies such as NGOs, university research centres, farmer associations, students, technical departments, projects, etc. CRAM has established a Master in Agroecology program in partnership with foreign universities, which will help to promote the exchange of experiences, knowledge and technical advice among institutional stakeholders and field operators.

3. Gender Equality and Women's Empowerment. Are issues on gender equality and women's empowerment taken into account? (yes ☒ /no☐). If yes, briefly describe how it will be mainstreamed into project preparation (e.g. gender analysis), taking into account the differences, needs, roles and priorities of women and men.

Biomass energy and sustainable land management are environmental and development challenges where men and women in Madagascar typically have clearly defined and differentiated roles. In Madagascar, women tend to be responsible for the procurement of fuel wood and for cooking activities; for this reason, project interventions related to fuel wood production and use have the potential to benefit women in particular by reducing the physical hardship of collecting firewood, increasing disposable household incomes, and reducing indoor air pollution. On the other hand, men tend to dominate in the production of charcoal and will benefit from more efficient charcoal production processes. To ensure that project activities take account of the interests, priorities and needs of all stakeholders, including women, the project team will conduct extensive social assessments and consultations with women and men in the project target sites during the preparation phase, including the recording and analysis of gender data to identify current gender gaps in policy, local capacity, and practices that the project will need to address. For the landscape restoration elements of the project, the project will use IUCN's Restoration Opportunities Assessment Methodology (ROAM), which explicitly calls for the inclusion of gender considerations in designing restoration plans, and factors in criteria such as the need to have a good gender balance of participants and to include a social scientist with a clear understanding of gender and formal and customary land and resource rights, as part of the coordination team for assessments. For the cook stove and household energy use components of the project, the team will apply a set of tools developed by ENERGIA that help project managers, staff and local capacity builders to mainstream gender in their work. These tools allow project teams to identify the main entry points for gender in Improved Cook Stoves (ICS) programs, as well as a gender marker self-assessment tool that allows project staff to review the efficacy of their activities; these tools will be adapted for the assessment of gender aspects related to charcoal and bamboo processing and marketing activities. During the PPG a

comprehensive gender analysis will be conducted to fully address the inequality and the framework will be adjusted to accommodate findings from such analysis.

4. Risks. Indicate risks, including climate change, potential social and environmental risks that might prevent the project objectives from being achieved, and, if possible, propose measures that address these risks to be further developed during the project design (table format acceptable).

Risk	**Level**	**Risk Mitigation Measure**
Resistance of beneficiaries to bamboo production (bamboo is not widely cultivated or utilized in the region and there may be negative attitudes toward its use among communities, local authorities and private sector actors)	Low	The project will adopt participatory approaches and outreach at the local level to ensure that communities, MSEs (Micro & Small Enterprises), and government are aware of the advantages of bamboo-based value chains and support their development. The project also will ensure the involvement of local administrative and traditional authorities in advocacy and participatory planning. INBAR will be the focal point for these efforts, and also will provide national-level coordination to promote research, extension and demonstration, as well as experience sharing.
Insecure and/or unclear land tenure and user rights undermine incentives for improved land management	Medium	Land tenure is a major issue in Atsinanana, as in much of Madagascar. Nurseries and woodlots will only be supported where land ownership is clear and not regarded as a risk to the project. At the household level, bamboo planting in home gardens and homesteads will be encouraged to mitigate the risk of land tenure / use conflicts. The project will coordinate with the government focal point to negotiate for the use of lands in government-owned reserves and concessions.
Cost of wood biomass energy generation is lower than bamboo-based energy generation	Low	The project will support sustainable land management and land restoration through bamboo, which will increase raw material supplies and lower costs over time. Moreover, through training and capacity building, communities will have the opportunity to diversify income from bamboo by using the raw material for additional applications, such as in construction, furniture making, and as a food, feed and fodder.
End users adopt inefficient technologies and generation processes that lead to increased GHG emissions and indoor air pollution	Low	The project team will work with MSEs and end users to ensure the adoption of best practices and technologies, such as improved charcoal making technologies and cook stoves
Local poverty undermines conservation efforts (i.e. improved agricultural practices take several years to produce results, and poor rural populations may not be willing to wait for positive results)	Low - Medium	Under Project Components 2 and 3, activities will be designed to support local communities during the process of developing and implementing new agricultural processes so that they see livelihoods improvements while waiting for improved agricultural technologies to deliver results
Climate change and climate variability, such as seasonal droughts and flooding, undermine project achievements.	Low - Medium	The Project aims to introduce an *adaptive management* approach that will give local communities the tools, capacity and information to *adapt* to changes, and to increase their ability to overcome challenging conditions. In addition, agroecological approaches to conserve water and soil use and restoration activities to restore ecosystem services will increase the resiliency of natural and productive landscapes to climate change impacts
Political instability	Medium	There is a risk that due to ongoing political instability, the project could experience delays, particularly if the forthcoming elections lead to further instability at the regional level. The project will carefully monitor the political situation and will ensure that the capacity for delivering the project is built at multiple levels in order to avoid delays.
Limited capacity to effectively tackle all project components	Low - Medium	Establishing a robust multidisciplinary project implementation team supported with additional training if necessary will help mitigate against this risk. Targeted capacity building will be delivered at national regional and local level at project start.
Local poverty undermines conservation efforts.	Medium	Under Outcome 2, activities will be designed to support local communities during the process of developing new agricultural processes – hence their livelihoods should improve whilst waiting for the improved agricultural techniques to deliver results.

