GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

Naoko Ishii
CEO and Chairperson

June 14, 2016

Dear Council Member:

UNDP as the Implementing Agency for the project entitled: ***Benin: Promotion of Sustainable Biomass-based Electricity Generation in Benin***, has submitted the attached proposed project document for CEO endorsement prior to final approval of the project document in accordance with UNDP procedures.

The Secretariat has reviewed the project document. It is consistent with the proposal approved by Council in May 2014 and the proposed project remains consistent with the Instrument and GEF policies and procedures. The attached explanation prepared by UNDP satisfactorily details how Council's comments and those of the STAP have been addressed. I am, therefore, endorsing the project document.

We have today posted the proposed project document on the GEF website at www.TheGEF.org. If you do not have access to the Web, you may request the local field office of UNDP or the World Bank to download the document for you. Alternatively, you may request a copy of the document from the Secretariat. If you make such a request, please confirm for us your current mailing address.

Sincerely,

Naoko Ishii
Chief Executive Officer and Chairperson

Attachment: GEFSEC Project Review Document
Copy to: Country Operational Focal Point, GEF Agencies, STAP, Trustee

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REQUEST FOR CEO ENDORSEMENT

PROJECT TYPE: FULL-SIZED PROJECT

TYPE OF TRUST FUND: THE GEF TRUST FUND

PART I: PROJECT INFORMATION

Project Title: Promotion of sustainable biomass based electricity generation in Benin			
Country:	Benin	GEF Project ID:	5752
GEF Agency:	UNDP	GEF Agency Project ID:	5115
Other Executing Partner(s):	Ministry of Energy and Water; Ministry of Environment; Ministry of Agriculture, Société Béninoise d'Energie Electrique (SBEE); Communes of Kalalé, Djougou, Savalou, and Dassa.	Submission Date: Resubmission Date: Resubmission Date:	6 November 2015 10 February 2016 4 May 2016
GEF Focal Area(s)	Multifocal Area	Project Duration (Months)	60 months
Name of Parent Program (if applicable): • For SFM/REDD		Project Agency Fee ($):	367,897

A. INDICATIVE FOCAL AREA STATEGY FRAMEWORK

Focal Area Objectives	Trust Fund	Indicative Grant Amount ($)	Indicative Co-financing ($)
CCM-3: Renewable Energy: Promote investment in renewable energy technologies	GEF TF	1,959,132	12,750,000
LD-3: Reduce pressures on natural resources from competing land uses in the wider landscape	GEF TF	1,000,228	7,000,000
SFM-1: Reduce pressures on forest resources and generate sustainable flows of forest ecosystem services	GEF TF	913,242	6,000,000
Total Project Cost		3,872,602	25,750,000

B. INDICATIVE PROJECT FRAMEWORK.

Project Objective: To introduce an integrated energy and ecosystems-based approach to sustainable biomass electricity generation in Benin.						
Project Component	**Grant Type[1]**	**Expected Outcomes**	**Expected Outputs**	**Trust Fund**	**Indicative Grant Amount ($)**	**Indicative Co-financing ($)**
1. Policy, institutional, legal and regulatory framework for biomass electricity generation established.	TA	Streamlined and comprehensive market-oriented energy policy and legal/regulatory framework for biomass electricity generation by Independent Power Producers (IPPs).	1.1 Appropriate policy and legal/regulatory framework established and operational for *(a) Biomass electricity generation.* *(b) Establishment and implementation of a mechanism for re-investment of partial energy proceeds into community lands conservation.* 1.2 Technical report on grid capacity requirements to enable feed-in for grid-connected renewable energy systems followed by development of an updated grid code; as well provision for isolated mini-grid options. 1.3 Established procedures and standardized PPAs for the introduction of a transparent procurement process in the selection/award of biomass-based electricity supply agreements by private developers/IPPs. 1.4 One-stop shop for issuance of construction licenses and permits to private RE developers. 1.5 Methodology developed for a joint environmental, economic and financial evaluation of biomass plants in line with government regulations and policies. 1.6 Capacity developed within SBEE, local banks and key national actors such as Ministries of Energy, Agriculture and Finance to appraise renewable biomass[2] projects for PPAs and lending.	GEF	$270,000 (CCM) Total= **$270,000**	2,500,000

[1] TA includes capacity building, and research and development.

[2] Renewable Biomass is here referred as biomass originating from agricultural and forestry residues, which is the focus of this project. Renewable biomass from forestry plantations and non-renewable biomass, obtained from tree cutting and active deforestation, are not the subject of consideration under this project.

2) Promotion of investment in biomass-based electricity generation through appropriate catalytic financial incentives available for project investors.	TA & INV	Increased investment in clean energy technologies and low-carbon practices in the agro-forestry waste sector.	2.1 Financial Support Mechanism (Renewable Energy Guarantee Scheme) established and capitalized to support private investment in biomass plants. 2.2 MOU signed with the Central Bank setting out the objective, funding mechanism, administration rules and confirmation of their participation as fiduciary agent of the Financial Support Mechanism (FSM). 2.3 Financial and other incentives to be provided to project developers/Independent Power Producers (IPPs). 2.4 Documents supporting financial closure (Power Purchase Agreements, where applicable) with identified investors. 2.5 Reports confirming completion of construction of at least 4 MW of on-/off-grid biomass-based electric plants by IPPs at various sites by end of project.	GEF	200,000 (TA) 1,500,000 (INV) Total= **$1,700,000** (CCM)	12,000,000
3) Sustainable land use and forest management and implementation at the commune level.	TA & INV	Integrated land use, sustainable forest management and natural resource management over 14,000 ha provide social benefits and sustain biomass for electricity production.	3.1 Integrated Land Uses Management Plans (ILUMPs) are adopted in the four communes and strengthened the local institutional framework. 3.2 Fire management practices are operational over 3,000 ha in the Classified Forests in the neighbour of the biomass plants. 3.3 Woodlots are established over 2,000 ha in order to provide sustainable biomass and incomes. 3.4 New methods and techniques of agro-ecology (conservation farming practices) are implemented over 9,000 ha and reduce lands degradation and increase lands productivity (agricultural harvests and residues).	GEF	500,000 (TA) + 370,000 (INV) = $870,000 (LD) 500,000 (TA) + 300,000 (INV) = $800,000 (SFM) Total= **$1,670,000**	10,000,000
4) Outreach and results dissemination programme aimed at sustaining a growing market for	TA	Outreach programme and dissemination of project experience/best practices/lesso ns learned for replication	4.1 National Plan to implement outreach/promotional activities targeting domestic (and international) investors. 4.2 Capacity development of concerned Ministries / Institutions to monitor and document project experience.		15,000 (CCM) 30,000 (LD) 15,000	500,000

biomass gasifiers.		throughout the region.	4.3 Published materials (including video) and informational meetings with stakeholders on project experience/best practices and lessons learned.		(SFM) Total= **$60,000**	
Subtotal					3,700,000	25,000,000
Project Management Cost (PMC)[3]				GEF	172,602	750,000
Total Project Cost					3,872,602	25,750,000

C. SOURCES OF CONFIRMED CO-FINANCING FOR THE PROJECT BY NAME ($)
Please include letters confirming co-financing for the project with this form.

Sources of Co-financing	Name of Co-financer	Type of Co-financing	Amount ($)
National Government	MERPMEDER through PAPDFGC (EU funded project)	In kind	**1,000,000**
		Cash	**3,500,000**
National Government	MERPMEDER through PAGEFCOM (AfDB funded project)	In kind	**1,000,000**
		Cash	**4,000,000**
National Government	ANADER	In kind	**250,000**
		Cash	**500,000**
National Power Utility	CEB (Electricity Community of Benin)	Equity	**15,000,000**
GEF Agency	UNDP	Grant/Cash	**500,000**
Total Co-financing			**25,750,000**

D. Trust Fund Resources Requested by Agency, Focal Area and Country

GEF Agency	Type of Trust Fund	Focal Area	Country Name/Global	Grant Amount ($) (a)	Agency Fee ($) (b)[2]	Total ($) c=a+b
UNDP	GEF TF	Climate Change*	Benin	1,959,132	186,117	2,145,249
UNDP	GEF TF	Land Degradation	Benin	1,000,228	95,022	1,095,250
UNDP	GEF TF	SFM	Benin	913,242	86,758	1,000,000
Total Grant Resources				3,872,602	367,897	4,240,499

E. DOES THE PROJECT INCLUDE A "NON-GRANT" INSTRUMENT? yes ☐ no ☒

PART II: PROJECT JUSTIFICATION:

A: DESCRIBE ANY CHANGES IN ALIGNMENT WITH THE PROJECT DESIGN OF THE ORIGINAL PIF

1. As formulated, the PIF did not include a Component related to outreach and dissemination of project experience/lessons learned for in-country replication, as well as in and outside the region. The PPG launch

[3] To be calculated as percent of subtotal.

workshop held in Benin in September 2014 recommended that is was necessary to include it; hence, the RCE has now included a new component which is labelled Component No. 4: Outreach and results dissemination programme aimed at sustaining a growing market for biomass gasifiers. This outcome is especially relevant as it will make information on best practices/lessons learned available both in-country and to several countries within and outside the region - those that have substantial unutilised agricultural residues that could be utilised in gasifiers to provide their rural population with access to modern energy services.

2. The PIF envisaged 4 Components, with Component 2 dealing with the promotion of investment in biomass-based electricity generation through the provision of catalytic incentives and Component 3 supporting the establishment of a 1 MW biomass plant for electricity generation. During implementation of the PPG, the view was expressed that it would be rational and appropriate to have incentives go hand in hand with actual investment. Hence, these two Components were combined into one, as Component 2, to deal with both investment promotion and establishment of not one 1 MW plant but 4 biomass gasifier plants with a total capacity of 4 MW.

3. The proposed Renewable Energy Guarantee Scheme (REGS) in the PIF has been re-named "Financial Support Mechanism" (FSM) as it makes it clearer that its objective is to support investment in agricultural biomass gasifiers for electricity generation in cases when private investors supply biomass gasifier-generated electricity to the SBEE main grid or one of its isolated mini-grids. Should SBEE default on its payment to the developers, the FSM kicks in as a "risk minimisation fund" to compensate them for electricity already supplied.

4. In addition, Article 25 of the Electricity Law 2006-16 of 27 March 2007 allows the private sector to build its own isolated mini-grid and supply electricity that it produces to consumers, thus operating as a small utility without having to resort to selling electricity to SBEE. In such cases, the project will consider supporting private investors in sharing the costs for the preparation of feasibility studies and business plans and, eventually, providing an upfront investment grant, with a view to jumpstarting the market, for construction of the generating plant and distribution system. In this particular case, regular project funds will be utilised and will constitute grant funds designed to reduce the developers' transaction costs and make it easier for them to access debt financing from lending institutions.

5. The PIF envisaged development of a standardised baseline for renewable energy-based electricity generation, leading to reduced carbon finance transaction costs under the Voluntary Carbon Market mechanism. When the PIF was formulated a year ago, the carbon market was doing pretty well, enabling developing countries to capitalise on additional financial resources to advance their development agenda. However, the carbon market has since then almost "crashed", given the lack of demand for both voluntary and certified emission reduction units. Therefore, it does not make much economic and financial sense to focus on this issue at the present time. If, however, the carbon market happens to recover during implementation of the project, this issue will be re-visited under UNDP's adaptive management procedures and all efforts will be made to tap into it in order to access additional resources that the Government could use to expand development activities in the biomass gasification sector.

6. The PIF proposed to implement SLFM activities only for the Borgou Department (Commune of Kalalé). During the PPG, the target communes were expanded to include Djougou, Savalou and Dassa (see Prodoc for a detailed description). During the participatory process of the prioritization exercise, the government and the other stakeholders expressed the need to implement SLFM activities on the ground also for the 3 others pilot sites identified. Activities of the component 3 (SLFM) are now oriented for results on the ground to reach 9,000 ha of land under sustainable agriculture practices and 3,000 ha of forest sustainably managed in the 4 pilot sites selected. Reforestation activities have been reinforced to reach 2,000 ha. Hence, the project targets now a total of 14,000 ha of SLFM.

A.1 NATIONAL STRATEGIES AND PLANS:

1. Situation Analysis

With an area of 114,763 km^2 and a population of almost 10 million inhabitants (May 2013), the Republic of Benin (Capital: Porto-Novo) is a located in West Africa bordering Togo to the west, Nigeria to the east and Burkina Faso

and Niger to the north, where the Niger River, one of the largest in Africa, forms a 120-kilometre-long border between the two countries. Agriculture employs 70% of the active population and its contribution to the GDP amounts to 32% (World Bank, 2012) – per capita GDP was $ 872 (2014 estimate, IMF). A majority of the population live on its southern 125-km wide equatorial coastline on the Bight of Benin, which forms part of the Gulf of Guinea in the northernmost tropical portion of the Atlantic Ocean. The population is estimated at being 70% rural and 30% urban, with more than half being concentrated in the south. Although the coastline measures only 121 km, the country extends a distance of 650 km from the Niger River in the north to its southern coastline and is about 325 km at its widest point. The country is divided into twelve departments which, in turn, are subdivided into 77 communes.

Very little of the country's subsistence agriculture is mechanized and irrigation is only slightly developed. The industrial sector as a whole remains under-developed, contributing only to about 13% of GDP in 2013, mainly with textile and cement industries. GDP per capita was estimated as $ 756 per person in 2012 (Source: World Bank). Projections show that Benin will continue to be dependent on subsistence agriculture, cotton production, (they both produce a huge amount of "renewable biomass" in terms of agricultural or crop residues that can be utilised for energy purposes) and small-scale regional trade.

For a more detailed description of the "Situation Analysis", including "Stakeholder Analysis and Institutional Framework" and "National Strategies and Plans", please refer to the UNDP Prodoc, pages 5 -17.

A.2 GEF FOCAL AREA AND/OR FUND(S) STRATEGIES, ELIGIBILITY CRITERIA AND PRIORITIES:

This project has been designed with the express intention of responding to GEF's overall strategic vision under GEF-5 of helping countries meet their sustainable development needs and achieve multiple environmental benefits through an integrated approach.

For a detailed description, please refer to the UNDP Prodoc, Section 2 "Project rationale and policy conformity", page 38 and "Country ownership: country eligibility and country drivenness", pages 43.

A.3 THE GEF AGENCY'S COMPARATIVE ADVANTAGE:

The proposed project is clearly within the comparative advantages of UNDP as stated in the GEF Council Paper C.31.5 "Comparative Advantages of GEF Agencies".

For a detailed description, please refer to "Section B.3: The GEF's Agency comparative advantage for implementing this project" of the PIF, page 23.

A.4 THE BASELINE PROJECT AND THE PROBLEM THAT IT SEEKS TO ADDRESS:

Some 75% of the population of Benin presently do not have access to electricity services; as an example, in 2008, only 27.1% of households in the country had access to electricity against a target of 33.7% established under the Millennium Development Goals. Over the next ten years, the grid in Benin will likely expand and more of the population will have access to electricity, albeit with frequent power cuts. Still, the national target for rural electrification of 36% by 2015 and 65% by 2025 is unlikely to be met - in 2008, the actual figure was 2.5% against a target of 6.6%. And where rural electrification is being undertaken, it is through expansion of the national grid or construction of diesel-based isolated mini-grids, rather than focus on renewable energy for electricity generation. At the present time, the share of renewable energy in the country's electricity generation mix is less than 5%, consisting mainly of a small amount of hydropower and some small industrial units generating their own electricity from the burning of biomass residues such as cotton and palm husks. In the near term, the future development of renewable energy in Benin for grid-connected solutions appears quite bleak for the simple reason that the Government has other

more pressing priorities with the limited resources it has at its disposal; hence, its willingness to create opportunities for the private sector in electricity generation.

The northern part of the country has an abundance of agricultural biomass that is left unutilised after the crops have been harvested. To utilise these "waste" biomass resources, UEMOA commissioned a feasibility study in 2008 for the installation of a gasifier to operate either a 250 kVA or a 400 kVA generator to supply a mini-grid in Bouka in the department of Kalalé in the north-eastern part of the country. For the 250 kVA case, the installation cost was computed at $ 3,600/kVA, while it was going to be $ 3,250/kVA for the 400 kVA case. With a 15-year gasifier life, operation during 7,000 hours/year (a Capacity Utilisation Factor (CUF) of 80%) and a payback period of 10 years, the sale price of electricity to the SBEE grid was computed to be US Cents 20.3/kWh. For comparison purposes, the average SBEE generation cost for diesel-based isolated mini-grids is 40 US Cents/kWh, to which should be added the cost of transmission and/or distribution, as appropriate.

For a detailed description of the baseline project and the problem that it seeks to address, please refer to the UNDP Prodoc, Sections 1.4 "Baseline Situation and Problem to be addressed" to Section 1.6 "Barriers to gasification technology for electricity generation in Benin", pages 17 – 34.

The Economics of utilising Gasifiers for Rural Electrification

At the present time, the biomass market in Benin is essentially dominated by non-renewable biomass, where active deforestation takes place as a result of charcoal production and direct fuelwood utilisation for cooking. Farmers barely take advantage of their crop residues which abound in quantity, mostly leaving them unused in the fields. However, as it is scattered randomly with low energy density, it is difficult to deal with centrally on a large scale. Hence, small-scale gasification-based power generation is an attractive resource for meeting the need for electricity services in rural areas, as demonstrated in Brazil, Burundi, China, India, Indonesia, Philippines, etc. In addition, it can address poverty issues in the rural areas through the creation of income-generating activities related to fuel collection, transport, commercialisation to the gasifier units and the eventual productive use of the electricity generated.

For a more detailed description of the "The Economics of utilising Gasifiers for Rural Electrification", please refer to UNDP Prodoc Section 1.7, pages 34 – 35.

Financial Support Mechanism (FSM)

Investment in renewable energy projects often requires to be supported with financial incentives, at least initially, because such projects are not only typically more investment-intensive in terms of upfront costs, but that they are also, in some cases, considered to be riskier investments due to technology or resource uncertainties. The degree to which cost and risk factors apply varies according to technology and geographical location and project developers expect some form of financial support/risk-sharing to compensate them for taking on additional financial risks due to unfamiliarity with the technology being proposed. In the case of Benin, the upfront investment cost related to a new technology (biomass gasification) for electricity generation can prove to be a major barrier faced by private investors in their efforts to secure credit funding from lending institutions. The second major barrier is the setting of an appropriate tariff, allowing financial viability of the system, but also taking into account the capacity to pay in rural areas. Hence, in order to assist in jump-starting the market and making the business of electricity generation through agricultural biomass-fired gasifiers attractive to private investors, the project considered the options of either a Loan Guarantee Fund (LGF) or a direct Financial Support Mechanism (FSM).

For a more detailed description of the "Financial Support Mechanism", please refer to UNDP Prodoc, Section 2 "Strategy", pages 38 – 43.

Project Components

The Ministry of Energy is the central body responsible for, among others, the design, formulation, and implementation of the Government's policy regarding development, supply and utilisation of energy at the national level. As such, it is entrusted with the responsibility of putting in place policy, plans and programmes that govern the promotion and rational utilisation of energy resources, development of renewable sources of energy and to participate in the

promotion of energy sources respectful of the environment. To achieve this, it relies on its Directorate for Energy and can count on the support of other Government Ministries and Department, including the Ministry of the Environment.

This project aims to pioneer a functioning and effective market for the widespread use and commercialisation of agricultural biomass gasifiers in Benin via four interrelated components: 1) development of an appropriate policy, institutional, legal and regulatory framework; 2) a business-friendly climate providing crucial catalytic incentives to promote investment in biomass-based electricity generation; 3) sustainable land and forest management at the commune level; and 4) increased capacity/awareness of stakeholders and private sector investors to adopt agricultural biomass gasification for electricity generation to capitalise on the economic and environmental benefits that it provides. It will focus on agricultural biomass-based gasification technology development and utilisation to substitute for forestry-based biomass and imported fuel used by the majority of Beninese households for domestic or business use. This is proposed to be achieved through the participation of the private sector at both electricity generation level and, in some cases, at the electricity distribution and sale level, as well. This programme will not only benefit household consumers and businesses, but will also connect financial institutions, technical training and local/women organisations to promote the establishment of an agricultural residue supply chain (Fig. 4) to develop the biomass gasification market.

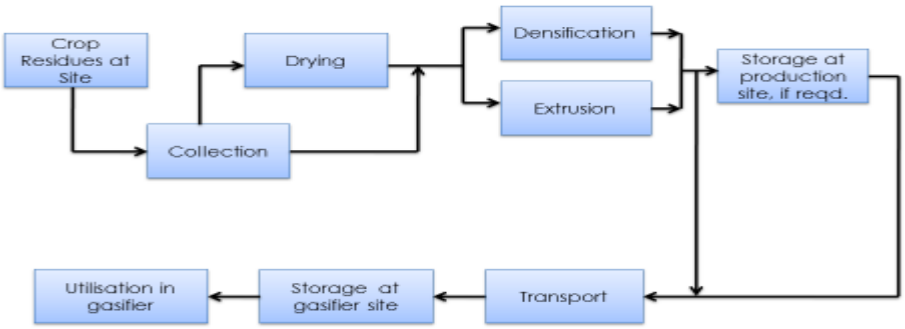


Fig. 4: Crop Residue to Gasifier Biomass Supply Chain

Source: World Bank, 2009.

For a more detailed description of "Project Components", please refer to UNDP Prodoc Section "Project objective, outcomes and outputs/activities", pages 45 – 55.

A.5 INCREMENTAL/ADDITIONAL COST REASONING

GEF intervention is needed to remove the policy, regulatory, technical, market and other barriers which hamper realisation of the Government plans to harness the abundant and unutilised renewable agricultural residue potential available in the country for electricity generation. This is expected to create a conducive environment for the private sector to invest in electricity generation through utilisation of biomass gasification technology to either supply the main grid or isolated mini-grids for meeting the needs of rural consumers for electricity services.

By project completion, some 76,651 MWh would have been generated and an annual generation of 24,498 MWh would be sustained over an expected 15-year projected life of the gasifiers installed under the project. All the electricity obtained from this biomass gasifier generation, if not implemented, would have otherwise been obtained from thermal power stations burning of imported diesel fuel. In doing so, the combined direct (340,399 t CO_2) and indirect (1,287,720 t CO_2) global benefits of the project have been assessed at almost 1.63 million tCO_2 for only the CCM-3 component.