5. Coordination. Outline the coordination with other relevant GEF-financed and other initiatives.

The project will link to the GEF-supported TerrAfrica Program, a coalition of 24 African countries promoting sustainable land and water management (SLWM). Both the Africa Environment and Natural Resources Unit of the World Bank, and the New Partnership for African Development (NEPAD), which manages the TerrAfrica program, agree that bamboo has a strong potential for use in their land restoration-supported activities and that bamboo cultivation to restore degraded lands and promote sustainable land management (e.g. for soil erosion and water runoff control, and soil improvement) will form a core component of the TerrAfrica program. The project co-financing partner INBAR is an observer to the TerrAfrica Steering Committee. The UNEP/GEF project "Participatory Sustainable Land Management in the Grassland Plateaus of Western Madagascar" is designed is to reverse land degradation and improve living conditions and food production in the Bongolava Region of Western Madagascar through participatory sustainable management of the grasslands. The National Association of Environmental Action (ANAE) is the executing agency of the Bongolava project as well as this proposed project, and will facilitate information sharing and learning between the two projects. The proposed project also aligns well with the Bonn Challenge to restore 150 million hectares of degraded land by 2020. In November 2014, INBAR's council of 41 member states voted to make a contribution of 5 million hectares to the Bonn Challenge using bamboo. INBAR will coordinate with the Government of Madagascar to help it define and confirm its Bonn Challenge bamboo-based commitments using the IUCN-Opportunities Restoration Assessment Methodology (ROAM). This will include provisions for conducting assessments to monitor and evaluate actual results, in coordination with established GEF projects in Madagascar. The proposed project also will seek to draw lessons learned and share information with several other relevant GEF-funded projects in Madagascar, including the UNDP-GEF project *"Enhancing the Adaptation Capacities and Resilience to Climate Change in Rural Communities in Analamanga, Atsinanana, Androy, Anosy, and Atsimo Andrefana",* whose objective is to strengthen the capacities of vulnerable communities to cope with the additional risks posed by climate change and variability on livelihood opportunities; the AfDB-GEF project *"Enabling Climate Resilience in the Agriculture Sector in the Southwest Region of Madagascar",* whose objective is to secure and improve rural farmers' livelihoods through water management and health interventions in Southwest Madagascar; and the WB-GEF project *"Sustainable Agriculture Landscape Project",* whose objective is to improve agricultural productivity and management of associated natural resources in selected landscapes.
With support from the Adaptation Fund, UNEP and MEEF are implementing the project *"Promoting Climate Resilience in the Rice Sector"*. The project will produce knowledge, data and climate predictions, as well as tools and methodologies, which can be of relevance to this proposed project. In addition, capacity for project management and coordination with multi-sectoral partners is being built within MEEF through this project, which will be beneficial for the proposed GEF project.

Finally, UNEP is currently developing the project *"Development and promotion of the Landscape Approach to increase the sustainability of production and improve water, energy and food (WEF) security through ecosystem management"*, which seeks to catalyse the adoption of landscape approaches to promote sustainable agriculture production in Africa, Asia Pacific and Latin America, and to enhance the ecosystem dimension of the WEF Nexus dialogue. The project will build capacity among decision-makers and other stakeholders to understand trade-offs, identify synergies and choices to be made in designing more sustainable food production and water-energy management systems, and strengthen the ecological basis of production.

The Ecosystem Services Economics (ESE) Unit of the Division of Environmental Policy Implementation of UNEP, in collaboration with partner institutions, recently completed a project entitled, *"Capacity-building in national planning for food security"* in India and Uganda. The project was designed to address increasing food security deficits and declines in ecosystem services by conducting pilot studies for strengthening the capacity of national policymakers and stakeholders through: i) better understanding of the principal drivers of food insecurity; ii) economic valuation of ecosystem services with relevance to food production and ecosystem management; and iii) trade-off analyses of food production and use of ecosystems for other services. The outcomes of this project can provide important lessons learned for the proposed project.

***6. Consistency with National Priorities*.** Is the project consistent with the National strategies and plans or reports and assessments under relevant conventions? (yes ☒ /no☐). If yes, which ones and how: NAPAs, NAPs, ASGM NAPs, MIAs, NBSAPs, NCs, TNAs, NCSAs, NIPs, PRSPs, NPFE, BURs, INDCs, etc.

The project contributes to the implementation of a number of national policies, plans and strategies for resource conservation and sustainable development in Madagascar, as follows:

The project supports the objectives of Madagascar's NAP (2001), including "improvement of the productive capital and the living environment of the populations, especially in the rural environment", "improved agricultural production, availability and access to food", and "sustainable management of natural resources". The project also supports the objectives of the country's NBSAP (2015-2025), including (*inter alia*) Objective 3 - "In 2025, at the latest, inappropriate and negative incentives on biodiversity will be eliminated or gradually reduced to minimize negative impacts; while positive incentives for conservation and sustainable use of biodiversity and natural resources will be developed and applied"; Objective 7 – "In 2025, all areas dedicated to agriculture, aquaculture and forestry are managed according to the sustainable output plan, ensuring an integrated

approach to biodiversity conservation"; Objective 14 – "In 2025, terrestrial ecosystems including forests, marine and coastal, sweet-brackish water including mangroves and lentic environments that provide essential services, particularly water supply and those that contribute to health, livelihoods and human well-being are protected and restored; equitable access to ecosystem services is ensured for all, taking into account the gender approach"; and Objective 15 – "In 2025, ecosystem resilience and the contribution of terrestrial, freshwater and marine waters to mitigation and adaptation to climate change are strengthened, including restoration of at least 15% of degraded ecosystems and the fight against desertification".

Madagascar's *National Environmental Policy* guides national activities on sustainable development, better management of natural resources, and the resolution of land issues, and identifies the fight against land degradation, desertification, and drought and reduced soil erosion and loss of vegetative cover as national priorities. The three environmental programs developed under the policy (PE I, PE II and PE III) include the fight against land degradation through watershed management and the conservation of water and soil as priority sector-based strategies. The objectives of the *National Environmental Policy for Sustainable Development (2015)* are to: i) maintain Madagascar in the category of biodiversity hotspot countries; ii) ensure the sustainable management of terrestrial, aquatic, marine and coastal natural resources, as well as associated habitats and ecosystems; iii) promote a healthy living environment for the population; iv) increase the contribution of environmental goods and services to the national economy; and v) establish a framework supporting the involvement of all sectors in a unified vision for the sustainable management of the environment. The Ministry of Environment, Ecology, and Forestry, with support from INBAR, has begun the process of formulating a *National Bamboo Policy*, which includes plans to support bamboo as a suitable crop for slope stabilization and control of water and soil erosion. The country's *National Forest Policy and Strategy for the Sustainable Management of Biodiversity* also identified sustainable land management (e.g. through habitat preservation and restoration) as a national priority, with the goals of stopping the process of forest degradation better managing forest resources to balance resources and needs, and increasing the area and potential of forests.

The project is aligned with various policy components under Madagascar's *Agricultural Sector Policy*, including: i) the Letter of Development Policy; ii) the Rural Policy Brief for Agriculture, Livestock, Fisheries Sector; iii) the Sector-Based Program on Agriculture, Livestock and Fisheries (PSAEP); iv) the Letter of Development Policy for Watershed and Irrigated Perimeters (BVPI); v) the National Strategy for Rice farming Development (NRDS); vi) the National Fertilizer Strategy; and vi) the National Strategy for Agricultural and Rural Training (SNFAR). For example, the Policy Guidance Note for the PSAEP includes two objectives directly supported by the proposed project, namely: a) expansion of production areas while ensuring the sustainability of resources, and b) improved productivity through the development of applied research and the advancement of sustainable systems and competitive production. The *National Energy Policy (1985)* promotes the development of reliable, low-cost energy supplies through the advancement of renewable energy, reforestation for energy, and improved technology for carbonization. The current policy does not take sufficient account of the measures needed to address the high dependence on forest resources for energy production in Madagascar (about 93%); recognizing this gap, the Ministry of Energy in partnership with WWF released a "Diagnostic Report of the Energy Sector" in 2012, and a new policy is being formulated with the major objectives of i) promoting renewable energy, including biomass technologies that are efficient and non-polluting, and ii) a target for a 50% reduction in the use of wood fuels. Thus, the proposed project is highly timely as it will help Madagascar to develop the tools and capabilities needed to meet this policy objective; in addition, the advancement of efficient practices supports the UNCCD's requirement on training and technology for the use of alternative renewable energy sources.

The *National Policy on Land* calls for improved land registration and allocation processes, as well as capacity building to address the prevalent and problematic issue of land grabbing. The *Policy on Integrated Management of Water Resources in Madagascar* is designed to i) Ensure that water needs are met sustainably, ii) develop the institutional framework for sustainable and integrated management of water resources, iii) implement the Water Code, (iv) improve knowledge about water resources, and (v) strengthen the capacity of management structures and actors. The *National Policy for Disaster Risk Management* identifies drought as an important natural hazard in the country and proposes various drought-related initiatives, such as establishing an early warning system for drought risk and empowering people affected by desertification and drought. The *National Strategy for the Fight Against Climate Change* advocates action to ensure the resilience of the population to climate change impacts through adaptation measures, including the dissemination of technical and agro-ecological information, as well as climate change mitigation through the concept of REDD + (Reducing Emissions from Deforestation and Forest Degradation).

7. Knowledge Management. Outline the knowledge management approach for the project, including, if any, plans for the project to learn from other relevant projects and initiatives, to assess and document in a user-friendly form, and share these experiences and expertise with relevant stakeholders.

As part of the project's strategy on knowledge sharing, strategic communication and information management, the General Directorate of Environment of the Ministry of Environment (MEEF) will lead project activities to capture, synthesize and share

knowledge in meetings and project interactions and activities; to develop a results framework for strategic communication that engages specific groups of stakeholders and is designed to inform and influence those groups; and to develop and share information about management practices and standards according to open access principles (including the use of standard global metadata and agricultural approaches and the use platforms that enable open sharing across the Internet). The project will develop a strategic communication plan that encourages project managers and key partners to explore three questions: 1) who can we influence directly; 2) what do we want to happen (what are the desired behaviour changes needed from specific groups); and 3) on this basis, what messages, services and activities need to be carried out to achieve these goals. Products, services and activities that may be developed as part of the strategic communications plan include weekly reporting of project progress using web resources (e.g. social media); build the evidence base by producing summaries, reports and other documentation of work in progress; development of training materials (print, web video, webcasting); publication by peer reviewed scientific journals of articles generated by the project; and briefings and meetings with decision makers to share results and demonstrate options based on project work. These various approaches will ensure that the knowledge and learning of the project is shared to improve project management and benefit the project partners; synthesized and actively promoted to specific user groups to encourage them to take specific actions; and widely available after the end of the project. Furthermore, the *University of Madagascar*, with assistance from the *Cercle de reflexion sur l'agroécologie à Madagascar* (CRAM), a think tank on agroecology created in 2015 and consisting of many partners such as NGOs, university research centres, farmer associations, students, technical departments, etc., has established a Masters in Agroecology program in partnership with foreign universities, which will help in the context of the project to promote the exchange of experiences, knowledge and technical advice among institutional stakeholders and field operators.

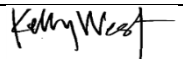
PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT(S) AND GEF AGENCY(IES)

A. RECORD OF ENDORSEMENT[18] OF GEF OPERATIONAL FOCAL POINT (S) ON BEHALF OF THE GOVERNMENT(S): (Please attach the Operational Focal Point endorsement letter(s) with this template. For SGP, use this SGP OFP endorsement letter)

NAME	POSITION	MINISTRY	DATE *(MM/dd/yyyy)*
RALALAHARISOA, Christine Edmée	General Director of Environment	MINISTRY OF ENVIRONMENT, ECOLOGY AND FORESTS	02/15/2017

B. GEF AGENCY(IES) CERTIFICATION

This request has been prepared in accordance with GEF policies[19] and procedures and meets the GEF criteria for project identification and preparation under GEF-6.