Including the associated sustainable forest and land management the project, an additional direct 50,951 tCO_2 will be

avoided every year: 3,600 tCO_2 for classified forest management, 29,351 tCO_2 for trees plantation (output 3.3) and 18,000 tCO_2 for conservation agriculture. Thus during the 15-year lifetime of the biomass gasifiers, a total of 1,094,253 tCO_2 will be avoided as direct global benefit.

For a detailed description of the Incremental/Additional cost reasoning, please refer to the UNDP Prodoc Section 1.6 on "Barriers to biomass gasification technology for electricity generation in Benin", pages 31 -34 and Section on "GHG Reduction", pages 60 -62.

A.6 RISKS (including climate change, potential social and environmental risks that might prevent the project objectives from being achieved and measures that address these risks).

The project presents some risks which are discussed in the Table below:

Risks	Rating (Probability of Occurrence)	Impact/Mitigation Approach
Policy and Regulatory: Reluctance in some quarters of the Government to introduce the necessary supporting policies and regulations.	Moderate	If this risk were to materialise, it would seriously affect project implementation. However, this is very unlikely the first sentence says it, as the Government of Benin is strongly motivated to provide access to modernised energy services to the large rural and peri-urban population that utilises fuel wood/charcoal for cooking and is driven by its plans to reduce the massive deforestation that accompanies the use of forestry resources. Hence, it will ensure that all Government Institutions (Ministries/Departments/Directorates, etc.) get on board to put in place a conducive policy and an enabling regulatory framework for biomass gasifier promotion and development. This will also be in line with its December 2003 "Energy Policy and Strategy" and the updated October 2009 "Strategic Plan for Energy Sector Development".
Economic/Financial: Non-availability of credit to promoters of biomass gasifiers.	Moderate	The project will work with local lending institutions to develop their capacity to understand and appraise gasifier projects for lending. In addition, the Financial Support Mechanism will contribute towards minimising risk exposure on the part of lenders.
Financial: Poor investment climate.	Moderate	The fact that Benin ranks 135 out of 189 economies on protecting investors and 169 out of 189 on enforcing contracts, as per the WB/IFC "Doing Business 2015" publication, provides insights into the difficulties that project developers may face. With this in mind, the project will put in place a Financial Support Mechanism that will be directed at minimising the financial risks that both project developers and lenders may face in doing business targeting biomass gasifiers.
Technology: Likelihood of gasifiers of inappropriate design and/or of poor quality introduced in the country.	Moderate	In order to avoid technology pitfalls, the project will establish network arrangements with other countries that have several years of experience with biomass gasifiers, like Brazil, Cambodia, China, India, etc. This will ensure that only successful models of gasifiers will be introduced and mistakes made elsewhere are not repeated. In addition, the project will bring in trainers from these countries to train Beninese technical personnel in high-quality installation, operation and maintenance of gasifiers.
Strategy: Village level commitment to change and adopt new agricultural methods is	Moderate	Project success will depend in very large part on changes in people's behaviour in rural villages. It is necessary to demonstrate the effectiveness (social, financial and environmental) of alternatives in the short and long-term to convince people to change long-held habits. Most rural villages operate at

not sufficient for the widespread adoption.		extreme levels of poverty and people may be unwilling to try new approaches when their basic livelihood needs are not being met. Participatory planning and decision-making processes as well as capacity building and organizational support will mitigate the risk of certain stakeholders restraining from participating in project implementation at least temporarily. Besides, pedagogic plots, trainings and visits to experimental farms are key activities to promote changes in rural areas.
Political: Land conflict and conflict among traditional / religious groups	Moderate	In order to avoid land ownership and use conflicts (in particular in the sacred forests), the project will be implemented through participatory processes, consensus building and conflict resolution and capacity building, with the underlying agenda of pre-empting conflict that could otherwise undermine project success. It will also work in close relationship with the GEF-UNDP Project entitled "Incorporation of Sacred Forests into the Protected Areas System of Benin" which generates useful results. Moreover, the recently adopted land tenure law reduces significantly the potential land conflicts as it improves the Rural Land tenure Plan, recognizing the customary rights ("Rural certificate").
Environmental/ Climate Change.	High	There are multiple environmental risks (e.g. decrease in the availability of agricultural biomass due to land degradation, reduced rainfall/water flows, drying up of watershed areas due to a change in climatic conditions) that can negatively affect agricultural output and result in a reduction in crop residues, thus negatively impacting on the biomass supply chain. This risk will be mitigated by introducing appropriate water management techniques in agricultural production, like drip irrigation and boreholes.
Overall	Moderate	

A.7 COORDINATION WITH OTHER RELEVANT GEF-FINANCED INITIATIVES

For a detailed description under this Section, please refer to UNDP Prodoc Section "Coordination with other relevant GEF-financed initiatives", pages 62 – 64.

B. ADDITIONAL INFORMATION NOT ADDRESSED AT PIF STAGE:

B.1 Describe how the stakeholders will be engaged in project implementation.

The project will be implemented through the NIM execution modality by the Ministry of Energy, Petroleum, Mineral and Water Resources, and Renewable Energy Development (referred to as Ministry of Energy, in short form). The Ministry will also have responsibility for implementing the companion UNDP-GEF Adaptation Project entitled "Strengthening the resilience of the energy sector in Benin to the impacts of climate change – NAPA Energy". For this, the Ministry will appoint a National Project Director who will assume overall responsibility for the implementation of both projects, ensure the delivery of project outputs and the judicious use of project resources. The National Project Director will be assisted by a Project Management Unit headed by a Project Manager (PM) and supported by 2 Deputy Project Managers, one each for the Adaptation and Mitigation (Energy) projects. The PM will be responsible for overall project coordination and implementation, consolidation of work plans and project papers, preparation of quarterly progress reports, reporting to the project supervisory bodies, and supervising the work of the project experts and other project staff. The PM will also closely coordinate project activities with relevant Government and other institutions and hold regular consultations with project stakeholders. A non-resident Technical Adviser (26 weeks/year) will be recruited to support the PM on technical issues, while a full-time Project Assistant (PA) will support him/her on administrative and financial matters.
Activities of the component 3 (SLFM) will be implemented by the General Directorate of Forests and Natural Resources (Ministry of Environment). A convention will be signed at the inception of the project implementation.

For additional information on "Stakeholder Participation", please refer to UNDP Prodoc, Section "Management Arrangements", pages 76 – 77.

B.2 Describe the socioeconomic benefits to be delivered by the Project at the national and local levels, including consideration of gender dimensions, and how these will support the achievement of global benefits.

The project will bring about benefits at both local and national/global levels through reduced environmental and human health threats due to less burning of diesel, wood and charcoal, thus reducing negative environmental impacts. Some of the benefits in the long term are listed below:

- Electricity from the mini-grids will provide opportunities for households, mainly women, to pursue income-generating activities requiring an electricity service and extend the hours of school children for homework.
- A rural development dynamism would be generated as farmers will now have a market for their "waste" agricultural residues, thus generating an additional source of income.
- Opportunities for the private sector in job creation for gasifier installation, operation and maintenance. The project will work with local training institutions (e.g. Ecole Polytechnique d'Abomey Calavi, Institut Universitaire de Technologie, Université Africaine de Technologie et de Management, Lycée Technique Coullibaly, Lycée Technique Kpondehou, Lycée Technique de Porto Novo, etc.) to develop technical capacity required by project developers.
- The project will seek to achieve gender equality through the empowerment of women to fully participate in all project activities and specifically those related to capacity development under the various project components.
- Paricipation of civil society, through the involvement of NGOs, including women NGOs**,** and stakeholder consultations, in the decision-making process related to biomass gasifier development, and for information and awareness raising activities.
- 500 jobs will be created in the gasifier/SFM/LD sub-sectors and 5,000 households will benefit from clean, modern electricity services.

B.3 Explain how cost-effectiveness is reflected in the project design.

As indicated in the Prodoc under para. 1 "Situation Analysis", SBEE (Benin Electricity Power Corporation) purchases power in bulk from CEB (Benin Electricity Community) at 10 US Cents/kWh. However, since 2006, CEB has been unable to supply the agreed amount of electricity to SBEE due to the energy crisis and this has resulted in SBEE operating its own costly gas turbines to generate electricity (e.g. at 69 US Cents/kWh in 2014 at Mariagleta) to supply the main grid. In addition, there are several villages that are not connected to the main grid and are served by isolated mini-grids that burn imported diesel fuel to generate electricity at the high cost of 40 US Cents/kWh, and that too for normally only 6 hours per day.

Introduction of biomass gasifiers for electricity generation to replace these isolated diesel generators can bring down the cost of generation to US Cents 20.3/kWh, as per a UEMOA feasibility study. This demonstrates the cost-effectiveness of generating electricity from biomass gasifiers in the off-grid areas of the country, compared to the alternative of utilising imported diesel fuel for that purpose.

It can be argued that that utilisation of solar and wind energy to generate electricity in these isolated mini-grids (very limited hydro sites are available in these remote villages) in lieu of biomass-fired gasifiers could provide a lower per unit emission abatement cost. However, Benin does not yet have any experience with grid-electricity generation from solar or wind in replacement of diesel fuel, although some proposals are in the works; hence, it is very difficult to determine generation costs in real-life situations, unlike the case of gasifiers where one installation at Songhai has been operating since 2012 and has provided valuable operational technical as well as economic/financial data.

During the 15-year lifetime of the biomass gasifiers, a total of 1,094,253 tCO_2 will be avoided, which means an investment of $ 3.50 of GEF funds per tCO_2. When the momentum generated by the project is factored in, resulting in the installation of additional gasifiers, an estimated 1,287,720 tons of CO_2 will be avoided in terms of both direct and indirect post-project emissions, and this translates into an abatement cost of $ 2.40/tCO_2 of GEF funds.

C. DESCRIBE THE BUDGETED M & E PLAN:

The Monitoring and Evaluation (M&E) Work Plan and Estimated Associated Budget are presented in the Table below:

Type of M&E activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, UNDP GEF	Indicative cost: 15,000	Within first two months of project start up
Measurement of Means of Verification of project results.	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members.	To be finalized in Inception Phase and Workshop.	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on output and implementation.	▪ Oversight by Project Manager ▪ Project team	To be determined as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project Manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	None	Annually
Periodic status/ progress reports	▪ Project Manager and team	None	Quarterly
Mid-term Review	▪ Project Manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: 40,000	At the mid-point of project implementation.
Terminal Evaluation	▪ Project Manager and team, ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost : 45,000	At least three months before the end of project implementation
Project Terminal Report	▪ Project Manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	▪ UNDP CO ▪ Project Manager and team	Indicative cost per year: $ 3,000 (Total: $ 15,000)	Yearly
Visits to field sites	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	For GEF supported projects, paid from IA fees and operational budget	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US$ 115,000	

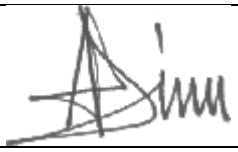
PART III: APPROVAL/ENDORSEMENT BY GEF OPERATIONAL FOCAL POINT AND GEF AGENCY

A. RECORD OF ENDORSEMENT OF GEF OPERATIONAL FOCAL POINT ON BEHALF OF THE GOVERNMENT

NAME	**POSITION**	**MINISTRY**	**DATE (**mm/dd/yyyy**)**
Mr Delphin **AIDJI**	GEF Operational Focal Point and Secretary General of Ministry of Environment, Housing and Urban Development	**MINISTRY OF ENVIRONMENT, HOUSING, AND URBAN DEVELOPMENT**	**MARCH 5, 2014**

B. GEF AGENCY (IES) CERTIFICATION

This request has been prepared in accordance with GEF policies and procedures and meets the GEF criteria for CEO Endorsement.

Agency Coordinator, Agency name	Signature	Date *(Month, day, year)*	Project Contact Person	Telephone	Email Address
Adriana Dinu UNDP/GEF Executive Coordinator		May 4, 2016	Saliou Toure Regional Technical Advisor, EITT	+251 912 503 320	saliou.toure@undp.org

ANNEX A: PROJECT RESULTS FRAMEWORK

An abridged version of the logframe is provided below. However, a complete version can be found in the GEF-UNDP project document.

Objective/Outcome	Indicator	End of Project Target(s)	Sources of Verification
To introduce an integrated energy and ecosystems-based approach to sustainable biomass electricity generation in the country.	Emission reduction over the 15-year lifetime of gasifiers. Biomass-based electricity generation by project end.	Biomass-based electricity generation of 76,651 MWh by project end. Direct reduction of 67,070 tons of CO_2 over the 5-year FSP project life cycle. Subsequent generation of 24,498 MWh/year and reduction of 340,399 tons of CO_2 over the 15-year lifetime of the plants. Cumulative indirect GHG emission reduction of almost 1.3 million tons of CO_2 by 2035.	Project's annual reports, GHG monitoring and verification reports. Project final evaluation report.
	Integrated Land Uses Management Plans (ILUMPs) adopted.	At least 4 ILUMPs for project sites have been successfully developed, adopted (endorsed) by communes and under implementation.	
	Emission reduction due to SLFM.	Direct reduction of 659 030 tCO_2 due to implementation of SLFM activities.	
	Number of ha under SLFM practices.	At least 9,000 ha are under SALM practices.	
	Over 5,000 rural households and small commercial/industrial enterprises connected to electricity services by project end.	At least 200 jobs created for technicians to install, operate and maintain gasifiers and 300 permanent jobs for other operations.	
	500 jobs created in the gasifier/SFM/LD sub-sectors.		
Outcome 1: Streamlined and comprehensive market-oriented energy policy and legal/regulatory framework for biomass electricity generation by Independent Power Producers (IPPs).	Existence of adequate policy and regulatory framework.	Completed within 12 months of project initiation and approved by Government early in Year 2.	Published documents. Government decrees/laws.
Outcome 2: Increased investment in clean energy technologies and	Investment in biomass gasifiers in $$.	Completed within 12 months of project initiation and applied by Government thereafter.	Project documentation.

low-carbon practices in the agro-forestry waste sector.		$ 15 million invested in clean energy projects by project end.	Project reports.
Outcome 3: Integrated land use, sustainable forest management and natural resource management provide social benefits and sustain biomass for electricity production.	a. Carbon stock enhanced in the forests. b. Number of ha under SALM practices. c. CO2 sequestration with trees plantation.	a. At least an enhancement of 72,000 tCO_2 during the 20-year lifetime. b. At least 9,000 ha are under SALM practices. c. At least 587,030 tCO_2 sequestered during the 20-year lifetime.	Project's yearly reports. Project site visits and evaluation for verification Monitoring scheme.
Outcome 4: Outreach programme and dissemination of project experience/best practices/lessons learned for replication throughout the country/region.	Awareness about biomass gasifiers and their possibilities.	Increased awareness among some 30 stakeholders in place to monitor, promote and develop the market for biomass-based electricity generation.	Project final report and web site.

ANNEX B: RESPONSES TO PROJECT REVIEWS (from GEF Secretariat and GEF Agencies, and Responses to Comments from Council at work program inclusion and the Convention Secretariat and STAP at PIF)

RESPONSES TO COUNCIL RECOMMENDATIONS

Comment	Response	Reference
Germany's Comments *Germany approves the following PIF in the work program but asks that the following comments are taken into account:* The development of new (biomass) power plants should not result in additional pressures on ecosystems, in particular forest resources, or have a negative impact on the provision of ecosystem services in the Three River area. Otherwise, mitigation measures should be taken.	As demonstrated in the table 5 of the Prodoc (page 50), the crop residues available for electricity generation at each of the pilot sites by far exceeds the biomass need for the proposed installed power plants. Besides, the gasifiers implemented during the project will be supplied only by agricultural residues. Hence, no additional pressures on ecosystems will come from the installation of the power plants. Moreover, the project develops an integrated approach with a SLFM component. While the biomass power plants will be installed, the project will support the land uses planning in the four communes, the protection of the surrounding forests through fire management practices, the plantation of woodlots, and the dissemination of sustainable agricultural practices. These activities will have positive impacts on forests and on ecosystems services.	ProDoc, page 50
France's Comments Overall, we are not convinced by the phasing of this project. Components 1 and 3 of the project aim respectively at working on the institutional framework and setting a first pilot unit, and constitute a first project. Working on component 2 (establishment of financial tools for the implementation of other units) assumes that we have already solved the previous two (1 and 3). As for the 4th component (land use and forest management), it is clearly out of the project's scope. In other words, initiate component 1 without techno-economic feedback from component 3 may prove risky. Indeed, in the absence of lessons learnt from a project in operation (and thus a market of agricultural residues), who can say what will be the actual cost of electricity?	As explained under "Changes in project alignment" above, the PIF envisaged 4 Components, with Component 2 dealing with the promotion of investment in biomass-based electricity generation through the provision of catalytic incentives and Component 3 supporting the establishment of a 1 MW biomass plant for electricity generation. During implementation of the PPG, the view was expressed that it would be rational and appropriate to have incentives go hand in hand with actual investment. Hence, these two Components were combined into one, as Component 2, to deal with both investment promotion and establishment of not one 1 MW plant but 4 biomass gasifier plants with a total capacity of 4 MW. Component 3 now deals with sustainable land use and forest management, while Component 4 discusses outreach and dissemination. Policy, and legal/regulatory framework for biomass electricity generation are dealt with under Component 1. In addition, each "Component" represents only a grouping of activities and, as such, it does not necessarily imply that activities under, for example, Component 1 need to be completed first and the results fed into implementation of the subsequent Component(s). In fact, all four Components will can and will be implemented in parallel, except for Component 4 "Outreach and results dissemination" which will be somewhat out of "synchronism", for obvious reasons). The project develops an integrated approach at the commune level in order to address sustainable	CEO ER, pages 4-5

	energy, sustainable agriculture and forest management in a comprehensive and most effective manner that include both the supply and demand sides of the biomass feedstock. As biomass power plants will operate with agricultural residues, it makes sense to promote sustainable agricultural practices (increase of agricultural productivity and thus of biomass availability) and to reduce pressure on the surrounding forests.	
In details: • It may be preferable to start a pilot installation without private investment (but with private management) in order to identify the barriers which will appear, whether regarding raw material supply, connection to an electricity network with pop-up and multiple cuts (when there is a cut on a network, those producing are not paid throughout this cut), or human resources challenges to manage and maintain such a facility in such an isolated city (about 100 km from asphalt road, except if new roads have been recently built).	• As described in the Prodoc, a 40 kVA (32 kW) gasifier has been successfully operating at the Songhai Centre (an NGO established in 1985) in Porto Novo since 2012. The funding for this gasifier was raised as a grant raised by a Dominican priest, but it has always operated under a private management business model. As such, it can already be considered as constituting a "pilot" that has been operating for the last 4 years in Benin and that provides exactly the kind of information that this comment seeks to elicit. The lessons learned from Songhai will be very useful for the private sector when planning to embark in electricity generation from the gasification of agricultural residues.	ProDoc, pages 17-18 and pages 35-36
• Availability and management of raw material. The project seems based, technology-wise, on the gasification of cotton stalks (but it is not clear whether the project gives priority to this agricultural residue or not). Apart from a mention in a study conducted by UEMOA in 2008 (unavailable on the internet), availability at the ginning factory of this resource is nowhere mentioned. Although there is of course cotton in this territory of Benin, there is no practice of collecting and centralizing cotton stalks (the logistics of the cotton seeds is already difficult...). Such a project would involve setting up a chain of these stalks, which suggests studying the schedule of collection, storage issues, pricing and back on the fields as (directly or indirectly) of the value in terms of fertilization of these stalks that are usually burned in the field;	• The project does not focus exclusively on the use of cotton stalks. In fact, the gasifiers will utilise agricultural residues in general from crops such as maize, sorghum, millet, rice and cotton. The total availability of agricultural residues and the volume that can be available for gasifier electricity generation were evaluated during the PPG and the results are presented in Table 3a: Availability of Agricultural Residues, 2008 – 2013. Data gathered and analysed during the PPG show that some 45% of the huge amount of agricultural (crop) residues produced remain unused, after allocation is made for utilisation as fuel for cooking and allowed to rot to "strengthen" the soil as fertiliser. This so-called "nuisance" biomass is discarded through open-air combustion in the fields, but can be an important source of income to farmers if they can be sold to operators of biomass gasifiers. The project will address the issue of setting up an appropriate mechanism to establish the price for the agricultural residues that will provide a win-win situation to both the farmers in terms of collection and sale of agricultural residues to the gasifier owners and to the latter in ensuring a regular, uninterrupted and sufficient feedstock supply chain so as not to disrupt their electricity generation activities.	ProDoc, pages 20-21
• Indicators: as it is mentioned "avoided tCO2", the document does not provide information on the necessary quantity of agricultural residues, and their equivalent in hectares.	• As indicated in the preceding bullet point, the availability of agricultural residues is provided in Table 3a. The 4 MW installed during the project will required about 13,327 tons of residues per year,	

	which is equivalent to the quantity of agricultural residues produced on 20,000 ha of maize fields (with an average yield of 1.3 tons per ha for maize).	
• Human Resources competence and maintenance circuits: knowing that the selected municipality has not the easiest access to the Department, the question of the provision of a team of skilled technicians for maintenance or settings will be part of the delicate aspects for a private operator.	• The issue of capacity development is addressed by the project both in terms of training of biomass gasifier installers and operators / maintenance staff in the rural areas and safe utilisation of electricity by consumers. In addition, training will be provided to farmers to disseminate good practices around the biomass power plants.	
• Finally, central biomass technology is not, unlike solar or hydro, highly capital-intensive. The issue, in addition to be sure that the public actor will respect its contract, is the access to raw material with an interesting rate for both parties.	• The ProDoc has addressed the issues of biomass gasification technology, experience over a 4-year operation of a gasifier in the country, availability of agricultural biomass for electricity generation, the supply chain to minimise disruption in the feedstock chain and the opportunities for implementing MW-size gasifiers for electricity generation in Benin. On an average, and excluding the cost of the electricity distribution system, the capital investment for electricity generation through biomass gasification in developing countries is approx. $ 1,800/kW. After factoring in maintenance, lube oil, biomass fuel, etc., the cost of electricity generation varies, depending on the capacity utilisation factor (CUF) of the equipment. A Master's thesis prepared by a Beninese student in 2013 shows the following cost of generation for the Songhai 40 kVA installation located at Porto-Novo: 25% CUF: 43 US Cents/kWh; 50% CUF: 23 US Cents/kWh and 80% CUF: 16 US Cents/kWh. In other countries with extensive experience with gasifiers (Cambodia, China and India), a similar cost pattern is observed, although the actual costs/kWh are somewhat lower, showing a decrease in generation cost with an increase in CUF. In addition, the cost effectiveness section above shows the advantage of biomass compared to alternative RE systems in Benin. The proposed project intervention addresses the key barriers to biomass based power generation. The availability of and access to agricultural residues as feedstock for the gasifiers are described in the Prodoc and have been addressed above.	ProDoc, pages 35-36
❖ **Opinion*: A major revision of the PIF is required in order to address the above weaknesses.***	During implementation of the PPG, Project proponents took into consideration the very useful comments made by GEF Council Members and ensured that these were addressed in the formulation of the CEO ER and ProDoc. This has now been taken care of in these documents. There was no need for major revisions, but instead, to come up with additional details for some key issues (feedstocks, gasification techniques, etc.) raised in the comments.	

RESPONSES TO STAP RECOMMENDATIONS

Comment	Response	Reference
1. STAP welcomes this project which addresses electricity regulations and grid integration from bioenergy power plants and capacity building across a wide range of stakeholders. Financing of 4 MW capacity is planned and a 1MWe gasifier demonstration plant is to be established. Biomass forest feedstock are to be managed sustainably.	1. During the 5-year project period, a total of 4 MW of biomass gasifier electricity generators will be installed, as outlined in the PIF.	
2. With only a quarter of the population having access to electricity, either imported or from costly fuel oil plants at a very high USD 0.40/kWh generation cost, developing bioenergy plants will assist rural electrification. But deforestation has to be strictly controlled and must not be used to supply the biomass. The UNEP/GEF guidelines on Biofuels can provide useful guidance in this regard (even though they target liquid biofuels rather than solid biomass).	2. The project proposes to exclusively utilise agricultural biomass that is left over after other uses like soil strengthening, fuel for cooking, raw material for hedges, etc. Available data show that there is a subsequent excess of "nuisance" agricultural residues that annually get disposed of. No active "forestry" biomass will be utilised to power the gasifiers. Specific plantations will be established, if required, in the neighbourhood of the power plants for (i) sustainable biomass supply, (ii) restoration of degraded lands, and (iii) income generation for households. While the project does not target liquid biofuels, as suggested by STAP, it will refer to the UNEP/GEF guidelines on Biofuels for any relevant biomass-related issues and lessons learned that may be pertinent to the implementation of this project.	
3. The carbon balances from LD and SFM are complex and difficult to assess, but the use of residues avoiding deforestation and the encouragement of afforestation are major contributors.	3. The project will support both afforestation and forest conservation in the commune where power plants will be established. The plantation of 2,000 ha (500 ha per pilot site) will stock 29,351 tCO_2 per year. The improvement of SFM through development of wildfires practices will avoid the emission of 3,600 tCO_2 every year.	
4. Agricultural residues are proposed as a feedstock for bioenergy. There is apparently a large resource of residues from maize, with substantial amounts also from sorghum and cotton. To assess the sustainability of using these residues for bioenergy it is necessary to determine their current use. For example, if they are currently burned in the field, then their use for energy is not likely to have a detrimental effect on soil carbon levels or crop production. However if they are retained in the field as mulch, their removal could reduce yields due to loss of soil moisture and higher soil temperature, and increase risk of soil erosion. If they are gathered and used for fuel, then there is a potential leakage issue	4. Present usage of agricultural biomass has been assessed and there is ampler excess "nuisance" agricultural biomass for utilisation in the gasifiers.	

unless the proposed bioenergy plant will provide a suitable alternative energy product to those affected. Thus, it is important to determine the conventional use of the agricultural residues in order to assess and manage the likely impacts of residue removal.		
5. Sustainable land management encourages the retention of residues, to enhance soil properties and productivity and resilience of agricultural production, and minimise erosion and soil carbon losses. Thus it is important that a new demand for biomass for bioenergy does not jeopardise the implementation of sustainable land management. The quantity of residue that should be retained will depend on the soil type and landscape position (which determine erosion risk). Education on the benefits to production from SLM is more likely an effective strategy than regulation, to encourage sustainable use of agricultural residues for bioenergy.	5. The project will start with the development of integrated land uses at the commune level which integrate the demand of biomass for electricity generation. Then SLFM activities will enhance biomass production with (i) increase of crop productivity thanks to SALM practices implementation and (ii) reforestation of 2000 ha (500 ha per pilot sites).. The approach for dissemination of SLFM practices is based on a training approach to raise education on the opportunity to implement SLM for land conservation and additional income generation.	
6. Agricultural residues could provide useful biomass feedstock for the proposed 400 kWe gasifier if carefully managed. Low moisture content of biomass is essential for efficient gasification. The GEF project is to seek finance models for similar plants and to increase the capacity of this demonstration plant to 1 MW. Technically this is not easy, other than by adding multi-gasifiers in addition to the existing plant. It is not usually possible to retrofit an existing gasifier to increase its capacity. The challenges in operating and maintaining a gasifier should not be under-estimated and the experience from India in particular could be useful in this respect, though it is noted that experiences from other African countries are being sought.	6. The project will solicit expertise from countries like Brazil, Burundi, China, India, Indonesia, Philippines, etc. where there is a wealth of experience with gasifiers. In addition, the private sector investors will make their own decisions as to single- or multiple-unit biomass gasifiers they wish to install.	
7. The design, type and manufacturer of the gasifier is not described and seems has already been selected for the demonstration plant under construction. It is hoped due diligence was undertaken in this regard as plants vary widely in efficiency and reliability, particularly with respect to tar formation.	7. The project document describes the 2 types of common biomass gasifiers (updraft and downdraft) and explains the reasoning behind downdraft gasifiers being the preferred choice for electricity generation. Average cost figures of $ 1,800/kW are also provided. It also mentions those countries (Brazil, China, India, etc.) that have a long experience in utilising biomass gasifiers for electricity generation and where gasifiers are available for purchase. However, the project does not recommend from which manufacturer the gasifier should be purchased. While the project will support interested developers with technical/economic information on gasifiers, it will be exclusively the decision of the developer to select the gasification system it wishes to procure and install.	
8. Integrating the generation plant into an existing grid can be challenging as a gasifier output cannot be easily ramped up and down to meet ever-changing loads as can hydropower (i.e., it is non-dispatchable). It is therefore possibly easier to run	8. The gasifiers will run continuously as base-load plants, except for scheduled maintenance and repairs. For peak loads, either hydro or diesel generation will step in.	

it continually as base load or possibly for periods during the day to meet higher load demand. 9. Calculations suggest that avoided CO_2 from the bio-power plant assumes the power generated displaces a portion of the current thermal power plant output. However, with continuing growth in demand and expansion of rural electrification, this will be additional generation but it is a form of low-carbon generation so should be supported. 10. Overall, the project will need to develop an appropriate M&E framework to assess project performance against agreed targets. 11. In the PIF it is noted that 75% of Benin's population do not have access to electricity. In addition to biomass energy, mini and micro-hydro and PV could be important technologies to increase access to electricity. Project proponents are recommended to consider specific incentives supporting on-grid and, particularly, off-grid RETs beyond biomass. Such support could be appropriate for policy component 1.	9. This is correct. Where the SBEE grid is available, the gasifier-generated electricity will be connected to the grid. Where there is no grid, the gasifiers will operate in isolated-grid mode. 10. This will be undertaken and is described in the project document. 11. As indicated in the RCE, Benin's Second National Communication (June 2011) recommends the installation hydropower plants (147 MW), biomass plants (30 MW), solar plants (25 MW), and wind plants (10 MW) by 2030 in an effort to reverse the increasing trend in GHG emissions in the country. While this project focuses on biomass gasification for electricity generation, all the other renewable energy options for on/off-grid electricity generation are being pursued by the Government. However, except for large hydro, little has been achieved in terms of grid/mini-grid electricity generation from PV and wind machines, with the result that generation cost figures are not available.	

ANNEX C: STATUS OF IMPLEMENTATION OF PROJECT PREPARATION ACTIVITIES AND THE USE OF FUNDS

A. EXPLAIN IF THE PPG OBJECTIVE HAS BEEN ACHIEVED THROUGH THE PPG ACTIVITIES UNDERTAKEN.

The PPG objective of formulating detailed Project Document has been achieved. The project formulation was done through consultations involving a range of stakeholders. Consultative activities were taken up through individual interviews with stakeholders and workshop (Problem/solution analysis and Log frame Workshop).

B. DESCRIBE FINDINGS THAT MIGHT AFFECT THE PROJECT DESIGN OR ANY CONCERNS ON PROJECT IMPLEMENTATION, IF ANY:

N/A

C. PROVIDE DETAILED FUNDING AMOUNT OF THE PPG ACTIVITIES AND THEIR IMPLEMENTATION STATUS IN THE TABLE BELOW:

The activities achieved during PPG are shown in the table below:

Project Preparation Activities	***Implementation Status***	***GEF Amount ($)***				***Co-financing ($)***
		Amount Approved	***Amount Spent to date***	***Amount Committed***	***Uncommitted Amount****	
Collection and analysis of baseline data including comparative review of other countries under similar conditions and circumstances	Completed	40,000	40,000			30,000
Review of experiences in Benin and other countries of the following:	Completed	15,000	15,000			15,000

Project Preparation Activities	*Implementation Status*	*GEF Amount ($)*				*Co-financing ($)*
		Amount Approved	*Amount Spent to date*	*Amount Committed*	*Uncommitted Amount**	
- Application of biomass electricity generation - Land use and forestry - Area/community-based energy needs assessment and planning						
Conduct a Logical Framework Analysis (LFA) to define project goal, objectives, outcomes, outputs and activities, including success indicators as well as delineation of responsibilities and coordination mechanisms	Completed	15,000	15,000			10,000
Stakeholder engagement, capacity needs assessment of key local implementing partners and co-financing	Completed	20,000	20,000			10,000
Detailed design of project implementation plan	Completed	10,000	10,000			5,000
Preparation and finalization of the full-sized Project Document	Completed	0	0			10,000
Total		**100,000**	**100,000**			**80,000**

*Any uncommitted amounts should be returned to the GEF Trust Fund. This is not a physical transfer of money, but achieved through reporting and netting out from disbursement request to Trustee. Please indicate expected date of refund transaction to Trustee. N/A

Empowered lives.
Resilient nations.

United Nations Development Programme

Country: Benin

PROJECT DOCUMENT

Project Title: Promotion of sustainable biomass based electricity generation in Benin.

UNDP Strategic Plan (2014-2017): Outcome SP1: Growth and development are inclusive and sustainable, incorporating productive capacities that create employment and livelihoods for the poor and excluded; **Output 5.1:** Inclusive and sustainable solutions adopted to achieve increased energy efficiency and universal modern energy access (especially off-grid sources of renewable energy

UNDAF Outcome(s): By 2018, institutions and the target population in the communes ensure better management of the environment, natural resources, energy resources, quality of life, the consequences of climate change, crises, and natural crises and disasters.

Expected CP Outcome(s): By 2018, institutions and the target population in the communes ensure better management of the environment, natural resources, energy resources, quality of life, the consequences of climate change, crises, and natural crises and disasters.

Expected CP Output(s): Institutions and the population are equipped to better manage natural resources, energy resources and quality of life.

Executing Entity/Implementing Partner: Ministry of Energy.

Implementing Entity/Responsible Partners: United Nations Development Programme.

Brief Description: The objective of this project is to promote electricity generation through gasification of waste agricultural residues (biomass) to supply both the main grid and isolated mini-grids. It will also promote an integrated approach towards fostering sustainable land management that balances environmental management with energy and development needs. It will do so by leveraging significant private sector investment over its five-year implementation period to initially pilot 4 biomass gasifier installations having a total installed capacity of 4 MW. Over the project period, the 4 pilots scheduled for implementation will generate a total of 76,651 MWh of electricity. Moving forward, these 4 pilots will have an annual generation of 24,498 MWh that would be sustained over an expected 15-year projected life of the gasifiers, resulting in the cumulative avoidance of 329,981 tCO_2. When activities related to sustainable forest and land management are factored in, a total of 1,094,253 tCO_2 will be avoided over the 15-year gasifier lifetime, translating into a unit abatement cost of $ 3.50 of GEF funds per tCO_2 reduced. The project will achieve this target by introducing a conducive policy, institutional and regulatory framework for electricity generation through biomass gasifiers utilising waste (nuisance) agricultural crop residues and by putting in place a financial support mechanism that, together, will facilitate private sector participation in biomass gasifier electricity generation in the country. The project will accompany the surrounding communities to improve their agricultural techniques over 9,000 ha and to restore lands with tree plantations over 2,000 ha. Sustainable management practices will be supported in the forests in the vicinity of the biomass gasifiers.

Programme Period:	2014-2018
Atlas Award ID:	00090776
Atlas Project ID:	00096384
PIMS #	5115
Start date:	July 2016
End Date:	June 2021
Management Arrangements:	NIM
PAC Meeting Date:	30 March 2016

Total resources	US$ 29,622,602
Regular	
• GEF	US$ 3,872,602
• UNDP	US$ 500,000
Other	
○ Government	US$ 10,250,000
○ CEB	US$ 15,000,000

Agreed by (Government):

Date/Month/Year

Agreed by (Executing Entity/Implementing Partner):

Date/Month/Year

Agreed by (UNDP):

Date/Month/Year

Table of Contents

List of Acronyms

APR	Annual Project Review
A/R	Afforestation/ reforestation
BD	Biodiversity
CBNRM	Community-based natural resources management
CO	UNDP Country Office
CO_2	Carbon dioxide
EU	European Union
FAO	Food and Agriculture Organisation of United Nations
FRA	Forest Resources Assessment
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIC	Groupement Intercommunal des Collines
kW	Kilowatt
kWh	Kilowatt-hour
LD	Land Degradation
LUCF	Land use change and forestry
LULUCF	Land use, land use change and forestry
M&E	Monitoring and Evaluation
Mtoe	Million tons of oil equivalent
MW	Megawatt
MWh	Megawatt-hour
NGO	Non-Governmental Organization
QPR	Quarterly Progress Report
PES	Payment for Environmental Services
PIF	Project Identification Form
PIR	Project Implementation Review
PMU	Project Management Unit
PPG	Project Preparation Grant
RSC	UNDP Regional Service Centre
RTA	UNDP Regional Technical Adviser
SFM	Sustainable Forest Management
SLFM	Sustainable Land and Forest Management
toe	Tons of oil equivalent
TPR	Tripartite Review
TTR	Terminal Tripartite Review
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

1. SITUATION ANALYSIS

1.1. Context and Global Significance

With an area of 114,763 km2 and a population of almost 10 million inhabitants (May 2013), the Republic of Benin (Capital: Porto-Novo) is a located in West Africa bordering Togo to the west, Nigeria to the east and Burkina Faso and Niger to the north, where the Niger River, one of the largest in Africa, forms a 120-kilometre-long border between the two countries. Agriculture employs 70% of the active population and its contribution to the GDP amounts to 32% (World Bank, 2012) – per capita GDP was $ 872 (2014 estimate, IMF). A majority of the population live on its southern 125-km wide equatorial coastline on the Bight of Benin, which forms part of the Gulf of Guinea in the northernmost tropical portion of the Atlantic Ocean. The population is estimated at being 70% rural and 30% urban, with more than half being concentrated in the south. Although the coastline measures only 121 km, the country extends a distance of 650 km from the Niger River in the north to its southern coastline and is about 325 km at its widest point. The country is divided into twelve departments which, in turn, are subdivided into 77 communes.

The economy of Benin (the "economic capital" is Cotonou, approx. 33 km to the west of Porto-Novo) is dependent on subsistence agriculture, cotton and cashew production as cash crops, and regional trade. Cotton accounts for 40 percent of GDP and roughly 80 percent of official export receipts. Growth in real output has averaged around 5 percent in the past seven years, but rapid population growth has offset much of this increase. Benin's economy has continued to strengthen over the past years, with real GDP growth rising from 3.5% in 2011 to 5% percent in 2013. The main driver of growth remains the agricultural sector, with cotton being the country's main export, while services continue to contribute the largest part of GDP largely because of Benin's geographical location, enabling trade, transportation, transit and tourism activities with its neighbouring states.

Very little of the country's subsistence agriculture is mechanized and irrigation is only slightly developed. The industrial sector as a whole remains under-developed, contributing only to about 13% of GDP in 2013, mainly with textile and cement industries. GDP per capita was estimated as $ 756 per person in 2012 (Source: World Bank). Projections show that Benin will continue to be dependent on subsistence agriculture, cotton production, (they both produce a huge amount of "renewable biomass" in terms of agricultural or crop residues that can be utilised for energy purposes) and small-scale regional trade.

The agricultural sector, under the responsibility of the Ministry of Agriculture, contributes 75% of export and 15% of State earnings. The country has considerable untapped agricultural potential, with natural conditions suitable for cultivation of a wide range of agricultural products like cotton, sorghum, rice, corn, etc. It is estimated that 62.5% of the country surface area consists of potential arable land, of which only 20% is farmed. The climate is sub-equatorial in the south with two rainy seasons from April through July and again from September through November, and tropical in the north with one rainy season from April through September. Agriculture is essential for the country to meet its goals aimed at poverty reduction and food security, but is driven by traditional farming that relies heavily on rainfall for 95% area under cultivation. In the North, traditional subsistence agriculture based on cereals is being progressively replaced by extensive cotton production. This trend started about ten years ago and has been accelerating recently as a result of increased promotional activities on the part of cotton

companies. Today, cotton is a major industry in Benin. Maize is the main food crop. According to OECD, livestock production is the second biggest contributor to the GDP of the country (7%).
The forestry sector, under the responsibility of the Ministry of Environment, contributes 6% of the GDP and almost 100,000 people are active in the wood value chain, manly for timber production and fuelwood supply. The need in energy wood is growing very fast: 7.6 million m3 of wood were consumed in 1997, whereas 11.5 m3 of wood have been consumed in 2012 (Akouehou, 2012).
As regard to the energy sector, Benin's total energy consumption was 3,750 ktoe in 2013 (Table 1), with an average of 0.46 toe per capita (compared to 0.6 in India, 2 in China, 3.2 in the European Union and 6.8 in the US - Source: IEA).

Table 1: Total and Specific energy consumption in Benin

Year	Population	Total energy consumption (toe)	Specific consumption/head (toe)	Specific electricity consumption (kWh/head)
2006	7,611,228	2,593,336	0.341	83.74
2007	7,833,744	2,801,555	0.358	90.72
2008	8,056 394	2,894,437	0.359	96.08
2009	8,285 378	3,113,235	0.376	96.63
2010	8,520,876	3,343,810	0.392	101.89
2011	8,776,502	3,474,219	0.415	107.80
2012	9,039,797	3,609,713	0.439	114.05
2013	9,310,991	3,750,492	0.464	120.67
Average Increase / year	3%	3.9%	5.8%	5.8%

Source: SIE (Benin's Energy Information System). Data from 2011 onwards are based on projections.

Biomass, in the form of fuelwood and charcoal, is the principal source of energy utilised by households for cooking; very little LPG is used for cooking in the country. In the peri-urban and rural areas, households cook on both fuelwood and charcoal, sometimes utilising a charcoal stove and a wood stove side by side. In the urban areas, charcoal is widely used as both the electricity supply and the availability of imported bottled gas (LPG) can be very erratic. For example, the household sector consumed 52% of energy in 2013, mainly from biomass resources, followed by the transportation, services and industries sectors (Fig. 1).

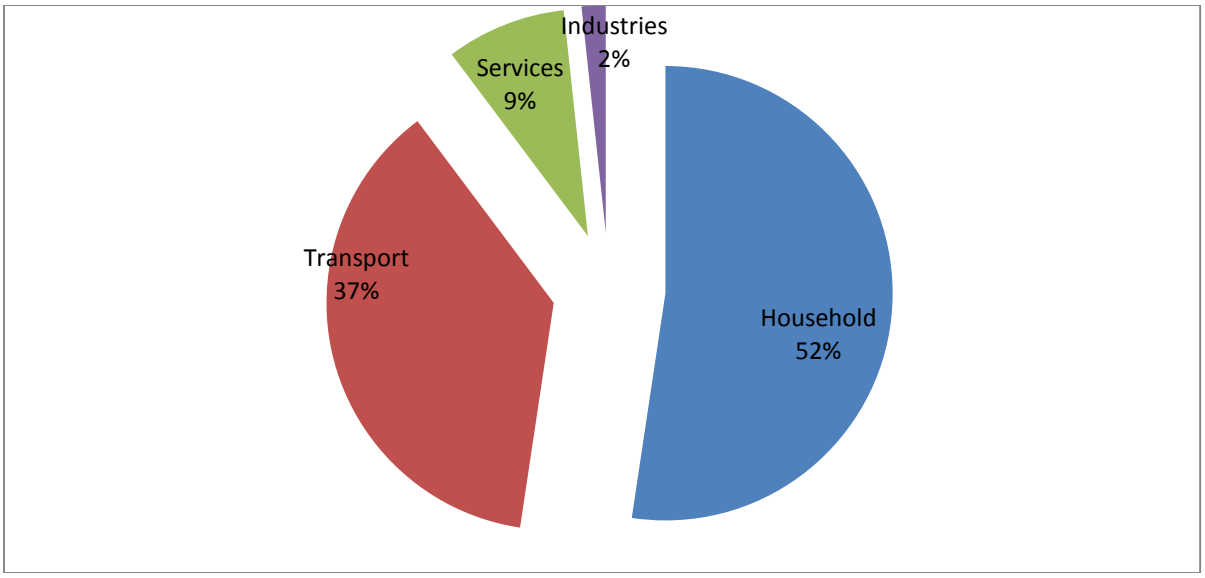


Fig. 1: Energy Consumption by Activity Sector (2013) – Source: SIE

The woody biomass situation gets compounded by the slash and burn process to transform forests into agricultural land and forest clearing for mining and logging activities, including that of charcoal production. The recent data from the Eros Data Centre for Benin[1] (2014) show that, from 1975 to present, there has been a national regression of almost 2 million hectares of forest covered lands in the country. With an average rate of 55,900 ha deforested per year (0.49%), Benin has one of the highest rates in West Africa[2]. The latest FAO Forest Resources Assessment (FRA 2010) estimates the trend of deforestation slowed from 70,000 ha per year (0,61%) from 1990 to 2000 to 50,000 ha per year after 2000 (0,44%) thanks to the efforts made by the country and its partners. In 2010, the forests cover 7.67 million ha, equivalent to 68% of the country. The agriculture and energy sectors are the principal drivers of deforestation. Uncontrolled fires used to clear land for agriculture, the collection of firewood to feed the daily needs for cooking fuel in villages, coupled with the production of charcoal in peri-urban areas are a major concern for both natural resource management and climate change. As per FAO, this loss in forest cover is a result of several factors, including "absence of planning in expansion of cities, demographic explosion, poverty and poor governance". This reduction in forests also results in reducing the animal habitat, exposing the soil to erosion (land degradation) and seriously affecting water resources. This problem is more acute in the northern part of the country that receives lower rainfall than the southern part. According to the UNCCD fourth report (2012), 29% of the national land area is strongly degraded (mostly in the North) and 33% is moderately degraded. More than 2.8 millions of people are affected by land degradation in the country.