Agency Coordinator, Agency name	Signature	Date *(MM/dd/yyyy)*	Project Contact Person	Telephone	Email
Kelly West, Senior Programme Manager & Global Environment Facility Coordinator Corporate Services Division UN Environment		August 28, 2017	Adamou Bouhari, UNEP Task Manager	+225 22514626	Adamou.Bouhari@unep.org

C. ADDITIONAL GEF PROJECT AGENCY CERTIFICATION (APPLICABLE ONLY TO NEWLY ACCREDITED GEF PROJECT AGENCIES)

For newly accredited GEF Project Agencies, please download and fill up the required GEF Project Agency Certification of Ceiling Information Template to be attached as an annex to the PIF

[18] For regional and/or global projects in which participating countries are identified, OFP endorsement letters from these countries are required even though there may not be a STAR allocation associated with the project.
[19] GEF policies encompass all managed trust funds, namely: GEFTF, LDCF, SCCF and CBIT

Annex 1: Biomass gasification[20]

Gasification processes convert biomass into combustible gases that ideally contain all the energy present in the biomass. In practice, conversion efficiencies ranging from 60% to 90% are achieved. Gasification processes can be either direct (using air or oxygen to generate heat through exothermic reactions) or indirect (transferring heat to the reactor from outside). The gas can be burned to produce industrial or residential heat, to run engines for mechanical or electrical power, or to make synthetic fuels. Large-scale applications of gasifiers include comprehensive versions of the small-scale updraft and downdraft technologies, and fluidized bed technologies. The superior heat and mass transfer of fluidized beds leads to relatively uniform temperatures throughout the bed, better fuel moisture utilization, and faster rate of reaction resulting in higher throughput capabilities.

Biomass criteria for gasification:

- Direct bamboo of any variety to maintain the moisture content to less than 20%;
- The bamboo of 2-3 inch length and 1-2 inch diameter. The sizing can be done either manually or by machine;
- The chopped bamboo is then used for gasification purpose.

The requirements for the gasification units are a small proportion of the total availability. A 100 Kw gasifier would require only about 1000 ton per annum, the equivalent of a truckload every three days on the average. An added advantage of gasification of bamboo is that 15% of the biomass would also be available as a by-product in the form of high-grade charcoal. In the case of a 100 Kw gasifier around 135 ton of charcoal would be available each year to meet local needs of fuel. It is clean, cheap & renewable source of energy. One of the most important reasons why there is limited income earning opportunities in rural areas is lack of electricity or availability of quality electricity. Biomass gasification technology can not only generate power but also create employment in rural areas. This distributed power generation can cut down the limitations of centralized power generation. Biomass has got huge potential to electrify the non-electrified villages.

Benefits of bamboo biomass energy

A biomass fuel based power plant converts an existing waste stream to useful electrical energy.

- A biomass fuel based power plant uses a completely renewable fuel. The energy output displaces generation from non-renewable fossil fuels that have limited reserves and are being rapidly depleted.
- A biomass fuel based power plant provides a completely domestic energy supply, reducing the dependence on foreign oil;
- A biomass fuel based power plant utilizes a local fuel source, resulting in a boost to the local economy.
- A biomass fuel based power plant is completely dispatch able, i.e. output can be varied and matched with customer demand. Unlike other sources of renewable energy that are instantaneously dependent on natural forces.
- A biomass fuel based power plant diverts material from landfills, prolonging the life of these landfills.
- A biomass fuel based power plant has extremely low air emissions
- Sulphur dioxide emissions are insignificant since there is virtually no sulphur in wood. Due to the moisture content, biomass combust at a cooler temperature than fossil fuels resulting in inherently lower nitrous oxide emissions. Although all combustion processes release carbon dioxide, biomass combustion has a neutral "carbon balance", since trees convert carbon dioxide to oxygen. In addition, decomposing wood emits carbon dioxide, as well as methane – a greenhouse gas 22 times worse than carbon dioxide.
- A biomass fuel based power plant can recycle the fly ash produced. It is for example recycled as an agricultural liming agent.

Recommendations[21]:

Financing: During the study, it is observed that the funding for biomass power projects is mainly through self-funding and grants (from different funding agencies). Very few commercial banks had shown interest in funding these projects. While interacting with various stakeholders, it was revealed that financing institutions, such as banks, consider biomass as the best resource for power generation in comparison to other renewable sources. However, they have been concerned about the availability of adequate biomass, pricing of biomass, gaps at the policy level, etc. As the Government of India is looking for megawatt-scale biomass power generation through entrepreneurs, a robust biomass policy is a must regarding financing of bigger projects.

[20] Citation from Eco-Energy Solutions, Project Report on "Cultivation of Bamboo and its bioenergy production", http://ecoenergysolutions.co.in/pdf/Bio_Energy_Bamboo_project_EES.pdf

[21] UNDP, 2013. Study of Available Business Models of Biomass Gasification Power Projects under the project *"Removal of Barriers to Biomass Power Generation in India"* New Delhi: United Nations Development Programme, 46 pp.

Biomass supply: Biomass supply is the most critical component of biomass power projects as all other components ranging from financing to technology to tariff are the function of it.

Financial institutions consider biomass as a potential resource for power generation, but still they are not very enthusiastic about these projects. This is because of uncertainty in biomass supply, its pricing and logistics. The recommendations are:

- Technology of biomass gasifiers has to be improved/changed so that biomass of varying nature can be used. Briquetting or pellet technology can play a pivotal role provided the cost of final fuel for gasifier remains competitive.
- Second most critical challenge is consistent biomass availability. For sustainable operation of the biomass-based power plant, both for short and long term basis, the following biomass supply arrangement can be made:
    - Collection from nearby areas: Collection of biomass with the help of local people (villagers) from the nearby areas (forests waste / agriculture waste) for meeting the requirement of the power plant on commercial basis.
    - Agreements with state forest department will also ensure the biomass supply either from depot, forest (weeds) or through providing forest wastelands for energy plantation.
    - Agreements with village authorities for allocating village waste lands for energy plantation.
    - Government should make efforts to develop a strong policy for biomass trading in line with the agro product policy for announcing minimum support price. This brings the focus on providing better market linkages based on product cluster formation and effective strengthening of the credit and marketing links for financial security of the developer and entrepreneur.
    - Capacity building programmes on biomass supply chain mainly focusing towards backward integration, for local people (especially youths) can also be a useful in ensuring biomass supply throughout the year.