Table 1a: Benin's forest cover and land use types in 2010 and its evolution since 1975 (adapted from CENATEL 2010, IFN 2010 and CERF 2013)

[1] Publication of the EROS Centre (US Geological Survey), in collaboration with CENATEL, DGFRN, Agryhymet. This publication is an output of the project West Africa Land-Use and Land-Cover Dynamics (2014).

[2] According to reports from World Resources Institute and Greenpeace, Benin had the fourth highest deforestation rate in the world.

Land uses	Surface in 1975 (km^2)	Rate (%)	Surface in 2000 (km^2)	Rate (%)	Surface in 2010 (km^2)	Rate (%)	Evolution between 1975 and 2010 (%)
Forest	656	0.57	460	0.4	336	0.29	- 49
Gallery forest	4,308	3.76	3,708	3.23	2,901	2.53	- 33
Savannah	89,340	77.94	76,136	65.55	71,500	62.38	- 20
Wetlands	3,244	2.83	1,720	1.5	1,692	1.48	- 48
Plantation	576	0.42	504	0.44	612	0.53	+ 6
Mangrove	140	0.12	100	0.99	100	0.09	- 29
Crops and fallow lands	14,756	12.87	30,964	27	35,147	30.54	+ 138
Irrigated crops	44	0.04	164	0.14	148	0.13	+ 236
Habitation and lakes	956	0.83	1,248	1.09	1,532	1.34	+ 60
Others	680	0.62		3.79	732	0.69	+ 8
Total	114,700	100	114,700	100	114,700	100	0

As Table 1a shows, there is very little dense forest left in Benin (National Forest Survey, 2007). The future of the remaining natural forest in Benin is subject to managing a range of variables and socio-economic factors, which can be broadly attributed to a rapidly increasing population, continued use of unsustainable agricultural practices by farmers, the continued and increasing demand for wood fuels and general poverty. According to the World Bank, only 27.9% of the total population have access to electricity services and, in the rural areas, this figure drops down to 2%. Hence, firewood and charcoal remains the main source of energy in the country.

With regard to electricity, the average per capita electricity consumption (Table 1) was a low 121 kWh in 2013 (compared to 684 kWh in India, 3,298 kWh in China, 7,292 kWh in France and 13,246 kWh in the US – Source: World Bank).

1.2. Stakeholder Analysis and Institutional Framework

Communauté Electrique du Bénin (CEB – Benin Electricity Community)

The Electricity Community of Benin (CEB-"Benin" here refers to the Bight of Benin and not to the country of Benin) was established in 1968 by a treaty between Benin (the country) and Togo, and its headquarters are located in Lomé (Togo), with a representation in Cotonou. CEB is a public entity wholly owned by the Governments of Benin and Togo and its overall mandate is to function as a cooperation agency, managing importation from neighbouring countries, and generation and transmission of electricity in both countries. As a part of its electricity generation functions, it operates the 65 MW Nangbeto Hydropower Station, commissioned in 1987, located in the south-east of Togo (generation on 165 GWh in 2012) and the 20 MW gas turbine each in Cotonou and Lome (generation of 98 GWh in Cotonou in 2012) commissioned in 1998 in response to the energy crisis. Again in 2012, as per its Annual Report, CEB purchased, generated and transmitted 1,125 GWh to Benin and 1,042 GWh to Togo. All electricity purchased or produced in Benin for consumption in the country is sold to the Société Béninoise d'Energie Electrique (SBEE - Benin Electricity Power Corporation). On an average, Benin imports 85% of its electricity from Côte d'Ivoire, Ghana and Nigeria through the CEB, the bi-national power utility. In 2014, CEB purchased/generated electricity (almost exclusively from hydro) at an average price/cost of 8 US Cents/kWh from these suppliers and its sale price to SBEE was 10 Cents/kWh (these are real, unsubsidised prices). However, because of increasing demand in both countries, it recently signed a PPA with Global Contour,

a Togo-based IPP, for the purchase of electricity at 20 US Cents/kWh, while the sale price to SBEE has remained unchanged for the time being.

In a financial report presented in April 2014, CEB indicated that "The financial situation keeps on worsening despite efforts made to manage costs with regard to purchase of electricity and the low level of the January 2013 tariff increase". CEB losses in 2011 were $ 7.244 million, increasing to $ 14.912 million in 2012. CEB losses (and profits) are shared equally between Benin and Togo and were attributed to high administrative costs, generous amounts of free electricity provided to its employees and, in the case of the PPA with Global Contour, to the sale of electricity to SBEE at half the purchase price. With the implementation of remedial measures in late 2012/early 2013, CEB operations returned to profitability, with a positive balance of almost $ 3 million in 2013, the latest year for which financial figures are available.

Société Béninoise d'Energie Electrique (SBEE - Benin Electric Power Corporation)

The Benin Electric Power Corporation (SBEE – Table 2) was founded in 2004, after a separation between the water and electricity management. It is a public company wholly owned by the Government and its overall mandate is to manage grid-connected distribution and sale of electricity in Benin, in addition to decentralized generation for rural electrification. As exception to the electricity generation rule between Benin and Togo, SBEE owns and operates the 80 MW gas turbine at Mariagleta, Cotonou (the other 20 MW gas turbine installed at the same location is owned and operated by CEB), and the 500 kW Yeripao (north Benin) hydropower station built in 1997, but which has been out of service since 2012. SBEE operates under the supervision of the Ministry of Energy and has a parastatal status that gives it management autonomy and flexibility. However, for important issues such as pricing and major project investments, SBEE needs to seek clearance from its parent Ministry. There is some degree of overlap between CEB and SBEE on the generation side, as indicated above, but this is clearly spelled out in agreements between the 2 countries so as to avoid problems associated with ownership/operation of assets. There is also the case of joint ownership of assets between Benin and Togo like the 147 MW Adjaralla hydropower station presently under construction on the Mono River that straddles the border between both countries.

Table 2: SBEE Snapshot, 2010 – 2013

Data / Year	2010	2011	2012	2013
Purchase from CEB/Auto-Generation, GWh	877.89	1,005	1,065	1,095
Sale, GWh	770.39	796.24	840,55	864,69
Losses (%) (approx. 80% technical and 20% non-technical).	20.09	21.76	21.70	21.27
Low Voltage Grid, km	4,597	4,891	4,968	5,256
Medium Voltage Grid, km	2,900	3,3600	3,380	4,770
High voltage Grid, km	136.11	136.11	136.11	136.11
Low Voltage Consumers	416,211	437,092	454,199	483,649
Medium Voltage Consumers	667	731	772	837
Operational Loss/Profit (Million $)	-2.76	2.8	5.46	3.65

The electricity grid in Benin consists of two parts: the northern grid and the southern grid and they have no direct in-country connection; interconnection of these two grids takes place via Togo through the wider bi-national grid. This results in, for example, electricity generated in the northern grid for supply to the southern grid having to transit via Togo and vice versa. Electricity purchased by SBEE from CEB was in 2014 at an average of 10 US Cents/kWh (to which should be added another approx. 5 - 6 US Cents/kWh for distributing and commercialising it) while its own production at the Mariagleta gas-turbine plant was 69 US Cents/kWh. For those consumers connected to the SBEE main grid/isolated grid, the tariff structure is as per Table 2a below. Technical losses in

the SBEE grid in 2012 were on the high side at 17.4% while non-technical (commercial) losses due to non-payment of bills and/or electricity heft amounted to a fairly low 4.3 %, thus indicating that the general capacity of consumers to pay their electricity bills is quite high.

Table 2a: SBEE Electricity Tariff Structure (2014)

Consumer Category	Tariff (US Cents/kWh)
BT1: Domestic ≤ 20 kWh	15.6
BT1: Domestic 20 kWh - ≤ 250 kWh	21.8
BT1: Domestic ≥ 250 kWh	23.0
BT2 : Professional (Stores, Cafés, Restaurants, Beauty Salons, etc.	22.2
BT3: Public Lighting	24.4
MT1: Hotels, Services, Businesses	18.8
MT2: Hotels, Services, Businesses	18.8 + $ 9/kVA charge
MT3: Industries	15.6
MT4: Industries	15.6 + $ 14/kVA charge

During the years up to 2010, SBEE use to run operational losses, with the main culprits being usage by Government services. That is when the Government made the decision to introduce prepayment for all consumers, with implementation of this decision to be completed by 2012. Hence, since 2011, SBEE has returned to profitability. Still, the financial situation remains fragile due to the increasing costs of auto-generation and technical/commercial operations, an increasing trend in non-technical losses and implementation of rural electrification, despite this responsibility lying on the shoulders of ABERME, the Rural electrification Agency (see below). In addition, there is always the risk that the Governments of Benin and Togo may decide to substantially increase the sale price of electricity to SBEE, which is presently maintained at the low price of 10 US Cents/kWh.

Since 2006, the CEB has been unable to supply the agreed amount of electricity to SBEE, the national electricity utility, due to the energy crisis in the three supplier countries. In order to meet the main grid-connected domestic demand, the SBEE now operates costly gas turbines to generate electricity (at 69 US Cents/kWh in 2014 at Mariagleta), which consume annually about 120,000 tons of imported gas through the gas pipeline that supplies gas from Nigeria to Ghana via Benin and Togo. Gas turbines are very expensive to operate; that is why they are mostly utilised a few hours a day to meet the peak demand. However, because of shortage of generating capacity, they often operate at off-peak hours. Even with the gas turbine running almost as a base-load plant, the country is unable to meet the demand for electricity by consumers connected to its main grid and has to resort to power cuts and load shedding. Table 3 provides information on the share of electricity in the country's energy mix; as it can be evidenced, it is quite low compared to biomass and petroleum products.

Table 3: Final energy consumption by source (ktoe)

Source / Year	Biomass	Petroleum Products	Electricity	Total
2006	1,480	1,059	55	2,593
2007	1,525	1,216	61	2,802
2008	1,567	1,261	67	2,894
2009	1,609	1,435	69	3,113
2010	1,654	1,615	75	3,344

2011	1,722	1,825	82	3,581
2012	1,792	2,062	90	3,836
2013	1,866	2,330	98	4,108
Average increase (%/year)	4,1%	13%	9.5%	7.1%

There are also several villages that have no access to the main grid and, instead, are supplied by isolated diesel-based mini-grids operated by SBEE, e.g. in Kandi (5.5 MVA), Malanville (1.5 MVA), Nikki (1 MVA), Parakou (31.25 MVA), etc. The electricity in these mini-grids is generated at a high cost (40 US Cents/kWh), normally for only 6 hours per day. The same tariffs provided in Table 2a above are practised in these mini-grids, resulting in rural consumers being heavily subsidised, with the subsidy on every kWh varying from 30% to 50%. (Source: On-Grid Rural Electrification in Benin, GIZ, 2010).

Some 75% of the population presently do not have access to electricity services; as an example, in 2008, only 27.1% of households in the country had access to electricity against a target of 33.7% established under the Millennium Development Goals. Over the next ten years, the grid in Benin will likely expand and more of the population will have access to electricity, albeit with frequent power cuts. Still, the national target for rural electrification of 36% by 2015 and 65% by 2025 is unlikely to be met - in 2008, the actual figure was 2.5% against a target of 6.6%. And where rural electrification is being undertaken, it is through expansion of the national grid or construction of diesel-based isolated mini-grids, rather than focus on renewable energy for electricity generation. At the present time, the share of renewable energy in the country's electricity generation mix is less than 5%, consisting mainly of a small amount of hydropower and some small industrial units generating their own electricity from the burning of biomass residues such as cotton and palm husks. In the near term, the future development of renewable energy in Benin for grid-connected solutions appears quite bleak for the simple reason that the Government has other more pressing priorities with the limited resources it has at its disposal; hence, its willingness to create opportunities for the private sector in electricity generation. Hopefully, with the recent establishment of ANADER (National Agency for the Development of Renewable Energy and Energy Efficiency – see below), renewable energy should receive a boost if the objective of having a minimum of 25% of renewable energy in the national electricity mix were to be met. To achieve this, the Government will need to capitalise on harnessing hydropower, in particular in the northwest for capacities lower than 1,000 kW, in the centre of the country for capacities between 1,000 and 2,000 kW and in the south for larger installations – these capacities are constrained by the availability of hydro resources. In addition, reported solar radiation of 3.5 to 5.0 kWh/m^2/day provides Benin with a good potential for generating electricity from PV. With regard to wind electricity generation, the wind speed fluctuates between 3 and 5 m/s at a 10-m height; however, wind measurements need to be undertaken at/extrapolation undertaken for higher altitudes to accurately map the country's potential which appears particularly promising along the Bight of Benin.

In addition, agricultural practices in the country produce an abundance of "renewable biomass" in terms of crop residues such as cotton and maize stalks, rice husks, etc. that can be utilised for energy purposes, i.e. for electricity production in gasifier engines. The Government is cognisant of the fact that the country's heavy reliance on forestry biomass for most of the energy needs of the population, both in the rural and urban/peri-urban areas, is not sustainable, especially when some 50% of the huge amount of agricultural (crop) residues produced remain unused and is allowed to rot in the fields or disposed of through open-air combustion. Thus, there is a keen awareness among decision makers of the need to shift towards more sustainable and modern forms of energy utilising this "waste" renewable, non-forestry biomass. Gasification technology utilising these agricultural by-products presents an interesting alternative for generating electricity to provide modern electricity services to the rural areas. In addition, increased use of gasifiers for electricity generation for lighting and income-generating activities will displace the importation and use of petroleum products for this purpose. Kerosene used to be the fuel of choice for lighting in the rural areas, but it is being largely replaced by widely-available disposable

battery-operated LED lamps, commonly known as "Chinese lamps", reflecting their country of origin/manufacture. Thus, the transformation of the rural energy sector to an economically viable and environmentally friendly system requires a comprehensive and multi-faceted approach in the design of appropriate policy and planning frameworks, and incentives to fully integrate gasification technology into the country's energy mix.

The Ministry of Energy, Petroleum, Mineral and Water Resources, and Renewable Energy Development (in future referred to, in short form, as "Ministry of Energy") has responsibility for formulating Energy Policy in the country. Implementation of this policy is entrusted to several Departments under its responsibility, including:

- La Direction Générale de l'Energie (DGE – The Energy Directorate): It formulates, in cooperation with other national relevant entities, Government's policy in the Energy Sector and ensures implementation, follow-up and evaluation.
- La Communauté Electrique du Bénin (CEB): It is responsible for electricity import from neighbouring countries and electricity generation and transmission for Benin and Togo, as indicated earlier.
- La Société Béninoise d'Energie Electrique (SBEE): It is responsible for distribution and commercialisation of electricity in Benin, and for operating diesel-based isolated mini-grids for rural electrification.
- L'Autorité de Régulation de l'Electricité (ARE – The Electricity Regulatory Authority): Its mission is to ensure that legislation and regulations governing the electricity sub-sector are followed, to protect general interest and guarantee service continuity, the quality of service, the financial stability of the sub-sector and its development. This authority was established in May 2013 and reports directly to the Office of the President of the Republic. However, it is not yet operational.
- L'Agence Béninoise d'Electrification Rurale et de Maîtrise de l'Energie (ABERME – Agency for Rural Electrification and Energy Management): It is responsible to implement the Government's policy on rural electrification and energy management. In this connection, it recently embarked on the formulation of a National Energy Management Policy (PONAME - Politique Nationale de Maîtrise d'Energie) which will serve as a framework for actions on energy efficiency in the country.
- L'Agence Nationale de Développement des Energies Renouvelables et de l'Efficacité Energétique (ANADER – National Agency for the Development of Renewable Energy and Energy Efficiency): It became operational in June 2014 and is geared towards promoting the growth of renewable energy to meet the needs of the population for modern energy services and the rational use of energy in all sectors of the national economy. Its objective is to have a minimum of 25% of renewable energy in the national electricity mix and a 20% savings on energy consumption, both by 2025. As of today, these are at 5% for renewable energy and 4% for energy efficiency[3].
- Benin is also part of the West African Power Pool (Échanges d'Énergie Électrique Ouest Africain - EEEOA), an ECOWAS institution that aims to integrate the national electricity grids of the participating countries into a unified regional market that would ensure, in the medium and long term, and through development of cross-frontier electricity exchange, an optimal and viable electricity supply at a cost that would be affordable to the population of its member states.
- Commission de Modélisation Economique des Impacts et de l'Intégration des Changements Climatiques dans le Budget General de l'Etat (CMEICB – Commission on Economic Modelling of Impacts and Integration of Climate Change in the State Budget - established on 16 June 2014): This Commission is under the Ministry of Development and its objective is to develop tools and evaluation methodologies, modelling and economic forecasting climate change impacts in order to optimise low carbon and climate resilient adaptation strategies.

[3] SE4All Draft Country Report, 2015.

1.3. National Strategies and Plans

In December 2003, the Government approved an "Energy Policy and Strategy" document that underscores the necessity to address the following issues:

- To meet the energy needs necessary for economic and social development (production sector, household requirements, both quality- and quantity-wise);
- To ensure protection of the environment; and
- To promote the development of technical and administrative structures for an intersectoral approach.

In order to meet the objectives of the policy, the Government elaborated an implementation strategy that would focus on:

- Improving the commercial balance by reducing the energy bill and improving the competitiveness of enterprises producing goods and services;
- Management of the national energy system through improved development of natural resources and a reduction in the negative impacts of energy on the environment;
- Energy use in the rural areas for income-generating activities and to reduce the rural exodus towards urban areas; and
- Improved coordination of resources in the energy sector taking into account communal, departmental and national plans.

This implementation strategy was updated in October 2009 when the Government released a new document entitled "Strategic Plan for Energy Sector Development" that reaffirmed "the commitment of the authorities to pursue reforms initiated since 1998 in the electricity sector to: (i) improve technical management of SBEE and ensure its financial viability, (ii) promote private investment in the sector and (iii) improve access to quality energy services to the population". Strong support for renewable energy is an integral part of this Strategic Plan aimed at providing the country with the resources necessary to diversify and secure its energy supply. To achieve this, the following four specific objectives are targeted for the electricity sub-sector:

- Increase electricity generation, transmission and distribution capacity;
- Promote rural electrification and energy management;
- Put in place an adequate policy for tariffs and financing for the sub-sector; and
- Develop institutional and regulatory capacities and strengthen human resources.

As the law presently stands, the private sector in Benin is allowed to generate electricity either for self-consumption and/or for sale to CEB or SBEE and/or for operating isolated mini-grids.

The Strategy Document for Poverty Reduction (Le Document de Stratégie de Réduction de la Pauvreté (DSRP III)) 2012-2015 builds upon DRSP I and DRSP II to strengthen democracy, macro-economic stability, human development and management of the environment. In order to meet the country's energy needs from biomass and renewable energy, DSRP III articulates the importance "to focus on interventions related to the rational use of forestry resources and a continuation of the improved cook stoves programme, promotion of renewable energy. Implementation of rural electrification will be conducted through dissemination of the successfully-tested decentralized model". In the operational component 8 of the DRSP III, the government insists on the following priorities: (i) the promotion of the environmental best practices, (iii) the promotion of the integrated management at the local/territory level, (iii) the rational management of forests and natural resources. The overall objective of the government is to encourage a sustainable and harmonious development through the valorisation of resources and local potentialities, as a basis for jobs and wealth creation, and reduction of inequalities in terms of infrastructure and equipment. By enhancing value of sustainable biomass in rural areas of Benin, the project aims at injecting human and economic development into rural livelihood.

The Ministry of Environment, Climate Change, Reforestation and Protection of Natural Resources and Forests (in future referred to, in short form, as "Ministry of Environment") holds the mandate for implementing national environmental policies including environmental impact assessments, management of natural resources and protected areas and relevant international conventions (biodiversity, desertification, etc.). The Directorate General of Forest and Natural Resource (DGFRN) is directly responsible for the country's forest resources belonging to the "public domain" including the gazetted forests (forêts classées) and the forest plantation perimeters. The DGFRN designed in 2008 and implemented the National Program for Sustainable Management of Natural Resources, which aims at coordinating all projects in the forestry sector under a common strategic and participative umbrella. The DGFRN has decentralized staff in each of the country's twelve departments. They work at the grassroots level in cooperation with NGOs and village associations, but, unfortunately, their weak capacities limit their participation in sustainable management of forests. The Ministry of Environment has four other institutions also involved in the forestry sector:

- The National Office for Wood: it manages the national plantations in Teak (12,000 ha),
- The National Centre for Management of Reserves and Fauna: it manages the national parks and the wildlife reserves,
- The National Centre for tele-metering and ecological monitoring: it monitors the ecosystems through cartography and satellite technologies.
- The Research, Studies and Training Centre: it organises the research and training for the forestry sector.

Through the Decentralization law in 1999 and the more recent National Policy for Decentralization and De-concentration (PONADEC) in 2009, the government gives responsibilities to communes for the management of natural resources, plantation and land uses management. To support the decentralization, the DGFRN created Communal Section for Environment and Nature Protection (CSENP). At the level of the classified forest, Technical Units for Forest Management (TUFM) have been created.
Capacity of all institutions involved in this project requires strengthening to achieve the introduction of an integrated energy and ecosystems-based approach to sustainable biomass electricity generation in the country. For instance, the recent assessment of the forestry sector in 2011 highlights the need to strengthen the capacities for data collection and better monitoring of the natural resources.

The Forestry sector is regulated by the forestry code (law n°93-009) validated in July 1993. It organises the conservation and sustainable management of forestry resources, but is prior to the decentralisation process. A Policy for the Development of the Forestry Sector was adopted in 1994 and introduced the co-management of the forests by the population. This opens the way to a very dynamic decade of design of management plans, supported by many projects: 22 classified forests and 2 National Parks have now a Participatory Management Plans.
In order to include the decentralisation of the management of natural resources, the National Forestry Policy were updated and validated by the government in 2012. Its objective is the "conservation and the sustainable, integrated and rational management of forests, fauna and other natural resources in order to contribute to poverty alleviation of population of Benin".

The National Policy reaffirms the concept of transfer of the responsibilities to the local authority for the management of natural resources. It states three major priorities of the forestry sector:

- Implementation of the Management Plans in order to guarantee the integrity of ecosystems,
- Increase the value of natural resources (% of the GDP) while conserving the production potential,
- Improve the coordination of the management of the forestry sector while involving the active participation of all stakeholders.

With the decentralisation process and the National Forestry Policy, a new forestry code was needed and was drafted in 2013. It is currently under validation by the government.

As regards the land tenure, the government adopted in 2013 law n°2013-01 - 14 decrees were drafted and approved in December 2014. The new law defines the new legal provisions for access to property, for transactions relating to land and state land, for the rights of the confirmation process from the rural land (Certificate of Land Property), etc. This law clarifies the land tenure in Benin, gives obligation to land owner to enhance value on his land, encourages trees plantation by private landowners. It institutionalises the Rural Land Tenure Plan (RLTP), which is the legal recognition process to customary rights of land introduced by the law 2007-003. At the request of the villages, a socio-land survey on local rights and demarcation of plots is performed and a map of the village territory and a list of beneficiaries are established. Landowners identified through this process can benefit from a land certificate (Certificate of Land Property), which certifies new legal status of their individual or collective rights. To date, 383 villages are endowed with a RLTP.

The Ministry of Agriculture, Livestock and Fisheries (in future referred to, in short form, as "Ministry of Agriculture") have also decentralized staff to serve as technical advisors to communes for integrated management of agriculture, crops production and development at the grassroots level. The local staff is called "CARDER". The Declaration of Rural development Policy, adopted in 1999, gives the strategy of the sector and focusses on the conservation of the ecological heritage and the development of soil fertility management techniques. The Master Plan for rural and agricultural development (adopted in 2001) and more recently the Strategic Plan for the Revival of the Agricultural Sector (2011-2015) gives clear orientations: (i) contribute to growth and to food security with an efficient and sustainable production, (ii) encourage competivity, access to market for products with agricultural value chains. Main operational strategies are: (i) the availability of improved intrants, (ii) the mechanization, (iii) the creation of financial instruments, (iv) a better professional knowledge for innovation, (v) the sustainable management of farms, and (vi) the securisation of land tenure. A chapter of this document is dedicated to sustainable land management.

More broadly, the integrated approach promoted by the project is also in line with the following national strategies and priorities:

- "Alafia Benin 2025": published in 2000 after a participative process, this document states the vision of the country in 2025 and puts sustainable development as a major theme.
- The Wildlife Law (n° 2002/16) regulates the management and use of wildlife. Participatory management of wildlife is introduced. Article 3 states: "the management of wildlife and its habitat must be made in partnership with neighbouring communities in order to maintain and develop for the long-term their value and biological, ecological, socioeconomic, nutritional, scientific, cultural, aesthetic, and recreational functions."
- The Declaration of National Policy for Territory Management (DEPONAT): adopted in 2002 and followed by a document of Operational Strategy, the policy gives three main orientations: (i) the promotion of territorial planning and sustainable use of natural resources, (ii) the promotion of decentralization, (iii) the strengthening of local level. Tools have been developed at national and at local level: Master Plan for Territory Management (in future referred to, in short form, as "SNADT"), and Master Plan for Communal Territory Management (in future referred to, in short form, as "SDAC").
- The National Strategy for implementation of rural markets for fuelwood: adopted in 2009, the document introduces the Rural Markets for Fuelwood (RMF), which are centres of commercialization of wood and charcoal. These centres are managed by communities and supplied by sustainably managed forests.
- The National Strategy for strengthening capacities for management of forest fires: adopted in 2012, the strategy states three lines of intervention: (i) improve the organisation at the communal level to managed the forest fires, (ii) educate and communicate on the forest fires, (iii) strengthen the capacities to local communities on the forest fires.

Benin has ratified a number of multi-lateral environmental agreements, including the United Nations Convention to Combat Desertification (UNCCD), the Convention on Biological Diversity (CBD), and the Framework Convention on Climate Change (UNFCCC).

With the support of GEF and UNDP, Benin conducted a National Adaptation Programme of Action (NAPA) formulation exercise that culminated in the NAPA report being published in January 2008. The report highlights sectors where Climate Change Adaptation is possible, Adaptation scenarios and provides a list of implementable projects with high adaptation potential. The NAPA formulation exercise focused on the following 6 sectors: Agriculture, Coastal Zone, Energy, Forestry, Health and Water Resources. Among others, NAPA recommends formulation and implementation of renewable energy development strategies and sound waste management practices in agricultural development through utilisation of biomass residues to meet the energy needs of the rural population. No Nationally Appropriate Mitigation Action Plan (NAMA) yet exists for the country. However, the May 2003 National Strategy for implementing recommendations of UNFCCC highlights, among others, mitigation of GHG emissions in the country through efficient use of energy resources.

Under the United Nations Sustainable Energy for All Initiative, UNDP and ECREEE (the Cabo Verde-based ECOWAS Centre for Renewable Energy and Energy Efficiency) are assisting Benin in undertaking the mandatory exercise of evaluating the levels of efforts required in meeting the initiative's three objectives by 2030, viz. ensuring universal access to modern energy services, doubling the rate of improvement in energy efficiency and doubling the share of renewable energy in the global energy mix. The national report is still under preparation/discussions and is expected to be issued around mid-June 2015 following which the next steps would focus on mobilising technical partners and financial resources for implementation.

With regard to GHG emissions, Benin ratified the UNFCCC on 30 June 1994 and the Kyoto Protocol on 25 February 2002. The First (Initial) National Communication to UNFCCC prepared in December 2001 noted the fact that Benin was not a net emitter of GHG; the country emitted 48 million tons CO_2 in 1995 (reference year), as per the Communication, but sequestered/absorbed an estimated 65 million tons of CO_2. The GHG emissions were mainly due to the agricultural sector (70.5% of the total emissions in 1995), followed by land use and forestry (26.9%). The energy sector was responsible for only a tiny 1.84% of the total emissions, with the use of fuelwood for cooking in the household and the predominance of individual transport means, coupled with sub-quality fuel transportation sub-sectors being the main culprits. To address this issue and reduce GHG emissions, the country developed strategies to promote the use of improved cook stoves by households, charcoal and LPG use in the household sub-sector and mass transmit in the transportation sub-sector.

The Second National Communication to UNFCCC submitted in June 2011 presented significant progress achieved since submission of the First National Communication, both in terms of the range in the topics addressed and the methodological approach utilized. This Communication showed that in 2000, GHG emissions from agriculture and forestry constituted 68% of the total while those from energy had substantially increased to 30% from 1.84% in 1995; hence, among agriculture, forestry and energy, GHG emissions in the country amounted to 98%. In absolute terms, the total emissions in 2000 were 63 million tons of CO_2, an increase of 30% from the 1995 reference year, with the agricultural sector contributing 55% and the energy sector contributing 45%, while the country's net absorption capacity had decreased from 17 million tons of CO_2 in 1995 to 13 million tons of CO_2 in 2000. This net absorption capacity has further decreased to 10 million tons of CO_2 in 2005, thus showing a disturbing trend.

The Third report to UNCCD shows, on one hand, significant achievement at the institutional level (for example, the National Action Plan against desertification adopted in 2000 or the active participation of Benin in TerrAfrica). But, on the other hand, desertification is increasing in Benin mainly because of (i) little capacities at the local level, (ii) lack of synergies and coordination between initiatives, (iii) little financial resources and projects dedicated to sustainable agriculture practices promotion. The Strategic Plan for Investment on

Sustainable Land Management, published in 2012, has the objective to turn into actions the strategy of the country in term of sustainable land management.

The Ministry of Environment published in 2014 the fifth report to UNCBD, which presents an improvement in terms of habitat protection (land forest cover) thanks to efforts made by the government and support by projects during the last decade. However, the report highlights a number of spaces for improvement, both in terms of green economy (enhancing value of biodiversity), better management of forests and sustainable agricultural techniques adoption. The National Biodiversity Atlas has been published and 10 species are in the UICN Red List.

In the absence of mitigation measures and with the increase in deforestation due to fuelwood consumption for cooking and land clearance for agriculture and mining, it is evident that the absorption capacity of the forests will decrease further over the coming years; however, no forecast has yet been made for these years. Hence, the Second National Communication recommends an integrated approach involving the agriculture, energy and land use sectors to both address the issues of increasing GHG emissions and decreasing absorption capacities of the country's forestry resources. In this connection, the use of the tremendous amount of biomass waste generated in the agricultural sector for electricity generation, through the utilisation of biomass gasifiers to both supply the existing grid and to implement decentralised rural electrification through isolated grids, is one of the options in a basket of measures that the Government wants to pursue to reverse the increasing trend in GHG emissions. In fact, the Second National Communication recommends the installation hydropower plants (147 MW), biomass plants (30 MW), solar plants (25 MW), and wind plants (10 MW) by 2030 in an effort to reverse the increasing trend in GHG emissions in the country.

1.4. Baseline Situation and Problem to be addressed

The northern part of the country has an abundance of agricultural biomass that is left unutilised after the crops have been harvested. To utilise these "waste" biomass resources, UEMOA commissioned a feasibility study in 2008 for the installation of a gasifier to operate either a 250 kVA or a 400 kVA generator to supply a mini-grid in Bouka in the department of Kalalé in the north-eastern part of the country. For the 250 kVA case, the installation cost was computed at $ 3,600/kVA, while it was going to be $ 3,250/kVA for the 400 kVA case. With a 15-year gasifier life, operation during 7,000 hours/year (a Capacity Utilisation Factor (CUF) of 80%) and a payback period of 10 years, the sale price of electricity to the SBEE grid was computed to be US Cents 20.3/kWh. For comparison purposes, the average SBEE generation cost for diesel-based isolated mini-grids is 40 US Cents/kWh, to which should be added the cost of transmission and/or distribution, as appropriate.

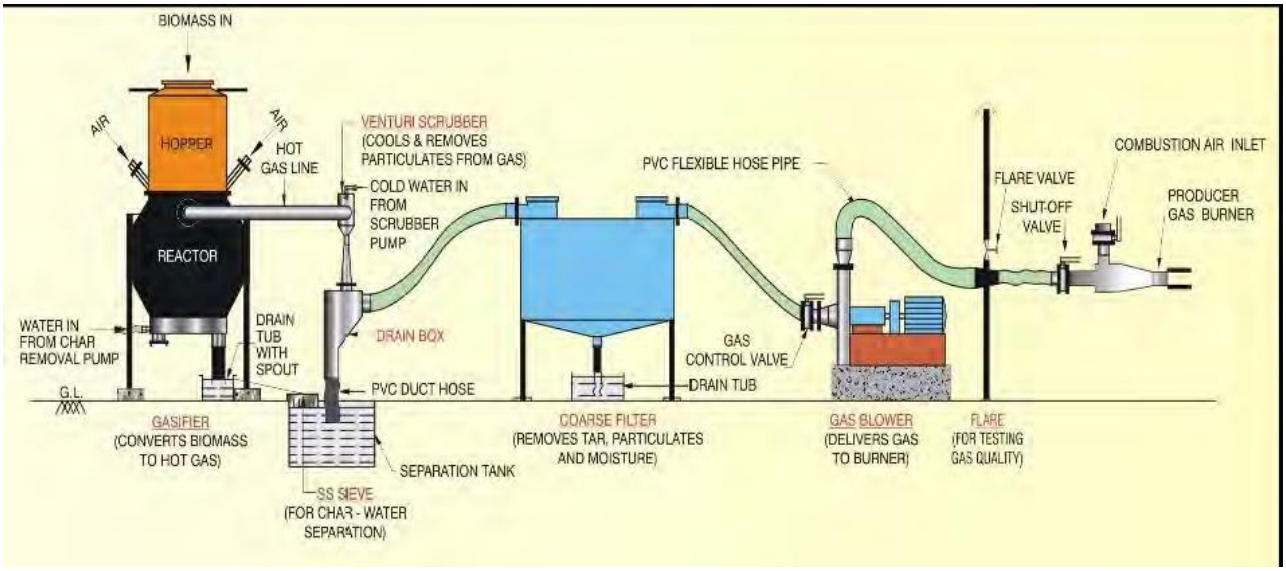
Upon completion of the feasibility study, a call for bids from private investors was issued. However, although proposals were received from potential private investors, no acceptable Power Purchase Agreement (PPA) could be negotiated with any one of them; hence, this project was shelved indefinitely. Following this aborted start, the German company Novis in 2010 piloted the first biomass gasifier in the country when it installed a 40 kVA (32 kW) generator operating on forestry biomass to supply electricity to the hospital in Gohomey, located some 200 km to the west of Cotonou. The villagers were committed to bringing biomass to the gasifier and, in exchange, they benefited from free healthcare. Although the hospital was connected to the grid, the gasifier was installed to provide back-up electricity during the frequent power cuts. This installation operated for about a year, after which it started experiencing technical problems due to insufficient maintenance; the result is that it has not been in operation since then. Following this, a private entrepreneur installed a 25 kVA gasifier at his farm in Sekou, some 50 km from Cotonou, to operate on agricultural waste that the farm produces and to utilise the electricity generated to operate his furniture factory. Unfortunately, this pilot also failed in approx. a year, again due to lack of proper maintenance. Next, another pilot was implemented at the Songhai Centre (an NGO established in 1985 in Porto-Novo) in 2012 when it installed a mixed wood (acacia)/agricultural waste-fuelled gasifier that operates a

40 kVA (32 kW) generator 8 hrs a day to supply electricity to its factory producing plastic bags. The Songhai gasifier continues to operate as of this day and the Centre technicians have accumulated a wealth of experience in its operation and maintenance. Lastly, Euro-Négoce is in the process of building a 6-MW single-unit gasifier plant to operate on agricultural biomass at Kandi (located in the north-eastern part of the country, 650 km from Cotonou) to supply the SBEE network; commissioning of this plant is expected around the first semester of 2016.

Biomass gasification is a process in which solid biomass fuels (e.g. wood/wood chips, rice husks, corn stalks, etc.) are broken down by the use of heat in an oxygen-starved environment to produce a combustible gas. The process involves essentially a chemical reaction in a reactor or gasifier where various complex physical and chemical processes take place. The biomass gets dried up, heated, pyrolysed, partially oxidized and reduced in this reactor as it flows through it. Four distinct processes (see below) take place in a gasifier and each process can be considered to be occupying a separate zone in which fundamentally different chemical and thermal reactions take place. The fuel (biomass) must pass through all of these processes (zones) to be completely converted to gas. The gas in the exit stream is relatively clean and can be burned in an internal combustion engine to produce shaft power to generate electricity[4].

Schematically, the process takes place as depicted in Fig 2 below.

Fig 2: Producer Gas Process



Source: UEMOA Feasibility Report "Benin: Pilot Decentralised Electrification through Utilisation of Agricultural Residues", October 2008.

Gasifiers have been used to make fuel (producer gas) from biomass (and coal) since the middle of the 19th century. In fact, town gas, made from coal, was supplied commercially in many countries in the early 20th century until it was replaced with natural gas.

The gasification of biomass takes place in four stages:

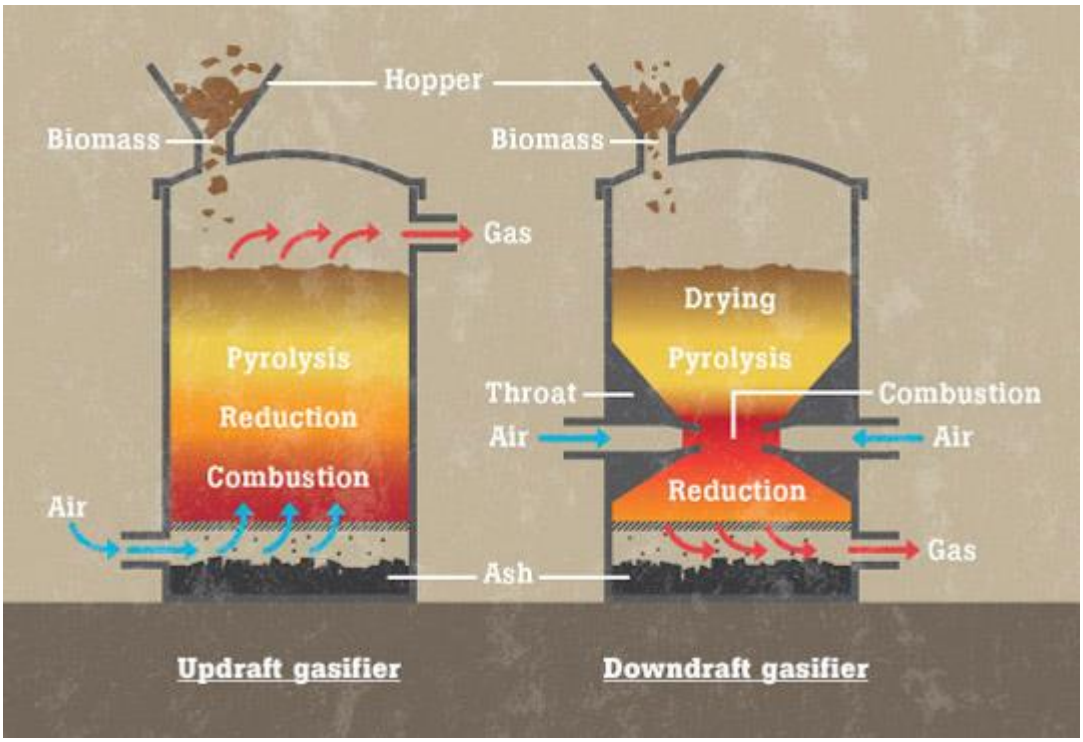
- Drying: water-vapour is driven off the biomass.
- Pyrolysis: as the temperature increases the dry biomass decomposes into organic vapours, gases, carbon (char) and tars.

[4] Source: www.biomassgasifier.com

- Reduction: water-vapour reacts with carbon, producing hydrogen, carbon monoxide and methane. Carbon dioxide reacts with carbon to produce more carbon monoxide.
- Combustion: some of the char and tars burn with oxygen from air to give heat and carbon dioxide. This heat enables the other stages of the gasification process to take place.

Producer gas (also known as synthetic gas or syngas) from a gasifier contains carbon monoxide, hydrogen and methane in various proportions depending on the biomass used, all of which can be burned to release heat, as well as nitrogen and carbon dioxide, which are inert. The heat released by producer gas is quite low (about 4 MJ per kg compared to 50 MJ per kg for pure methane).

Fig. 3: Updraft and Downdraft Gasifiers



Source: www.ashden.org

In gasifiers, the reactions take place in a stationary or fixed 'bed' of biomass (Fig. 3). In an updraft (French: à contre-courant) gasifier, biomass is loaded at the top of the gasifier and air is blown in at the bottom. This type of gasifier produces gas that is contaminated by tar and is therefore too dirty to be used in an internal combustion engine, causing clogging and corrosion. In a downdraft (French: à courant) gasifier, air is drawn downwards through the biomass. The main reactions occur in a constriction or 'throat', where the tars and volatile gases break down into carbon monoxide and hydrogen at a much higher temperature than in an updraft gasifier. The throat is usually made from ceramic to withstand this high temperature. The producer gas leaves at a temperature of over 600°C, and contains fine particles of char and ash. The gas must be filtered to remove these particles and also cooled to below 100°C to condense tars, before it can be used in an engine. Downdraft gasifiers produce cleaner gas and is often the preferred choice for electricity generation.

Agricultural waste produced from farming activities in Benin is used in the rural areas for a variety of purposes, including as fodder for animals, construction of fences around individual houses and, to a small extent, as fuel cooking, and the rest is left over in the fields to rot in order to "strengthen" the soil as fertiliser. Despite these "competitive uses", a large amount of agricultural waste (approx. 45%) is discarded as "nuisance" through open-

air combustion in the fields and this huge quantity of crop residues (Table 3) is potentially available to be used in gasifiers for generating a substantial amount of electricity.

Table 3a: Availability of Agricultural Residues, 2008 – 2013

2008-2009						
Crop	Average Annual Production	Conversion factor from yield to residues	Wet Agricultural Residue	Agricultural Residue available for Electricity Generation	Potential Generation Capacity	Annual Potential Electricity Generation
	tons/year		tons/year	tons/year	MW	MWh/year
Maize	978,063	5	4,890,315	2,102,835	630.85	3,848,188
Sorghum	142,016	2.5	355,040	152,667	45.80	279,381
Millet	36,282	2.5	90,705	39,003	11.70	71,375
Rice	109,371	1.2	131,245	56,435	16.93	103,276
Cottons	210,604	4	842,416	362,239	108.67	662,897
2009-2010						
Maize	1,205,200	5	6,026,000	2,591,180	777.35	4,741,859
Sorghum	123,959	2.5	309,898	133,256	39.98	243,858
Millet	27,430	2.5	68,575	29,487	8.85	53,961
Rice	150,604	1.2	180,725	77,712	23.31	142,213
Cottons	166,142	4	664,568	285,764	85.73	522,948
2010-2011						
Maize	1,012,630	5	5,063,150	2,177,155	653.15	3,984,194
Sorghum	168,090	2.5	420,225	180,697	54.21	330,676
Millet	26,926	2.5	67,315	28,945	8.68	52,969
Rice	124,975	1.2	149,970	64,487	19.35	118,011
Cottons	136,958	4	547,832	235,568	70.67	431,089
2011-2012						
Maize	1,165,957	5	5,829,785	2,477,659	612.2	3,754,673
Sorghum	133,213	2.5	333,033	141,539	42.6	261,329
Millet	24,690	2.5	61,725	26,233	7.9	48,435
Rice	219,626	1.2	263,551	112,007	37.7	231,374
Cottons	265,178	4	1,060,712	450,802	197.8	1,213,124
2012-2013						
Maize	1,200,936	5	6,004,679	2,582,012	775	4,750,643
Sorghum	137,209	2.5	343,023	147,500	44	271,385

Millet	25,431	2.5	63,577	27,338	8	50,299
Rice	226,215	1.2	271,458	116,727	35	214,766
Cottons	273,133	4	1,092,533	469,789	141	864,365

Source: Actual figures for 2010 – 2013 from Millennium Challenge Account's (MCA - A Development Aid Programme of the US Government) Project "Energy Access". Figures for prior years are based on estimates.