Peripheral services:

- During the study, it is observed that the entrepreneurs have also provided additional services to enhance the livelihood opportunities for the local people.
- While developing the business model of power generation through biomass gasification (especially in case of grid power projects), it is recommended that an integrated business model should be conceptualised for such projects. This should include livelihood opportunities identification, training for the local people, and also to facilitate the interested local people for accessing financing facilities.
- This model will ensure self-sustainability of the plant operations for the long term; will create spin-off benefits in the area in terms of enhanced working hours, increased incomes, improved lifestyle, better paying capacities, etc.

Annex 2: Carbon Calculations

Component 2:

3,500 ha of High Conservation Value Forests identified and conserved through active management as a result of Conservation Agreements with Local Communities avoided GHG emissions of 60,494 tCo2-eq over a 10-year period

Identifying the HCVFs and active management of the forests through Conservation Agreements will change regime from degradation and conversion to agricultural land and degraded land to one of conservation and sustainable utilization of biomass and this will halt the deforestation in these areas. Madagascar has an annual deforestation rate of 0.43%. Assuming that by year 3 of the project the conservation agreements have been entered into and deforestation is being addressed, over a 10 year period (but calculated as 7 years due to start of addressing deforestation at year 3), 74 ha of deforestation will have been prevented. For Harvested Wood Products (HWP), the above-ground biomass for Subtropical Mountain Forests is provided in Table 4.7 of IPCC 2006 Volume 4 (http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_04_Ch4_Forest_Land.pdf) as 50 tonnes dry matter/ha. The HWP was therefore estimated as 1.5 tonnes dry matter / ha based on the guidance stating that "The resulting HWP fractions (of total biomass) were 10% for the developed world and 3% for the developing world" (in Searle, S and Malins, C. 2011. Estimates of carbon storage in wood products following land clearing; ICCT http://www.theicct.org/sites/default/files/publications/ICCT_carbon_storage_in_wood_products_August_2011.pdf, in which Madagascar falls within the developing world). The GHG emissions reductions for preventing forest clearing are calculated at *60,494* tCO2eq over a 10-year period.

Output 2.2 states "At least 500 ha of degraded land adjacent or within identified High Conservation Value Forests restored using bamboo as pioneer species", therefore:

500 ha of degraded land reforested, ensuring sequestration of 65,283 tCO2eq over a 10-year period

See FAO EX-ACT Calculations below.

Component 3:

Improved Cook Stoves:

Assumptions:

1. All families supported with improved cook stove use three-stone fire (TSF) as stove and the biomass used is wood.
2. Daily consumption of 5-8 kg of wood (in line with developing world averages, especially in Africa)
3. According to Wilson et al. 2016[22] (see below table at a 55:45 per cent ratio between non-renewable biomass and renewable biomass), the carbon emissions from three-stone fire over the course of five years is 13,517 kg CO_2-e, and that of an Improved Cook Stove (Berkeley-Darfur stove – BDS) is 21,100 kg CO_2-e.

Table 4
Comparison of emissions between the Berkeley–Darfur stove and a traditional three-stone fire over the course of its five-year lifetime.

Category	TSF		BDS	
	Emissions (kg CO_2-e)	± Estimated error	Emissions (kg CO_2-e)	± Estimated error
Materials	0	0	14.6	1.4
Manufacturing	0	0	0.23	0.07
Transportation	0	0	2.2	0.44
Use (NRB:RB=55:45)	21,100	3700	13,500	2800
End of life	0	0	0	0

4. So for every unit of Improved Cook Stove, 7,583 kg CO_2-e is not emitted.
5. For 3,000 units, this equals 22,749,000 kg CO_2-e emission reduction

Biomass Gasification Generator:

Every gallon of diesel contains 2,778 grams of pure carbon. Every grain of atomic carbon, when oxidised with oxygen forms 3.666 grams of carbon dioxide. In an average liquid hydrocarbon-burning engine, it can be assumed that about 99% of the fuel will oxidize (it is assumed that somewhat less than 1% will fail to fully oxidize, and will be emitted as particulates or unburned hydrocarbons instead of CO_2).

Therefore, we can multiply the amount of carbon per gallon of diesel by the ratio of carbon weight to CO_2 weight by 99%:
2.778g x 3.66 x 0.99 = 10,084 g

Each gallon of diesel fuel produces, on average, 10,084 g of CO_2.

75 kW Diesel Generator at ¾ load fuel consumption = 4.6 gallon/hr[23]