Biomass gasifiers have been used/are presently in use in many developing countries, both small and large, like Brazil, Burundi, China, India, Indonesia, Paraguay, Philippines, Seychelles, Vanuatu, etc. As far back as in the late 1980s/early 1990s, the Biomass Gasification Monitoring Programme sponsored by the World Bank's ESMAP Programme (Energy Sector Management Assistance Programme) initiated a four-year biomass monitoring programme (1986-90) to compile uniform data on the performance, economics, safety, and public acceptability of biomass gasifiers in Africa, Asia, and Latin America. One of the main conclusions of this monitoring programme was very valid then and is still valid now, viz. "Donor agencies should concentrate on building local capability through training and transfer of technology rather than on simply providing expertise and equipment. Building local capacity is a slow process, but it is the only one that will lead to successful projects that benefit rural communities. Simply setting up a project and then leaving is a waste of time and money". This is exactly the issue that the present UNDP-GEF project is set to address.

Land Uses and Forests Management

In spite of the apparently favourable geographical position, Benin is not a forest country like neighbouring Nigeria, Ghana and Cote d'Ivoire. However, about 65% of the whole territory is covered by bushy vegetation (see table 1a). However, much of the trees are found in woodland savannah, open forests and in gallery forests along creeks and rivers.

Eight broad agro-ecological categories (based on ecosystem, soil and land use) were officially identified for Benin: (i) The Sudano-Sahelian area (in extreme North), (ii) The North-East Sudanese area, (iii) The North Sudanese area, (iv) The North-West Sudanese area, (v) The Sudan-Guinean savannah area, (vi) The "terre de barre" area, (vii) The depressed area, (viii) The coastal area. A detailed outline of each eco-geographic zone is given in Table 3b, where the global environmental significance of each eco-geographic zone is stressed.

AGRO-ECO-GEOGRAPHIC ZONES	KEY CHARACTERISTICS AND GLOBAL ENVIRONMENTAL SIGNIFICANCE
I/ The sudanese sahelian area (extreme North)	The Sudanese sahelian area covers about 6,000 ha over the two communes Malanville and Karimama. There are two types of soils in this zone: the ferro-soil with a crystalline base and the very fertile alluvial soils of the River Niger. The zone is susceptible to high erosion. This area is characterized by Sudanese ecosystems. The main species are *Aftelia africana, Daniellia oliveri, Burkea africana, Isoberlina doka, Vitellaria paradoxa, Parkia biglobosa, Terminalia spp., Lannea spp.Combretum spp., Pericopsis laxiflora, Detarium microcarpum, Crossopteryx febrifuga, Gardenia…*[5]. The classified forests of this area are: Alibori Supérieur, Gougou, Goroubi, le Parc W du Niger, la Djona. The ecosystems are threatened by erosion, fire, desertification, over-grassing of animals, extansion of agricultural lands and land uses change, and inappropriate agricultural practices. The main crops found here are millet, sorghum and cowpea. In addition, cotton, maize, rice, beans,

[5] DGFRN et CERF. 2014. 5ème Rapport national a la convention sur la diversité biologique au Bénin. 99 p.

AGRO-ECO-GEOGRAPHIC ZONES	KEY CHARACTERISTICS AND GLOBAL ENVIRONMENTAL SIGNIFICANCE
	onions and vegetables are also grown along the Niger and Alibori Rivers. Potato has only been recently introduced. The major advantages are the vast expanse of arable land and the practice of animal drawn harnessed cropping. The land bordering the rivers allows for large scale off season market gardening such as pepper and tomato. Two large markets namely the Karimama and Malanville markets provide outlets for marketing agricultural products.
II/ The North-East sudanese area	The North-East Sudanese area covers 20,930 km2 over the communes of Banikoara, Kandi, Ségbana, Gogounou in the department of Borgou, Kérou and the extreme North of Kouandé. The climate is tropical with only one rainy season (800 to 2000 mm per year). The soil type is ferrosol on a crystalline base. This area is characterized by degraded Sudanese ecosystems. The main species are *Aftelia africana, Daniellia oliveri, Burkea africana, Isoberlina doka, Vitellaria paradoxa, Parkia biglobosa, Terminalia spp., Lannea spp.Combretum spp., Pericopsis laxiflora, Detarium microcarpum, Crossopteryx febrifuga, Gardenia…*[6]. The classified forests of this area are: Alibori Supérieur, Sota, 3 Rivières, Alibori Supérieur. Extansion of cotton lands, illegal hunting and incresing need of woodfuel threaten the ecosystems of this area. The cropping of cotton is well-developed and adds some vibrancy to the socio-economic activities in the zone. The agro-economic conditions are conducive to the cultivation of a wide variety of crops such as cotton, maize, groundnut and sorghum which are grown each year. The perennial crops are shea-butter and cashew-nut trees. The root crops are yam and cassava used for chips.
III/ The North sudanese area	The North Sudanese area covers 23,442 ha and covers the southern Borgou except the south of Tchaourou and extends from Pehunco, eastern Djougou in the District of Donga, to northern Tchaourou, Parakou and N'dali, Perere, Nikki, Dinende, Kalade and Bembereke all in the Borgou District. It has a tropical climate with a monomodal rainfall pattern. The soil is tropical ferrosol and its fertility is variable and susceptible to leaching. The vegetation is savannah shrub with a dominance of *Butyrospermum paradoxa* (shea-butter) species and combretaceae. Gallery forests are also observed and host species such as *Syzygium guineense, Uapaca togoensis, Berlinia grandiflora, Breonadia salicina, Khaya senegalensis,Elaeis guineensis, Manilkara multinervis, Vitex doniana, Mimusops andongensis, Diospyrosmespiliformis, Synsepalum passargei, Fadogia agrestis, Ficus spp., Celtis integrifolia, Borassus aethioplium* et *Raphia sudanica.*[7]. The classified forests of this area are: *Ouémé Supérieur, TchaourouToui-Kilibo, la forêt de Parakou.* The main threats to ecosystems are unsustainable livestock management. The cropping system is mainly sorghum and yam with a high incidence of cotton and maize intercropping. Cassava, peanut, rice and legumes are also grown. The numerous advantages of this zone are (i) an agro-ecology suitable for fruit and forest crops, (ii) land availability, (iii) easy access to agricultural inputs, (iv) possible access to agricultural services: labour, transport for harvested produce, and (v) a relatively developed livestock breeding sector.

[6] DGFRN. 2014. 5th National Report for the Convention of Biodiversity, 99 p.

[7] Akoégninou et al. 2006. Flore analytique du Bénin. 1020

AGRO-ECO-GEOGRAPHIC ZONES	KEY CHARACTERISTICS AND GLOBAL ENVIRONMENTAL SIGNIFICANCE
IV/ The North-West sudanese area	The North-West Sudanese area covers 31,200 km2, and is made up of Ouake, Copargo, Boukoumbe, Tanguieta, Materi, Natitingou, Toukountouna, Kouandé, Cobly and the west of Djougou communities. The climate is tropical and tends towards the dry savannah with an irregular and fluctuating rainfall pattern. The soil type is ferrosol with a deep base and poor water reserve. These soils are scarcely fertile except the swampy areas. The vegetation includes (i) savannah in which main species are *Terminalia spp., Combretum spp., Guiera senegalensis, Pteleopsis suberosa, Entada africana, Pterocarpus erinaceus, Acacia sieberiana, Bombax costatum, Vitellaria paradoxa, Parkia biglobosa, Lophira lanceolata, Crossopteryx febrifuga, Nauclea latifolia,* (ii) dry forests in which main species are *Anogeissus leiocarpus, Acacia polyacantha, Khaya senegalensis, Aftelia africana, Burkea africana, lsoberlinia tomentosa, Diospyros mespiliformis, Celtis integrifolia* and forests gallery. The classified forests of this area are: the park of Pendjari, Kilir, Soubroukou, Tanéka Koko, Ouémé Supérieur, la forêt classée de natitingou. Vegetation and soil are very degradated (MDAEP PASD, 2014). Extansion of urban areas[8] is one of the main drivers. The cropping system is dominated by millet, sorghum, fonio, Bambara groundnuts, cowpea and groundnut. The swamps and some water reserves offer the possibility of growing cocoyam, water yam, sweet potato, rice and off-season market garden produce.
V/ The Sudanese Guinean transition area	The Sudanese Guinean savannah covers 16,900 km2 in the communes of Djidja, Savalou, Dassa-Zoumè, Savè, ouèssè, Aplahoué, Kétou, Parakou, Tchaourou and Bassila. The vegetation is dry semi-deciduous forest and a tropical guinea savannah with a high rainfall pattern (1 100 to 1 400 mm per year). The classified forests in this area are: Pénéssoulou, Soubouroukou, Sérou et Sèmèrè. The main species are: *Khaya randifoliola, Celtis zenkeri, Celtis toka, Zanha golungensis, Bosqueia angolensis, Anogeissus leiocarpus, Trichiliaprieuriana, Diospyros mespiliformis, Cola gigantea, Diospyros monbuttensis* et *Antiaris toxicaria*[9]. Yams, maize, cassava, groundnut, rice, citrus and cashew-nut are the main crops grown in this zone. Shea-butter, almonds and *Parkia* nuts as well as maize and groundnut are marketed in Djougou and Togo. In the Ouemé District (north of Ketou and north of Pobé), the zone is very fertile and is suitable for growing maize, groundnut, cowpea, cassava, yam and cotton. The income-generating activities revolve around the collection and marketing of maize, cowpea and yam. In the Zou District (northern Zou and Djidja), the annual crops grown are yams, cassava, cotton, groundnuts, cowpea, maize and pepper. Off-season farming such as off-season market garden produce and rice are undertaken in the swamps of Dassa, Glazoue and Savalou and the marketing of food crops and their derivatives is very developed.
VI/ The "terre de barre" area	This zone covers 10,500 km2 and extends from the Plateau, Atlantic, Mono-Couffo and Ouemé to the Zou districts and is characterized by a tropical guinea climate and a bimodal rainfall pattern

8 DGFRN et CERF 2014. Stratégie et Plan d'Action pour la Biodiversité 2011-2020. 89 p. et DGFRN et CERF. 2014. 5ème Rapport national a la convention sur la diversité biologique au Bénin. 99 p.

9 Henri Cossi MEDOADOKON. 2013. Evaluation de l'effet des méthodes d'enrichissement par layons-placeaux dans la forêt classée de Tchaourou-Toui-Kilibo en zone soudano-guinéenne au centre du Bénin. Mémoire de Thèse d'Ingénieur Agronome. Option : Faculté des Sciences Agronomique (FSA).Université de Abomey-Calavi : Option Aménagement et Gestion des Ressources Naturelles. 53 p.

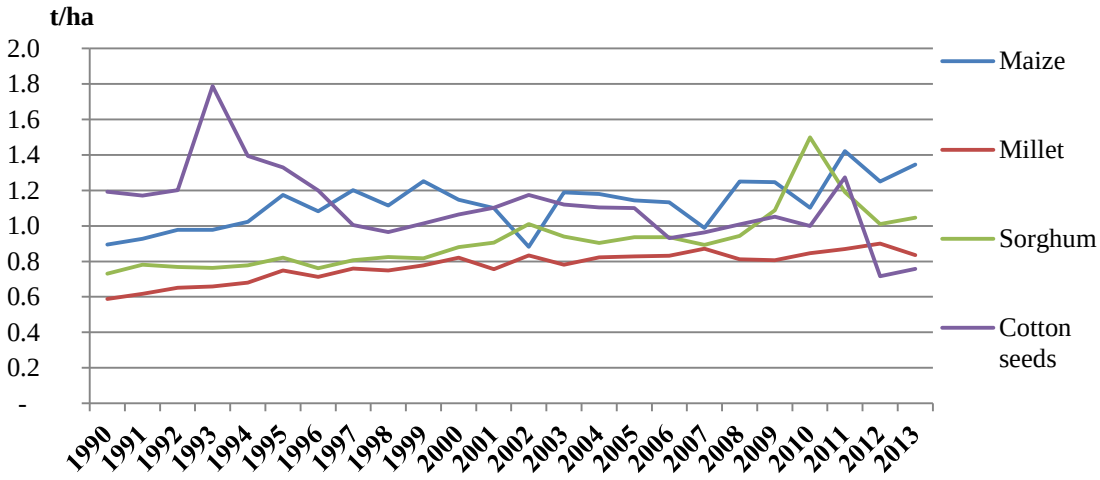
AGRO-ECO-GEOGRAPHIC ZONES	KEY CHARACTERISTICS AND GLOBAL ENVIRONMENTAL SIGNIFICANCE
	(1000 to 1200 mm each year). The soil is hard pan profoundly degraded and easy to work on. Vegetation is mainly dry forest with the following species: *Albizia adiantifolia, A. glaberrima, Aftelia africana, Antiaris toxicaria, Antidesma laciniatum* et *Antidesma membranaceum, Ceiba pentandra, Celtis mildbraedii, Cola cordifolia,* C. *millenii, Pterygota macrocarpa, Sterculia tragacantha, Terminalia superba* et *Triplochiton scleroxylon.* Collection of wood and non-forest products, especially medicinal plants, increases pressure on the ecosystems[10]. The crops cultivated here are maize, peanut, cowpea, cassava, pepper, coffee, fruit trees (mangos, citrus, and banana) and oil palm trees. Legumes, livestock breeding, aviculture and aquaculture are also practiced. Private irrigation initiatives from artisanal drillings or from waterways to support off season legume farming and rice cultivation have started in this zone.
VII/ The depressed area	This zone covers 2000 km2 and extends from the Atlantic, Mono, Ouemé and the Zou Districts. It is characterized by a tropical guinea climate with a bimodal rainfall pattern. Its humid and deep clayey soil is fertile but often hydromorphic and difficult to work on. Vegetation is dense with species suche as *Anogeissus leiocarpus, Diospyros mespiliformis, Culcasia saxatilis, Cynometra megalophyl/a,Dialium guineense, Drypetes floribunda, Lonchocarpus sericeus, Memecylon afzelii,Mimusops andongensis, Strychnos aftelii* and *Syzygium guineense.* Teak plantations are largely managed by ONAB. The classified forests are: la Lama, Agrimey, Djigbé, Toffo. The cropping system is dominated by maize (leading rotating crop), cowpea and vegetables, rice and forest trees, smallholder stock-raising and aviculture.
VIII/ The coastal area	The coastal area covers 3,500 km2 and it stretches from the Atlantic, Mono to the Ouemé Districts. The climate is tropical Guinean with a bimodal rainfall pattern. While the alluvial soil is very fertile, the sandy soil of the littoral is marginally fertile. Vegetation is dominated by coconuts trees, *Eucalyptus, Filao, Acacia auriculiformis*, cashewnut trees. Classified forests are : *Sèm et, Pahou.* The cropping system is dominated by maize (lead rotating crop), cowpea and vegetables. Maize and cassava are the major crops grown on the sandy soils. The Atlantic and Littoral Districts encompasses the urban towns of Cotonou, Ouidah and the Abomey-Calavi and So-Ava communities. Arable land is not readily available: off-season crop and vegetable cultivation is carried out in the valleys and include fresh maize, tomato, pepper, and vegetables.

All the selected pilot sites (see part 1.7) are affected by land degradation and deforestation. As indicated above, poorly managed shifting agriculture and the absence of effective land planning degrade soils and ecosystems. Moreover, major pressures on the ecosystems are driven by demand for wood and for charcoal as a domestic fuel in the capital, and by illegal trees cutting for extension of agricultural lands. However, land constitutes the necessary and indispensable support for all elements of natural resources, biodiversity and biomass production. Nevertheless, the degradation of lands is alarming in the country as 29% of the national land area is strongly degraded (mostly in the North) and 33% is moderately degraded. With more than half of the country affected by land degradation, about 2.8 millions of people are affected by land degradation in the country.

10 DGFRN et CERF. 2014. 5ème Rapport national a la convention sur la diversité biologique au Bénin. 99 p.

This land degradation process in Benin has indeed major impacts on livelihood. Crops yield decrease is one of them and lead to extension of agricultural lands (for example in the Three River Forest in the Kalalé Commune). At the national level, cotton yield has been decreasing since the 90's: mean of production was 1.8 tons per ha in 1993, whereas it is only 0.8 tons per ha in 2013. After 40 years of strong increase of maize yield, a decrease in this trend is observed (figure 5).

Fig. 5: Yield of cereals and cotton in Benin (1990-2013) – source: FAOSTAT, 2014.



The fertility of soil is decreasing at high rate, as stated by Houngbo (2012) for the south part of Benin: organic matter of soil has been going from 2.6% to 0.8% during the last 23 years, and pH decreased from 5.8 to 4.8. As a consequence, maize yield decreased from 1,000 kg to 400 kg in mean. The Ministry of Environment and UNDP have evaluated the cost of loss of soil fertility[11]: between 16 to 21 US dollars per hectare. This has been estimated through the cost of additional fertilizer needed where lands are degraded. This additional cost is estimated at more than 6 million US dollars at the level of Malanville, Banikoara, Gogounou, Nikki and Tchaourou. Despite the increase of these agricultural inputs, the yield decreased, which also cost $ 60 per ha for maize and $ 220 for cotton. At the end, the cost of land degradation is estimated at $ 45 million per year in these areas.

As states in A.1 section, the rate of deforestation is very high with a loss of 50,000 ha per year after 2000. The principal underlying causes of land and forest degradation and deforestation can be organized in three categories:

- *Unsustainable agricultural practices and extension of agricultural lands, especially in the classified forests*:

The main activity of the inhabitants of the four pilot zones is agriculture. Whereas maize is the larger food crop cultivated in Benin, UNDP reports a decrease of 0.6 tons per ha for maize and 0.7 tons of cotton per ha for cotton for the period 1996-2006. Persistent inadequate agricultural practices, such as slash and burn farming and very little crops rotation, are the cause of significant reduction of the fertility of agriculture soil. The practice of clearing, cultivating and then letting land lie fallow is widespread and is the major source of livelihood for the rural population. With human population exploding in the region, fallow periods are becoming shorter and the demand for richer soils provided by the remaining "pristine" forested land, including that in parks and reserves, is

[11] Sounon kon'de L. S. Adam (2008): *Evaluation of economic and financial cost of environmental degradation in Benin: case of Borgou and Alibori departments.* Ministry of Environment and UNDP

constantly on the rise. This situation is further aggravated by the influx of farmers and herders from arid northern Africa. Slash and burn agriculture is estimated to affect 160,000 ha per year. Extension of agriculture and grazing into areas of land which are either unsuitable for the purpose or are classified forests designated for biodiversity conservation or forestry are problems in all rural areas of Benin.

By causing agricultural productivity to decrease, erosion and land degradation result in land shortages as people seek out new, more fertile areas to clear for cultivation. Land shortages are also related to high rates of natural population growth (2.7% per annum, World Bank). Together with the common belief of "having better lands into the forest", these factors create incentives for agricultural encroachment within the classified forests. During the PPG phase, interviews were conducted and this situation is clearly observed in the vicinity of the Three Rivers Forest. The population growth and the decrease of soil fertility lead in extension of cultivated lands. Current agricultural practices also lead to pollution from agricultural runoff (particularly from cotton fields), as well as erosion and land degradation.
Specific issues include lack of effective land use planning and regulation implementation, uncontrolled movement of grazing animals, and conflicts between farmers, graziers and transhumant herders.

- *Uncontrolled bushfires*

Forest fires are a major cause of natural resource degradation, and, as shown by the mapping of fires in 2008, forest fires happened even more in the North of Benin. The government put this problem as a priority action and received support from FAO in 2010 to carry out a diagnosis on forest fires and to prepare a national strategy. This study highlighted the fact that fire management should be one of the main interventions within the overall strategy of sustainable resource management.

Whereas the communes have the legal competencies to take measure against forest fire, any device has been designed and implemented at the local level. During the PPG, interviews have been carried out and confirmed the importance of uncontrolled bushfire in the four pilot zones. Different types of fires have been reported:
(i) Agricultural clearing fires: this type of fire is linked with the traditional slash and burn agriculture. Farmers perceive burning biomass as necessary. However, this unsustainable practice reduces soil fertility in the long term. Clearing fires happened in dry season until the beginning of the first rainfall (May), and many fires are uncontrolled and burn the surrounding vegetation.
(ii) Hunting or honey collection fires: villagers light a fire in order to flush small game (in particular rodents and snakes). During the dry season, fires are lighted during the daytime and became uncontrolled in the night. They destroy vegetation and spread the following days, fuelled by the dry wind. For honey collection, the traditional practice consists in burning the surrounding vegetation in order to flush bees and to collect honey safely. Djougou is particularly affected by this unsustainable practice.
(iii) Grazing fires (fires to renew pasture): transhumant pastoralists and local herders used to light dry vegetation just before the passage of their herd. This practice stimulates the natural regeneration of fresh grass. These pastoral fires remain usually uncontrolled and are sometimes source of conflict with local farmers.
(iv) Protection fires: These are usually early fires that are practiced from the beginning of the dry season. They are used to burn biomass from spontaneous vegetation that may become fuel for accidental fires.
(v) Accidental fires: this happen where fires are used for lightening, driving or maintenance of roads. Also charcoal production may develop accidental fires which become uncontrolled.
(vi) Criminal fires.
In the department of Borgou, agricultural losses due to fires are estimated at 30 tons of cereals (300 bags of 100 kg)[12].

[12] Document to support the national strategy, FAO 2010.

• *Over-exploitation of natural resources, especially illegal cutting of trees for firewood and charcoal production*: Over-grazing, unsustainable hunting, unsustainable harvests of woody and non-woody products in forests, all threaten ecosystem integrity in rural areas of Benin. This is driven by short-term needs of people for food, resources and income. Communities lack secure access, user rights and management capacity to manage land and resources sustainably, with a longer-term perspective. Many products have the potential to be harvested sustainably but communities lack the knowledge of the resource base (e.g. population sizes and dynamics) and the capacity to establish, manage and monitor sustainable harvesting regimes. The need for income and lack of sustainable alternative income-generating opportunities drives destructive, illegal activities such as charcoal production in classified forests and wildlife poaching.

In a context of extreme poverty and economic degradation in the rural areas of Benin, many communities tend to rely on natural resources for their subsistence. Unsustainable activities in the rural areas includes logging, charcoal burning, wildlife hunting and poaching, palm wine farming, collection of medicinal plants, intensive vegetable growing under slaw and burn deforestation process.

Forests in Benin bring however major ecosystem services (such as provisioning food and fuel, regulating erosion and climate, supporting soil formation and protection, and regulating water flows and quality), which are threatened by land and forest degradation. 72.1% of the population still doesn't have access to a modern source of energy (World Bank), and this figure drops down to 2% in rural areas. Firewood and charcoal remains the main source of energy. The charcoal consumption is growing very fast: according to Akouehou (2011), national consumption of charcoal is 245,197 tons per year and 4,297,522 tons of fuelwood per year. Whereas the consumption per capita was 0.95 kg in 2002, it increased to 1.08 kg per capita in 2011. Moreover, the population increase by 32% during that period. These trends show the growing needs of biomass for energy, as well as the need for renewable energy development.

Benin's rich biodiversity is characterized by the transition zone known as the Dahomey Gap, an area that is now a mixture of farmland, woodland savannahs and relict patches of dry tropical forest that are highly threatened. There are approximately 3,000 higher plant species in Benin, of which at least 18 are listed as threatened. Of all plant species found in Benin, 814 of them (belonging to 130 families) have verified medicinal use. Benin's biodiversity also comprises 188 species of mammals, including 10 species of primates that are globally threatened, among them the mona (Cercopithecus mona), the magistrate colobus (Colobus vellerosus), the olive colobus (C. verus) and the red-bellied monkey (Cercopithecus erythrogaster). The latter is believed to be endemic to Benin. BirdLife indicates that 527 bird species are found in Benin[13].

The gradual degradation and loss of natural habitats inevitably result in declines in habitat quality and extent as well as numbers and distribution of wildlife in the wider landscape. Despite their importance, the species on the country are at risk. At least 13 species of birds are threatened: including the lappet-faced vulture (Torgos tracheliotus) and the lesser kestrel (Falco naumanni). Reptile and amphibian diversity is also high, with 97 species, including two critically endangered species of marine turtles.

[13] BirdLife database consulted in December 2014.

1.5. Long-term solution and barriers to achieving the integrated approach for Energy, Agriculture, Land and Forest Management at the commune level:

The project will develop an integrated approach for energy, agriculture, land and forest management at the commune level. The objective is to develop a landscape approach integrating conservation of ecosystems and local development of communities. This will be achieved through commune level land use planning and implementation of fire management methods (as part of the management plan of forest) and innovative agro-ecological techniques (which will support the sustainable production of biomass for gasifiers). This approach involves better coordination of land management and strategy to achieving sustainable development of communities. Stakeholders will use and manage their available land to maximize production from agriculture, livestock, biomass and forestry on land allocated for these purposes. This approach will be sustained through a sharing benefit mechanism.

The expected outcomes from the activities to be supported during the project include: (i) an increase in land area under SLM in the pilot areas (as measured by the number of additional hectares of forest or land brought under sustainable management, (ii) an increase in the number of forest reserves for which management plans have been effectively implemented, (iii) an increase in the capacity of local forestry institutions to implement forest-management plans. The project is oriented for results on the ground to reach 9,000 ha of lands under sustainable agriculture practices, thus providing increased availability of crop residues for use in gasifiers, and 3,000 ha of forest sustainably managed, and 2,000 ha of reforested lands in the 4 pilot sites selected. The integrated approach will develop 4 complementary axis of intervention at the commune level:

• The local planning tools (SDACs and PDCs) of the four selected communes will be updated in a manner that they address the integrated approach for agriculture, land, biomass and forest management. A biomass-monitoring tool will be established and available for all stakeholders at the commune level.
The SLFM concept exists in several documents and policies (cf section A.1). However, the planning tools at the commune level do not integrate it in an effective way, and local staff doesn't have the capacities to take initiatives in this sector. As a result, communes' staff and local stakeholders do not implement SLFM without the support of projects.
The project will support the integration of sustainable biomass supply of the gasifier plants in the SDACs (including the data collection and centralization of biomass availability at the commune level), and will produce a specific and operational document for implementation of SLFM practices in the commune. This document will include the management plan of biomass produced in the commune. This document will integrate land uses (agriculture, forest and livestock management) and will include the management plan of biomass produced in the commune.
As the forestry law 2013-01 is recent, the project will also support the lobbying for implementation of the proposed decrees and their implementation at the commune level. In particular, the project will support the implementation of the Rural Land Tenure Plan.

• In order to protect the forestry resources, effective sustainable management of classified forests and implementation of a fire management strategy will be supported by the project.
An initial mapping of the project zones will be carried out by a team of local experts. A detailed assessment for each area will include: a clear delimitation of forests, identification of the biodiversity and the ecosystems services (in particular, biomass supply), identification of the uses and the users and the stakeholders to the natural resources (forest dweller communities but also private sector, civil society, institutions and decision-makers), and an assessment of potential income generating activities. The data collected will support both the update of (i) participatory management plans and (ii) the fires management strategy and action plans.

The Adaptation Project, entitled "Strengthening the resilience of the energy sector in Benin to the impacts of Climate Change", has the objective of supporting the Government of Benin's strategy to adapt to climate change in the energy sector and to reduce the vulnerability of rural and urban communities to climate change and variability, through increasing the resilience of energy production, transport and distribution on the territory. It is designed to be in synergy with the present project, as they will be coordinated by a common management team and they have some common objectives. This will then finance the update and the implementation of Participatory Forest Management Plans in the four pilot sites.

The fires strategy and action plans will be develop in partnership with INRAB and the CERF (discussion hold during the PPG and convention to be signed at the beginning of the project) and will include (i) the situation description (reference assessment), (ii) the measures required to sustainably manage and control forests fires, (iii) the responsibilities of each stakeholders, (iv) a detailed work plan and budget. Each plan will be validated by stakeholders during meetings, before its official approval by authorities.
Actions plan will include (i) information workshops, (ii) management of early fires, (iii) establishment of firebreaks, (iv) set up of pedagogic plots, (v) monitoring of the fire at the commune level.

The project will then support the implementation of the actions plan, in coordination with:
(i) The CARDER, which will have the responsibilities of informing villagers through the design of technical guide sheets for establishment of firebreaks, opening of early controlled fires, selling of biomass to the IPP (instead of burning it), etc.
(ii)The SCEPN, which will have the responsibilities of supporting population in fire management and in monitoring of the impacts of fires. It will support the organisation of communities to fight against fire.
(iii) The civil society, which will inform through radio communication the population for the lightening of the early fires.
Fire management also includes organisational support and capacity building for communities. A committee will be established in each village in order to manage the forest fires. It will be formed by community leaders during the development of the participatory plans. The committee will benefit from a learning and capacity building process. It is expected that each community leader will act as a multiplier of knowledge within his own community, disseminating the principles for the sustainable management of fires.

• In order to reduce pressure on the natural resources, plantation activities will be developed in communities to meet their needs for wood, food, and other natural resources, harvested sustainably, and to provide alternative income-generation (output 3.3).
The plantation of 5 million trees will be achieved in agroforestry system. The project proposes to organise the implementation of trees plantations activities with the Simultaneous System for Wood and Food Production[14] (SSWFP). This is a sustainable agroforestry system, which has been already experimented in Benin, but need support for its large dissemination. Also called Taungya, it consists in planting *Acacia auriculiformis* in association with maize or cassava during the two first years. Increases in yield are reported to be: 4 tons per ha for maize (instead of 1.2 tons per ha in traditional system), 2 tons of cotton per ha (instead of 0.8 tons per ha), and 1 kg of honey per ha and per year. Hence, this activity will bring incomes to local population.
Trees plantation will have objective to produce biomass to be sold to the Wood Rural Market. In the long term (after 7 years – time for the trees to be harvested), biomass could also be sold to the IPPs (assuming that the gasifiers will not only function with agricultural waste, but also with wood biomass) as they will create a market for biomass. Thus, the project will anticipate this potential market and support the establishment of contracts between smallholder's farmers and IPPs.
The Adaptation project will also support the plantation of trees along the riverbanks. Hence, synergies will be sought for these activities (nurseries, training, and monitoring system in common). As regards the demand of fuel

[14] Source: Akouehou et al., Socio-economic performance of the agroforestry system with *Acacia auriculiformis*, 2011.

wood in the commune, the pilot zones will also benefit from the improved stoves dissemination supported by the Adaptation project.

• In order to address soil erosion and land degradation, the project will support the introduction of sustainable Agricultural Land Management (SALM) practices among the farmers through a capacity building process including pilot land plots, training, technical assistance to the farmers and investments for the adoption and dissemination of sustainable farming techniques (output 3.4). These measures will be described and illustrated in the completed SDAC (specific document on SLFM at the commune level).
Promotion of SALM practices and SFM activities will lead to an increase of biomass production. For example, the on-going PANA project reports an increase of biomass yield of 25% with the implementation of soil fertility practices.

In close partnership with INRAB (an agreement will be signed during the early stages of project implementation), the project will support the conception of a toolkit for wide dissemination of SALM practice. As sustainable appropriation by communities is reported by previous projects as a key elements, pilot demonstrative land plots will be also established and will meet two purposes: (i) organising practical training in field and (ii) producing scientific knowledge for capitalisation on SALM techniques in the commune and the country.
Emphasis is put on encouraging social and technical innovations, mutual learning through exchange visits (farmer to farmer) and linking research and traditional knowledge through joint experimentation.

A training programme will be organized for at least 3,000 farmers in SALM practices for reducing soil erosion and increasing productivity. The training plan will be developed in collaboration with the INRAB, farmer's organisation and international expertise. It will go into depth the efficient SALM techniques adapted in the context of each commune: (i) Agronomic practices (crop rotation, cover crops and green manure), (ii) soil fertility management (mulching, improved fallows and composting), (iii) water management (river bank protection) and (iv) mechanical land management (terraces, stone lines and anti-erosion small dams). The training program will also include the establishment of livestock corridors. The learning cycle will be sustain by monitoring in the field both by local agent of the Ministries of Environment and Agriculture and by a local NGO that will be also trained by the international expertise.
Investments for material and equipment for the implementation of soil management techniques at large scale will be done on plots of group of farmers.

The barriers to achieving the solution:

The Project will address the following specific barriers and groups of barriers which currently constrain positive changes towards the development of an integrated, sustainable and widely replicated integrated land uses approach in Benin:
Barrier (1): Land use planning and monitoring at the commune level is inconsistent and ineffective. The support for implementation of the policy and legal framework is required to achieve the sustainable management of lands.
Different development programmes are applying different planning approaches, many of which fit poorly the need for integrated planning for sustainable natural resources management. This fact is reflected in the diversity of management tools, e.g., Village territory management plans (SDAC), Local development plans (PDCs), Village Development plans, etc. In addition, the different initiatives emphasize different themes, which sometimes results in a mosaic of activities that loses coherence. For example, erosion control measures are not systematically applied following landscape-level priorities but are mostly driven by individual farmers' strategies. Furthermore, erosion control activities are carried out at farm/household or at best at village level. Similarly, land use planning efforts are so far being conducted only at village level without adequate coordination either at a

larger scale or with regard to conservation initiatives. The result is that the potential effects of the various activities are not optimized, limiting the impact[15]. Besides, traditional approaches to conservation and rural energy projects are compartmentalized and fail to understand the overall needs of populations at the scale of a commune and its community lands. The main purpose of the project is SLFM and energy production. The establishment of a power plant will impulse economic and human development at the commune level. However, information on biomass (both from agricultural and forestry sectors) is very limited and even within adjacent PAs there are very few examples of coordination of data between CARDER and CSENP. Adaptive management requires this information to allow for changes in management if conservation or biomass production or other objectives are not being met.

Barrier (2): Poverty, cultural habits and lack of alternatives, innovation and investment (private sector and public finance) at commune level make it hard for communities to break out of a cycle of unsustainable land, resource and energy use and rural exodus.

As evidenced by several previous development interventions at the village level, the principles of good land stewardship for villages' territory can be successfully introduced. However, bringing about lasting change will depend on communities having a positive stake in it. Poverty, tradition and lack of alternatives drive communities and individuals to continue to carry out unsustainable practices of resource exploitation both legal and illegal (e.g. charcoal production from Classified Forests, or extension of agricultural plots into the forest). The lack of jobs and alternative options for income generation drive the rural exodus – many villages lose young people who emigrate either seasonally/ temporarily to look for work or permanently to find work in other regions or countries. During village interviews at the PPG stage, all communities expressed the need for social benefits in villages (health, education, income-generating activities and employment) as well as improved natural resource management, sustainable use and more energy use.
Farming practices are among the hardest to change and this creates a barrier to the introduction of Sustainable Agricultural Land Management (SALM) alternatives (e.g. mulching, improved fallows, agroforestry and tree planting). Lack of knowledge of the environmental impacts of their practices and the inability of farmers to invest in equipment over the medium to long term are barriers to implement alternative techniques (typically intercropping, river banks protection, anti-erosion dams, etc.). There are challenges in term of appropriate economic incentives to make these technologies accessible, popular and progressively systematic in rural areas. The Local Biomass Enhancing Fund (LOBEF) will be a long-term solution to finance these innovations.

Examples of alternative income-generating activities (IGAs) exist in rural villages in Benin but these are limited and usually initiated under the umbrella of donor-funded development projects. Village activities with linked social / financial and environmental benefits seen at the PPG research stage include honey production, mushroom production, medicinal plants and revolving credit funds providing social benefits (start-up funds for household and community enterprises) and a percentage of profits to funds to support management of Forests. Similar approaches need to be widely replicated at the commune level, to lead to sustainable and lasting village level development.

1.6. Barriers to biomass gasification technology for electricity generation in Benin

There is very limited experience in Benin with biomass gasification technology development and utilisation. As indicated above, there were 2 gasifier systems for electricity generation installed, one in Gohomey and the other

[15] Source : Délégation de l'Aménagement du Territoire (2009) and PAGEFCOM (2011).

one in Sékou; and they each operated for only about a year, after which they broke down for lack of sufficient maintenance and were abandoned. A third gasifier was installed at the Songhai Centre in 2012 and it is still operational, running a 40 kVA generator for 8 hrs a day to supply electricity to operate a plastics factory. The 2008 UEMOA initiative for Kalalé mentioned earlier never proceeded beyond the feasibility stage; it was designed for the installation of a gasifier to operate a 400 kVA generator to supply a mini-grid in Bouka in the north-eastern part of the country.

The present project is designed to provide a fresh start to biomass gasifier development and utilisation in the country, operating on agricultural biomass residues to generate electricity, in view of the very promising potential that the technology has to drastically arrest deforestation (hence, increasing the availability of carbon sinks), reduce GHG emissions, prevent soil erosion and improve livelihoods of the population, especially of those 60% living in the rural areas. A novel approach will be applied through enabling the private sector to drive the initiative to develop and install biomass gasifiers in the country; the crucial role of the Government will be to create the appropriate environment for this private sector-driven modality to successfully move forward.

In line with the foregoing, GEF intervention is needed to remove the policy, regulatory and market barriers which hamper realisation of the Government plans to harness the abundant and unutilised renewable agricultural residue potential available in the country. Some of the main barriers are:

Policy/Regulatory: Even though the need for "private sector investment in the electricity sector" was articulated in the October 2009 "Strategic Plan for Energy Sector Development", a conducive policy and regulatory framework for the participation of the private sector in the utilisation of biomass resources from agricultural residues for electricity generation is still lacking. The issues relate to, for example, absence of a transparent process for the award of sites to the private sector, unavailability of a standard methodology for determining feed-in tariffs, absence of clear and standardised Power Purchase Agreements (PPA), lack of guidelines and methodology for joint environmental, economic and financial evaluation of renewable energy plants in line with existing government regulations and policies, etc. The Kalalé biomass gasification project mentioned earlier became a victim of the absence of clear policies and frameworks that led to the private sector backing out of its implementation after completion of the feasibility study.
The Republic of Benin has developed new laws at the national level during the last years (e.g. the recently adopted law for land tenure and its 14 decrees), but there is a need to promote these decrees at the local level and to support communes for effective implementation.

Financial: Discussions held during implementation of the PPG indicated that private sector investors (e.g. Euro-Négoce, MIERT and WAIO) consider the issue of payment guarantee for electricity supplied to CEB/SBEE as a major bottleneck to venturing into business opportunities in biomass gasifier development for electricity generation. Hence, before making any investment, they would like to see a payment guarantee scheme in place. Similar concerns were expressed by local potential lending institutions like, for example, Diamond Bank, OraBank and Société Générale Bénin. This, therefore, presents the project with a great opportunity to support both the Government and the private sector to enter into a win-win situation by having, on the one hand, a payment guarantee modality that will provide confidence to the investors and, on the other hand, enable the Government to secure confirmed interest from developers to generate electricity from agricultural residues, thus reducing the country's expenditures on imported fuel. The project will, therefore, establish a Financial Support Mechanism that will consist of $ 1.5 million from GEF and UNDP that will be available to: (i) support private investors in case of non-payment by CEB/SBEE and (ii) support private investors utilising biomass gasifiers to substitute for diesel generators either in existing or planned main grid/isolated mini-grids with an initial investment grant in order to jump-start the market.
In addition, in order to facilitate the uptake of biomass gasifier technology, a set of financial incentives to promoters in terms of reduction/elimination of import duties/taxes on equipment, income tax holiday for a specific duration, simplification of foreign exchange regulations, etc. will be developed. Preliminary discussions

were held with the Ministry of Finance during the PPG implementation and its interest was ascertained for detailed discussions when the project becomes operational.
The Ministry of Environment is largely dependent of external funding to implement its sustainable resources management policy, and thus the villagers are involved only on a "short term dynamic" (for the duration of a project). If projects are able to finance management plans for forest, there is a lack of recurrent funding for management plan implementation. Within the Integrated Communal Territory Management approach, a benefit sharing scheme will be established through a participatory approach involving biomass-based power investors, government and local communities in charge of forest co-management. The benefit-sharing scheme will support the community fund at the forest level. It will be fuelled by the IPPs proceeds (output 1.1) based on results achieved by the community such as number of hectare under SLFM and biomass production (output 3.5).

Technical: Except for the Songhai gasifier, there is a total absence of technical experience with gasifier design, installation, operation, maintenance, lack of any local manufacturing capacity, non-availability of any tested gasifier models appropriate for the Beninois context, etc. In fact, the great majority of the country's population has never heard of any biomass gasifier and the benefits it can provide in supplying modern electricity services for income-generating activities, lighting, operating of electrical appliances, etc. The lack of a global vision on the part of stakeholders means that anthropic pressures on natural resources, in particular forests, will continue to degrade these resources, releasing GHG. Communes have legal responsibilities through the decentralization process, but don't have the capacities to implement properly. Communities are not sufficiently involved in the management of their land and are not adapting their unsustainable practices in a systematic way. Communities need simple, repeatable survey and monitoring methods to obtain baseline information and to monitor trends in biomass and other natural resources to ensure that community management achieves conservation objectives and that natural resource exploitation is carried out sustainably. Adaptive management requires this information to allow for changes in management if conservation or other objectives are not being met.
The project will remove these technical barriers through capacity development at all levels from design to construction to operation and maintenance, etc. This will include training provided to rural and peri-urban consumers in the proper and safe use of electricity.

Integrated approach for agriculture, land and forest management: Traditional approaches to conservation and rural energy projects are compartmentalized and fail to understand the overall needs of populations at the scale of a commune and its community lands. Different development programs are applying different planning approaches, many of which fit poorly the need for integrated planning for sustainable natural resources management. This fact is reflected in the diversity of management tools, e.g., Village territory management plans (SDAC), Local development plans (PDCs), Village Development plans, etc. In addition, the different initiatives emphasize different themes, which sometimes results in a mosaic of activities that loses coherence. There is a need for adequate coordination in the planning tools at the commune level.
The Project will develop robust integrated plans for land use management, allowing a practice of sustainable agriculture (including livestock management), to support sustainable economic development, food security and environmental protection. Institutional planning will result in an integrated practice in the use of agricultural land resulting in the conservation of agricultural practices piloted in the four pilot sites, where the first biomass plant will be established.

Economic: Poverty, tradition and lack of alternatives drive communities and individuals to continue to carry out unsustainable practices of resource exploitation both legal and illegal (e.g. wood cutting and charcoal production from protected forest areas). The lack of jobs and alternative options for income generation drive the rural exodus. During village interviews at the PPG stage, all communities expressed the need for social and economic benefits in their villages (health and income-generating activities) as well as improved natural resource management.
The project will address this issue through training of biomass gasifier installers and operators in the rural areas, promotion of electricity services from gasifiers for better quality of life related to the provision of a modernised fuel for income-generating activities, lighting in replacement of traditional fuels and improved livelihoods

through the sale of left-over agricultural biomass residues that are presently disposed of as "waste". The project will also develop sustainable community activities with linked social/financial and environmental benefits.

Promotion/Outreach: In the absence of any experience with private sector-implemented biomass gasifier plants, there is evidently a lack of knowledge among a wide range of stakeholders on the benefits that biomass gasifier technology to the population, especially those living in the rural areas, can provide in terms of modern electricity services for a variety of household and commercial/industrial usage. In view of this, there is evidently a total lack of information on in-country best practices and lessons learned. Once implementation has started, this situation will be remedied through the compilation and publication of project experience and best practices in both printed and electronic forms.

A summary of the barriers and the strategy for addressing them are presented in Table 3b below.

Table 3b: Summary of barriers and mitigation strategies

Barrier	Present Situation	Strategy for addressing barrier
Policy/Regulatory	Absence of a conducive policy and regulatory framework to promote gasifier-based electricity generation. Insufficient capacities at the local level to implement the new regulatory framework.	Outcome 1: Develop a set of regulations that will facilitate private sector investment in gasifier technology. Outcome 3: Support to commune for effective planning and implementation of SLFM.
Financial	Absence of a Financial Support Mechanism (FSM) to jumpstart projects. Absence of financial incentives to facilitate the uptake of gasifier technology. Absence of benefit-sharing scheme to sustainably finance forest management.	Outcome 2: Establish FSM within the Central Bank of Benin. Outcome 2: Introduce financial incentives to promote uptake of gasifier projects. Outcome 1: Establish and implement a benefit-sharing scheme between IPPs and communities for maintenance of ecosystems services through sustainable forest management.
Technical	Lack of skills to design, build, operate and maintain biomass-based gasifiers. Absence of a proper assessment, monitoring and planning regime for the maintenance of ecosystem services in the commune territories.	Outcome 1: Capacity development of stakeholders. Outcome 3: Establish a carbon & biomass-monitoring scheme in the commune.
Integrated Approach for Agriculture, Land and Forest Management	Absence of Approach Integrated for Agriculture, Land and Forest Management	Outcome 3: Establish an integrated Land, Agriculture and Forest Management Plan, and implement SALM practices.