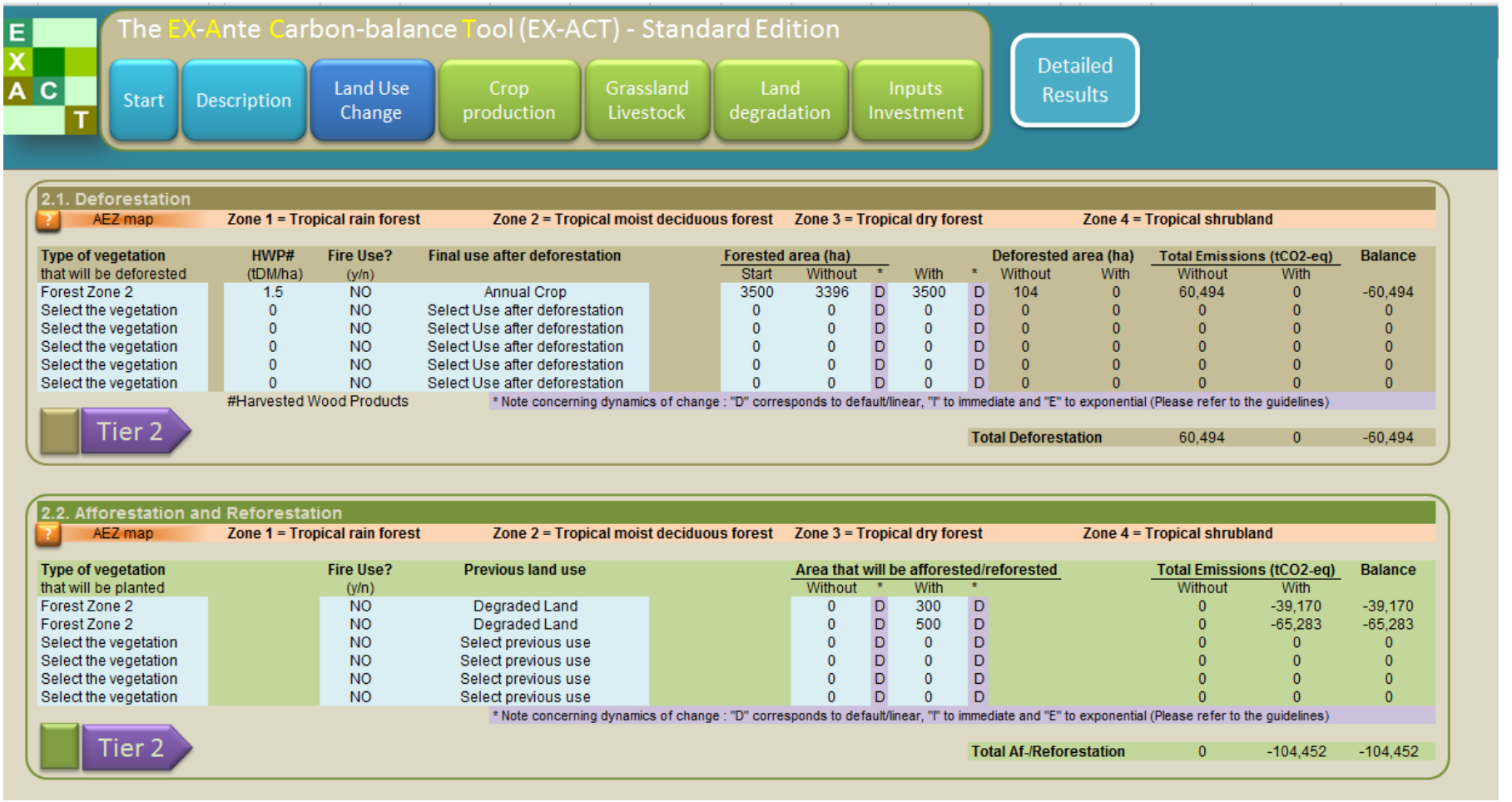
Bamboo Biomass Gasification Generator lifespan is considered 15 years – and it is assumed that all biomass used will be renewable, will have neutral carbon emission.

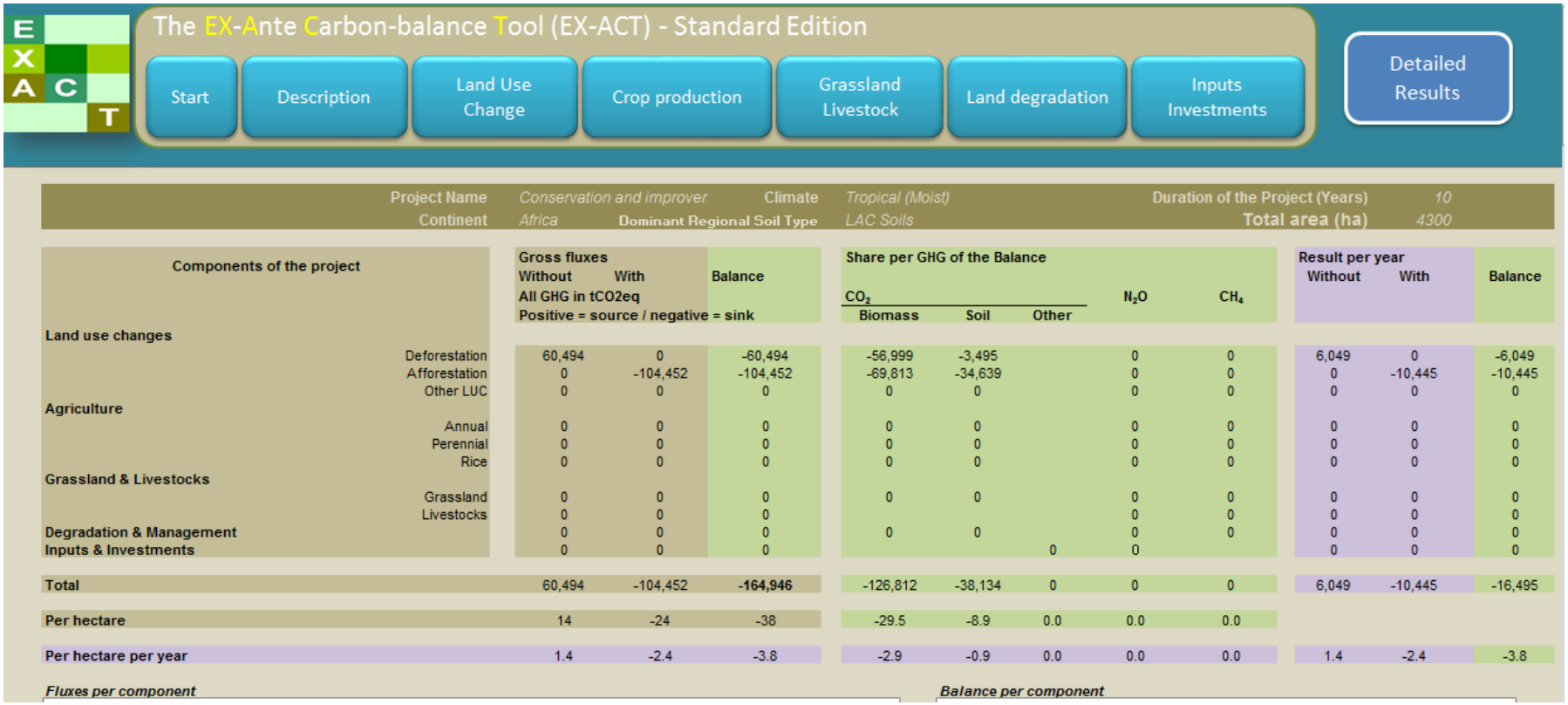
The carbon avoided from emission is therefore the emissions of the diesel generator over the same period – it is estimated that the generator will run at least 6 hours a day for at least 300 days a year over the 15-year period – resulting in 1,252,433 kg CO_2-e emission reduction.

300 ha of degraded land revegetated, ensuring sequestration of 39,170 tCO2eq over a 10-year period

39,170 tCO2eq over a 10-year period

[22] Wilson, D.L., Talancon, D.R., Winslow, K.L., Linares, X and Gadgil, A.J. 2016. *Avoided emissions of a fuel-efficient biomass cookstove dwarf embodied emissions.* Development Engineering 1 (2016) 45 – 52.
[23] www.dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx


The EX-Ante Carbon-balance Tool (EX-ACT) - Standard Edition
Start
Description
Land Use Change
Crop production
Grassland Livestock
Land degradation
Inputs Investment
Detailed Results
2.1. Deforestation
AEZ map
Zone 1 = Tropical rain forest
Zone 2 = Tropical moist deciduous forest
Zone 3 = Tropical dry forest
Zone 4 = Tropical shrubland
Type of vegetation that will be deforested
HWP# (tDM/ha)
Fire Use? (y/n)
Final use after deforestation
Forested area (ha)
Start
Without
*
With
*
Deforested area (ha)
Without
With
Total Emissions (tCO2-eq)
Without
With
Balance
Forest Zone 2 1.5 NO Annual Crop 3500 3396 D 3500 D 104 0 60,494 0 -60,494
Select the vegetation 0 NO Select Use after deforestation 0 0 D 0 D 0 0 0 0 0
Select the vegetation 0 NO Select Use after deforestation 0 0 D 0 D 0 0 0 0 0
Select the vegetation 0 NO Select Use after deforestation 0 0 D 0 D 0 0 0 0 0
Select the vegetation 0 NO Select Use after deforestation 0 0 D 0 D 0 0 0 0 0
Select the vegetation 0 NO Select Use after deforestation 0 0 D 0 D 0 0 0 0 0
#Harvested Wood Products
* Note concerning dynamics of change : "D" corresponds to default/linear, "I" to immediate and "E" to exponential (Please refer to the guidelines)
Tier 2
Total Deforestation 60,494 0 -60,494
2.2. Afforestation and Reforestation
AEZ map
Zone 1 = Tropical rain forest
Zone 2 = Tropical moist deciduous forest
Zone 3 = Tropical dry forest
Zone 4 = Tropical shrubland
Type of vegetation that will be planted
Fire Use? (y/n)
Previous land use
Area that will be afforested/reforested
Without
*
With
*
Total Emissions (tCO2-eq)
Without
With
Balance
Forest Zone 2 NO Degraded Land 0 D 300 D 0 -39,170 -39,170
Forest Zone 2 NO Degraded Land 0 D 500 D 0 -65,283 -65,283
Select the vegetation NO Select previous use 0 D 0 D 0 0 0
Select the vegetation NO Select previous use 0 D 0 D 0 0 0
Select the vegetation NO Select previous use 0 D 0 D 0 0 0
Select the vegetation NO Select previous use 0 D 0 D 0 0 0
* Note concerning dynamics of change : "D" corresponds to default/linear, "I" to immediate and "E" to exponential (Please refer to the guidelines)
Tier 2
Total Af-/Reforestation 0 -104,452 -104,452


The EX-Ante Carbon-balance Tool (EX-ACT) - Standard Edition
Start
Description
Land Use Change
Crop production
Grassland Livestock
Land degradation
Inputs Investments
Detailed Results
Project Name
Conservation and improver
Climate
Tropical (Moist)
Duration of the Project (Years)
10
Continent
Africa
Dominant Regional Soil Type
LAC Soils
Total area (ha)
4300
Components of the project
Gross fluxes
Without
With
Balance
All GHG in tCO2eq
Positive = source / negative = sink
Share per GHG of the Balance
CO2
Biomass
Soil
Other
N2O
CH4
Result per year
Without
With
Balance
Land use changes
Deforestation 60,494 0 -60,494 -56,999 -3,495 0 0 6,049 0 -6,049
Afforestation 0 -104,452 -104,452 -69,813 -34,639 0 0 0 -10,445 -10,445
Other LUC 0 0 0 0 0 0 0 0 0 0
Agriculture
Annual 0 0 0 0 0 0 0 0 0 0
Perennial 0 0 0 0 0 0 0 0 0 0
Rice 0 0 0 0 0 0 0 0 0 0
Grassland & Livestocks
Grassland 0 0 0 0 0 0 0 0 0 0
Livestocks 0 0 0 0 0 0 0 0 0 0
Degradation & Management 0 0 0 0 0 0 0 0 0 0
Inputs & Investments 0 0 0 0 0 0 0 0 0 0
Total 60,494 -104,452 -164,946 -126,812 -38,134 0 0 0 6,049 -10,445 -16,495
Per hectare 14 -24 -38 -29.5 -8.9 0.0 0.0 0.0
Per hectare per year 1.4 -2.4 -3.8 -2.9 -0.9 0.0 0.0 0.0 1.4 -2.4 -3.8
Fluxes per component
Balance per component

Annex 3: Initial Cost-Effective Assessment of Renewable Energy Options in the Atsinanana Region

Criteria	Solar Energy	Solar Cookstove	Wind Energy	Hydropower	Improved Cook Stoves	Biomass Gasification
Cost-efficiency	Advantages: Low maintenance requirement, solar cells are solid-state electronic devices with no moving parts. Solar power energy systems have the advantage of being able to operate with minimal cost. Disadvantages: High initial cost, Limited power supply: a conventional silicon-based solar cell does not generate a lot of power. A solar array is often required to capture sufficient energy in order to power up the load. Energy storage devices are almost certainly necessary. Costly energy storage devices along with charge regulating systems have to be attached along with the solar panel in nighttime usage is required. In rural area, where lightning solution is highly desired.	Advantages: Low initial investment, maintenance cost low.	Advantages: Cost effective in good location. Wind turbine systems use electrical induction to generate electricity, which has a potential of generating multiple times more power than what can be generated by a solar energy system of the same price. Can expect power output throughout the day. Unlike a solar energy system, which only generates power during daytime, wind power works throughout the day cycle as long as there are sufficient winds blowing in the area. Disadvantages: High maintenance requirement. Wind turbine systems consist of many mechanical parts. Systems that employ generators may reduce maintenance needs, but the fact that constant maintenance is required for maintaining the system remains unchanged. Unavailability of parts	Advantages: Cost effective in good location. Hydropower, like wind turbine systems, uses electrical induction to generate electricity, which has the potential to generate multiple times more power that that generated by solar energy of the same price. Power output is often predictable. Unlike solar energy, which only generates power when light is present, hydropower works throughout the day as long as there is sufficient water movement through the turbine. Since the volume of water flow tends to be periodic, it is possible to estimate future output to a reasonable degree of precision. Disadvantages: High maintenance requirement. The half-submerged design can reduce maintenance procedures and cost. However, since underwater and	Advantages: Low initial investment, maintenance cost low. Locally based manufacturing (cost efficient on labor and materials). Raw materials (bamboo) grow rapidly.	Advantages: Uses renewable fuel – bamboo which is fast growing. A biomass fuel based power plant provides a completely domestic energy supply, reducing the dependence on foreign oil. Low maintenance costs. Disadvantages: High initial investment cost, product needs to be imported.

			to rural area. Moving parts such as gears are going to wear down at some point. In rural areas with limited logistical capabilities, getting the right parts can be a big challenge. The costs of the parts as well as the associated transportation can pose a financial challenge for the community. Energy storage system is necessary for off grid usage. Since wind resources are not constantly available, an energy storage system like a battery bank is necessary to maintain a steady power supply at times when there is no sufficient wind blowing through the area.	mechanical parts are still involved, the maintenance requirement is considerably higher than solar power.		
Environmental benefits	Advantages: since solar panel employs photovoltaic effect to generate electricity rather than burning fuel, no byproducts are generated throughout the process.	Advantages: since solar cookers employ solar energy, no byproducts are generated throughout the process.	Advantages: As wind is used as energy form, no byproducts are generated throughout the process.	Advantages: As hydro movement is used as energy form, no byproducts are generated throughout the process.	Advantages: Reduction against traditional three stone cooking methods Disadvantages: Continued release of smoke, carbon emissions	Advantages: Extremely low air emissions, Sulphur dioxide emissions are insignificant since there is virtually no Sulphur in wood. Lower nitrous oxide emissions than fossil fuels Disadvantages: Continued release of carbon

						emissions
Location	Disadvantages: Power availability depends on external conditions. Solar panels rarely produce their rated maximum power because all the external factors (mainly light irradiance, temperature, and load resistance) are not met. For example, during nighttime, no meaningful amount of electricity can be generated.	Advantages: Can be used everywhere Disadvantages: Power availability depends on external conditions. Do not work at night	Disadvantages: Limited location choice for installation. Wind turbine systems are only cost efficient when they are placed at a location with strong winds, such as an offshore or mountainous area.	Disadvantages: Narrow location choice. River and water resources might not be accessible to many rural areas. In fact, such resources are often scarce.	Advantages: Can be used everywhere.	Advantages: Can be used everywhere.
Benefits to local economy/job creation	Benefits are low as technology to manufacture solar panels not in community resulting in the importing of solar stoves. Local agents will most probably be based in larger cities.	Benefits are low as technology to manufacture solar stove not in community resulting in the importing of solar stoves Local agents will most probably be based in larger cities.	Benefits are low as technology to manufacture wind turbines not in community resulting in the importing of turbines. Local agents will most probably be based in larger cities.	Benefits are low as technology to manufacture hydropower modules not in community resulting in the importing of solar stoves. Local agents will most probably be based in larger cities.	Benefits are high, both in selling of bamboo for fuel, and in the manufacturing of the cookstoves.	Benefits are high as cooperatives can be set up that manage bamboo plantations and earn income. Generators though need to be imported.
Cultural acceptance	Cannot foresee issue, but uptake in rural area might be an issue.	Cooking during daytime hours might require a cultural change, which can take a number of years and might lead to normal woodfuel to be used during nighttime.	Cannot foresee issue, but uptake in rural area might be an issue.	Can foresee now issue, but uptake in rural area might be an issue.	Acceptance high as it is only modifying/ improving existing practice	Cannot foresee issue, but uptake in rural area might be an issue.
Ability to	Low, due to initial	Medium	Medium, due to initial	Medium, due to initial	High, especially if	Medium, due to

upscale	investment and the fact that it mostly financed by individuals, not cooperatives due to low power delivery		investment, but can be financed through cooperatives	investment, but can be financed through cooperatives	the economic benefits of manufacturing cookstoves are realized.	initial investment, but can be financed through cooperatives
Linkage to project's objective	Poor linkage as PV systems do not provide sufficient power to cook food – the deforestation is driven by the sourcing of woodfuel for cooking.	Strong linkage to project as addressing the need for woodfuel for cooking	Poor linkage as wind energy systems do not provide sufficient power to cook food – the deforestation is driven by the sourcing of woodfuel for cooking	Stronger linkage to project as can produce sufficient energy for cooking	Strong linkage to project as addressing the need for woodfuel for cooking	Strong linkage to project as addressing the need for woodfuel for cooking

Scoring:

Red marking: 0 points

Orange marking: 1 point

Green marking: 2 points

Scores:

Solar Energy: 3 points

Solar Cookstove: 6 points

Wind Energy: 5 points

Hydropower: 6 points

Improved Cook Stoves: 13 points

Gasification Generators: 9 points

Conclusion: Based on the initial assessment and the selected criteria, the Improved Cook Stoves and the Gasification Generators appear the most cost-effective options.