Economical	Absence of options for alternative income-generating activities in the communities.	Outcome 1: Implement alternative income generating activities through electricity utilisation. Outcome 3: Implement alternative income generating activities.
Promotion/ Outreach	Lack of promotional/outreach activities and absence of project experience/best practices.	Outcome 4: Implement outreach/promotional activities and document project experience.

1.7 The Economics of utilising Gasifiers for Rural Electrification

At the present time, the biomass market in Benin is essentially dominated by non-renewable biomass, where active deforestation takes place as a result of charcoal production and direct fuelwood utilisation for cooking. Farmers barely take advantage of their crop residues which abound in quantity, mostly leaving them unused in the fields. However, as it is scattered randomly with low energy density, it is difficult to deal with centrally on a large scale. Hence, small-scale gasification-based power generation is an attractive resource for meeting the need for electricity services in rural areas. In addition, it can address poverty issues in the rural areas through the creation of income-generating activities related to fuel collection, transport, commercialisation to the gasifier units and the eventual productive use of the electricity generated.

Gasifier/internal combustion engine systems are commercially available and are being utilized for electricity generation of up to 1 MW in many countries, including Brazil, China and India. For installed capacities of 100 kW and above, the cost of electricity generation from gasification is lower than that of diesel power generation; however, it loses this competitive edge for lower capacities, except in those cases where diesel has to be imported. It also loses its competitive edge when the range radius of biomass collection exceeds several km.

The economic feasibility of a biomass gasifier power plant is dependent on several factors, including the capital costs of the equipment (i.e. gasifier, engine-generator set, civil works and local electricity distribution network), the specific fuel consumption, the capacity utilization factor, the useful lifetime of the equipment (15 years) and the fuel (biomass) price. In the Benin context, the excess of agricultural biomass is presently considered a nuisance that farmers have to dispose of. However, as soon as this biomass starts being utilized for electricity generation, an economic price will need to be attributed to it. It should not be expected that farmers will willingly donate this resource to the developer of the gasifier and, therefore, the cost of the biomass will need to be factored into determination of the electricity tariff.

Various studies have been undertaken to assess the economics of biomass gasification for electricity generation based on the levelised cost, Internal Rate of Return (IRR) and the Net Present Value (NPV). On an average, excluding the cost of the electricity distribution system, the capital investment in the above-mentioned developing countries is approx. $ 1,800/kW. After factoring in maintenance, lube oil, biomass fuel, etc., the cost of electricity generation varies, depending on the capacity utilisation factor (CUF) of the equipment. A Master's thesis prepared by a Beninese student in 2013 shows the following cost of generation for the Songhai 40 kVA (Box 1) installation located at Porto-Novo: 25% CUF: 43 US Cents/kWh; 50% CUF: 23 US Cents/kWh and 80% CUF: 16 US Cents/kWh. In other countries with extensive experience with gasifiers (Cambodia, China and India), a similar cost pattern is observed, although the actual costs/kWh are somewhat lower, showing a decrease in generation cost with an increase in CUF. Finally, for comparison purposes, the average SBEE generation cost for diesel-based isolated mini-grids is 40 US Cents/kWh. Hence, biomass gasifiers for electricity generation in Benin

presents itself as an attractive technical and financial proposition aimed at replacing imported diesel fuel to expand rural electrification.

Box 1: Songhai Gasifier at a glance.

Installed Capacity: 40 kVA (32 kW)

Year Installed: 2012

Total Cost: $ 120,000 or $ 3,750/kW. This high per kW cost is attributed to Songhai being one of the first functioning prototype gasifiers for electricity generation in the country.

Feedstock: Mixed wood (acacia)/agricultural waste

Electricity supply: 8hrs/day for plastics factory

Cost of electricity generation under various Capacity Utilisation Factors (CUF):

- 25% CUF: 43 US Cents/kWh
- 50% CUF: 23 US Cents/kWh
- 80% CUF: 16 US Cents/kWh

While the SBEE purchase price from CEB is 10 US Cents/kWh (2014) for grid electricity, the average SBEE generation cost for diesel-based isolated mini-grids is 40 US Cents/kWh. Hence, gasifiers can provide a very attractive business option to SBEE for isolated mini-grids.

1.8. Introduction to project sites

The Project will work through four pilot sites and villages in the zone 3 and 4 (see the identified pilot zones below), where agricultural biomass is largely produced and energy services are deficient. During the PPG phase, extensive consultations and a prioritization exercise have been carried out. The following communes were selected for interventions: Kalalé, Djougou, Savalou and Dassa. The communes were selected based on the following main criteria, which have been established through a participatory process (during workshops with stakeholders organized by UNDP): (i) Proximity to SBEE grid that will facilitate capacity extension to meet both local needs and export to the grid, (ii) Availability of biomass from agricultural residues, wood waste, etc., despite competitive use and at reasonable cost, (iii) Agricultural production including cotton, corn, rice, sorghum, etc. (iv) Climatic conditions conducive to rapid growth and high calorific value of residues and woodlots, (v) Availability of lands for trees plantations and potential for lands restoration, (vi) Presence of Economic Interests Groups, (vii) Gender representation in local management committees, (viii) Availability of a land-use plan. Besides, the stakeholders established a list of secondary criteria: (i) Fairly even distribution of population across target area, (ii) Presence of industrial units utilising biomass-based products to make up for any shortfall in agricultural residues in a given year, and (iii) Absence of another biomass-based electricity generation plant in the vicinity that would compete for agricultural residues.

Fig. 4: Map of project sites

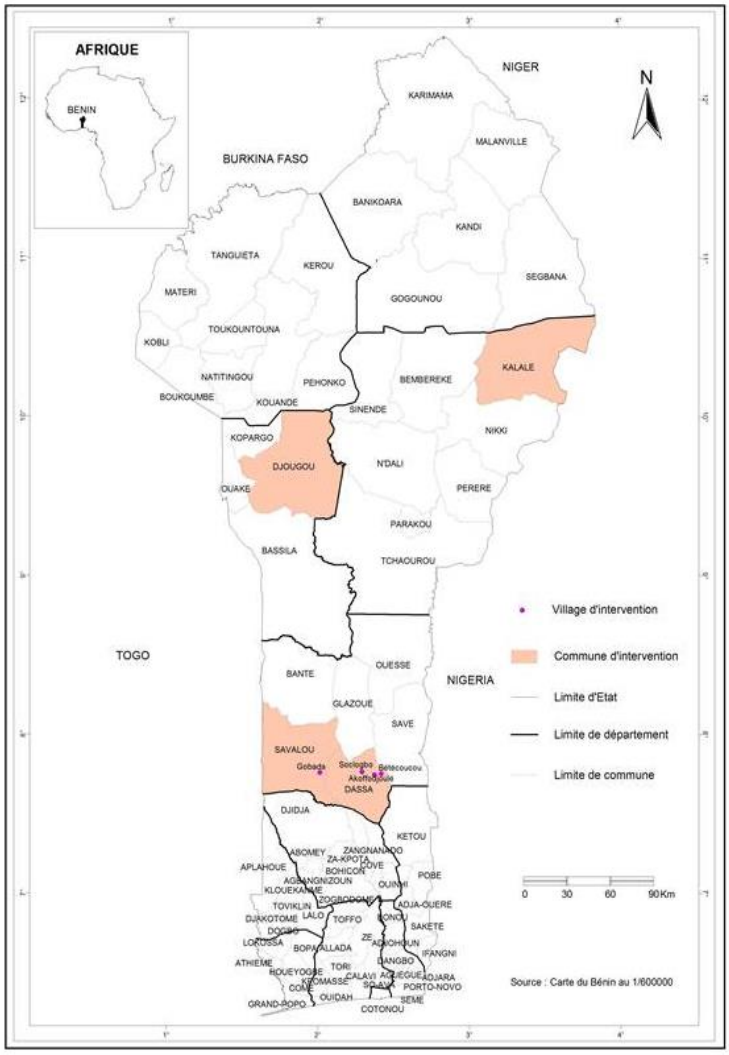


Table 4: Introduction to pilot sites of the project

#	Project site, ecosystem Name and capacity of biomass gasifier plants	Population of the commune and disctrict	Adjacent forests	Potential for reforestation and land restoration[16]	Socio-economic background
1	**Kalalé** In the agro-ecological zone # **3** Bouka (2 MW)	168,520 in the commune, 27,906 in the district of Bouka	Classified forest of Three Rivers (236,000 ha); 6 community forests	Reforestation: 3,000 ha Land restoration: 13,000 ha	Agriculture and livestock are the main activities of the commune. Cotton is the main crops with about 5,000 ha. Main ecosystem is dense forests and dry forest (*Anogesus leiocarpus* and *Diospyros mespiliformis* as characteristic species). There are 36 groups of women active in the project site.
2	**Djougou** In the agro-ecological zone # **3** Pélibina (0,6 MW)	266,522 in the commune; 27,906 in the district of Pélibina	Classified forest of upper Ouémé (35,000 ha); 2 community forests; 4 sacred forests.	Reforestation: 160,000 ha Land restoration: 13,000 ha	This area is an important cotton production, but also sorgho, mais and vegetable. There are 76 groups of women, and 12 groups of men. Women develop income generating activities such as gardening, transformation of cassava in gari, soya production.
3	**Savalou** In the agro-ecological zone # **4** Gobada (1 MW)	144,814 in the commune; 4,676 in the district of Gobada	Classified forest of Savalou and Logozohé.	Reforestation: 53,045 ha Land restoration: 22,700 ha	Agriculture, livestock farming, forestry (fuel wood, timber and wood for rural construction) are the main activities in the surrounding areas There are 112 groups of women, and 15 groups of men.
4	**Dassa Zoumé** In the agro-ecological zone # **4** Soklogbo (0,4 MW)	112,118 in the commune, 12,278 in the district of Soklogbo	Classified forest of Dassa (125,000 ha) and Ouémé Boukou.	Reforestation: 12,851 ha Land restoration: 186,000 ha	Agriculture is the main activity (cassava, sorgho, cotton, maize). This district is also welcoming transhumant herders from the North. There are 51 groups of women, and 11 groups of men.

[16] Potential for reforestation and land restoration have been estimated during the PPG based on field visits, discussions with CARDER and results of the Program for Sustainable Land Management.

2. STRATEGY

Project rationale and policy conformity

The project's goal is to reduce GHG emissions by creating favourable legal, regulatory and market environment and building institutional, administrative and technical capacities to promote electricity generation through gasification of unutilised crop residues.

The objective is to assist the Government of Benin, as outlined in the "Energy Policy and Strategy, 2003" document, "to ensure protection of the environment" and to provide electricity services to "the rural areas for income-generating activities and to reduce the rural exodus towards urban areas". As indicated above, since 2006, the CEB has been unable to supply the agreed amount of electricity to SBEE, the Benin national electricity utility, due to the energy crisis in the three supplier countries (.), resulting in SBEE operating costly gas turbines to generate electricity to meet the main grid-connected domestic demand. This leaves SBEE in a position not to be able to focus on decentralised rural electrification to meet the needs of 70% of the country's population for electricity services. Hence, in the business as usual scenario, implementation of rural electrification with reliance on budgetary resources and without the participation of the private sector, will take a very long time to materialise. The project will accomplish this by supporting the Government of Benin to introduce an integrated energy and ecosystems-based approach to sustainable biomass electricity generation in the country through:

✓ Developing a streamlined and comprehensive market-oriented energy policy and legal/regulatory framework for biomass electricity generation by Independent Power Producers (IPPs).
✓ Promoting increased investment in clean energy technologies and low-carbon practices in the agro-forestry waste sector.
✓ Developing integrated land use, sustainable forest and natural resource management that provide social benefits and sustain biomass for electricity production.
✓ Implementing an outreach programme and dissemination of project experience/best practices/lessons learned for replication throughout the country/region.

Institutional Structure

The Ministry of Energy is the central body responsible for formulating and implementing the Government's policy in the field of energy development and utilisation. In this capacity, it defines priority directions of development regulating the generation and supply of electricity. Implementation of the energy policy is entrusted to several Departments under its responsibility, including and in this task, it has the support of several directorates, including the Energy Directorate, Benin electricity Corporation, Agency for Rural Electrification and Energy Management and National Agency for the Development of Renewable Energy and Energy Efficiency. As such, it will be in the first line of support to implementing the project under the UNDP National Implementation Modality (NIM).

Financial Support Mechanism (FSM)

Investment in renewable energy projects often requires to be supported with financial incentives, at least initially, because such projects are not only typically more investment-intensive in terms of upfront costs, but that they are also, in some cases, considered to be riskier investments due to technology or resource uncertainties. The degree to which cost and risk factors apply varies according to technology and geographical location and project developers expect some form of financial support/risk-sharing to compensate them for taking on additional

financial risks due to unfamiliarity with the technology being proposed, given that the gasifier technology is almost absent in the country, except for the small Songhai installation mentioned earlier; hence, lending for gasifiers is perceived as involving additional risks. This constitutes a major barrier faced by private investors in their efforts to raise credit funding from lending institutions. The second major barrier is the setting of an appropriate tariff, allowing financial viability of the system, but also taking into account the capacity to pay in rural areas. Hence, in order to assist in jump-starting the market and making the business of electricity generation through agricultural biomass-fired gasifiers attractive to private investors, the project considered the options of either a Loan Guarantee Fund (LGF) or a direct Financial Support Mechanism (FSM).

Loan Guarantee Fund (LGF): A LGF, in its most common form, is an independent entity that acts as a third party between a lending bank and a borrower/investor who does not meet all of the bank's qualifications, but is otherwise considered a fairly good credit risk. The LGF provides the bank security, in the form of a guarantee for a portion of the loan, in order to enable the investor to obtain credit financing. If the loan application is approved, the LGF provides the bank a guarantee for the required amount of collateral, and the loan is issued. The investor, in turn, repays its loan to the lending bank plus an LGF annual fee, typically between 2-5% of the loan value, which can be included in the loan payments. If the borrower repays the loan, the LGF is released from its guarantee. However, if the borrower defaults on the loan, and the bank met all of its obligations in attempting to collect on the debt, the LGF will reimburse the bank for the agreed amount and, simultaneously, initiate judicial proceedings against the borrower to recover its payment to the bank.

In many countries where LGFs have been used, well-managed LGFs reasonably expect to have a multiple of 5 or more, i.e. $ 1 million in LGF capital can realistically translate into at least $ 5 million in guarantees to banks. In the specific case of Benin, FAGACE (Fonds Africain de Garantie et de Cooperation Economique – African Guarantee and Economic Cooperation Fund), with its Headquarters in Cotonou and a working capital of $ 700 million, has confirmed to UNDP (co-financing letter) its interest to collaborate with the project by entertaining requests from private sector investors for loan guarantees. Hence, there is no need for the project to put any additional effort into a Loan Guarantee Fund.

Financial Support Mechanism (FSM): The project then considered the other option i.e. that of an FSM that will provide direct support to private sector investors. The FSM will be established with an initial capital of $ 1,500,000, viz. $ 1,300,000 from GEF funds and $ 200,000 from UNDP - Box 2 below provides a snapshot of how the FSM will be set up and operate.

The main objective of the FSM in promoting electricity generation utilising gasifiers operating on renewable biomass from agricultural waste in Benin will be to provide more security to project developers/IPPs by giving them some level of protection against the risk of payment default for electricity already supplied to the SBEE main grid or isolated mini-grid. This will be beneficial to both SBEE and the country in that less foreign currency will be spent on importation of diesel fuel, entailing lower GHG emissions, while the end result, i.e. access to electricity services to the rural population will remain unaffected or the distribution grid coverage can even get expanded. For this to happen, the private sector would need a guarantee that it would get paid for electrical energy supplied to SBEE; this constitutes the main bottleneck, as perceived by the potential investors who were consulted.. In the WB/IFC "Doing Business 2015" data, Benin ranks 135 out of 189 economies on protecting investors and 169 out of 189 on enforcing contracts. In discussions with private project developers interested in gasification (e.g. Euro-Négoce, AF Power, SATAREM, IMEX international SA and Helios Energie), it was clear that this concern is very much present in their minds. Moreover, biomass gasification is not well known in Benin; hence, additional efforts, through the provision of capacity development, as outlined below, would be required to satisfy lending institutions to provide credit financing to the private sector for this activity. Also, while SBEE has been performing well financially over the last couple of years, its financial strength can take a negative turn if CEB, with a view to reducing its heavy losses, decides to raise the price of electricity at which it presently supplies SBEE.

Investments in biomass gasifier electricity generation are made for approx. 15 years and any doubt in the minds of developers regarding the business climate in a particular country will make them reluctant to invest. Specifically in the case of Benin, there has been a precedent, as mentioned above, when the UEMOA initiative to install a 400 kVA gasifier in Kalalé did not materialise because an acceptable Power Purchase Agreement (PPA) with a potential developer could not be negotiated. The main stumbling block was the issue of guarantee of payment for electricity that would have been supplied to SBEE. Hence, the FSM will act as a "risk minimisation fund" to compensate the private investor in case of default on the part of SBEE. Such a commitment from the Government that the chances of payment default by SBEE for energy already supplied to the grid is minimised would reduce the overall risk profile of the investment, making it easier and less expensive for the developer to raise the necessary debt financing. It will also provide assurance to project developers that there is a mechanism in place to shield them from default on the part of SBEE, should it happen.

Only the 3 pilots at Djogou, Kalale and Savalou will supply the SBEE existing grid/isolated grid (Table 5) and, annually, their feed-in to the grid will amount to 22,045 MWh (Dassa-Zoume has no grid; therefore, the developer will build his own mini-grid and supply his customers). Under the assumption that developers will negotiate a feed-in tariff of 20.3 US Cents/kWh, as determined by the UEMOA feasibility study mentioned earlier (this will be double the price that SBEE presently pays CEB, but the latter is unable to supply SBEE's total requirements and the purchase price from CEB is expected to increase to mop up its operational losses, but much less that SBEE's own cost of generation of 69 US Cents/kWh at Marigleta) like in the case of the UEMOA-financed feasibility study, SBEE's annual payment to the developers of the 4 pilots for electricity supplied would amount to almost $ 5 million (24,528,000 kWh x 20.3 US Cents/kWh), i.e. an average of $ 417,000/month. In the worst case scenario, if SBEE were to pay nothing to the developers, the $ 1.5 million from the FSM would barely cover 4 months of guarantee, approaching the default time limit the lending institutions mentioned earlier would be comfortable with. Hence, the argument provided below to mobilise additional resources for the FSM. Also, the probability that the FSM would get depleted in 3 months would be low, as remedial measures would kick-in as soon as SBEE starts falling behind on payments to IPPs. Moreover, IPPs would be encouraged to develop their own financial instruments with private insurance providers and in case of default of payment by SBEE, the FSM will step in as "subordinated insurance" to reimburse that portion of default not covered by the IPPs' own insurance companies. Such private insurance is available in Benin and can be provided by Bank of Africa or ORA Bank, for example: the terms are that a developer deposits an amount equivalent to 1 – 3% of the total cost of the project with the bank and, in addition, pays an annual insurance premium equivalent to 2% of the insured amount. At any time the developer decides that renewal of the insurance is no longer necessary for his operations, he can terminate it and recover his deposit.

There is, of course, a fundamental question of sustainability of resources available under the FSM for this financial support to rural electrification through agricultural biomass gasification beyond the projects' lifetime of 5 years. Neither the project nor the Government wants such an important modality for reducing the country's import of fossil fuel through substitution with locally available biomass resources and providing the unserved rural population with clean and modern electricity services not to be sustainable. In fact, the project expects that the experience gained through the operation of the FSM will act as a magnet to other donors (and the Government) to further capitalise it beyond the initial $ 1.5 million, with a total target of $ 10 million (based on indications from the power utility), so that the country can benefit from additional investment in agricultural biomass gasification technology. Hence, for all practical purposes, the FSM is not expected to be a short-lived mechanism; in fact, it will have to be operational for at least 15 years, equivalent to the normal duration of the PPAs signed by the IPPs with SBEE. The FSM is meant to be in operation until such time that project promoters/developers gain sufficient confidence that the risk of investing in biomass gasifiers and SBEE defaulting on its payments for electricity already supplied to its main grid/mini-grid has been minimised and/or eliminated through the project.

It has been clarified above that the purpose of the FSM is to reduce the overall risk profile of the private investment and to shield investors from default on the part of SBEE. In discussions with project developers, this issue will be highlighted and the website will also make clear the purpose for setting up the FSM. This, it is hoped, will sensitise project developers to the fact that the FSM is expected to decrease gradually over time and eventually be phased out, when private sector-driven electricity generation from agricultural biomass gasifiers has been fully understood, has proven to be a reliable source of electricity and no longer needs additional incentives. Still, during implementation of the project, discussions will be held with the Government to consider the options for putting in place its own FSM, in the unlikely circumstance that it should it still be necessary beyond the project time-frame to support project developers.

In addition to the above, non-FSM funds in the amount of $ 200,000 will be utilised to support biomass gasification-based electricity generation in those villages where SBEE is not present and where there is no mini-grid electricity supply. This will be achieved through the provision of a grant to eligible project investors to jump-start the market for biomass gasification in those unserved villages by supporting the preparation of feasibility studies/business plans (FS/BP) and providing an upfront investment subsidy for biomass gasification projects. The initial amount of the grant will be a maximum of 50% of the costs involved for the FS/BP, with an individual grant not exceeding $ 5,000 – this will be in addition to an investment subsidy of a maximum of $ 50,000 (please refer to next paragraph). Prior to allocating this grant for the FS/BP, project management may request the developer/private sector to provide evidence that he can bring in some 10 to 15% of equity capital and that he qualifies for debt financing from a lending institution. Also, while these funds will be ear-marked for the developer, they will be paid directly to the consultants/consultancy group preparing the FS/BP.

Following this, the project may provide an investment subsidy to the project developer, channelled through SBEE, whose FS/BP (including consumer electricity tariffs) has successfully cleared appraisal. The objective of this subsidy would be to reduce the developer's transaction costs and make it easier to access debt financing from lending institutions. This capital subsidy will constitute no more than 25% of the total project cost and will have an upper limit of $ 50,000 per project, inclusive of the grant for the FS/BP – these funds will be disbursed in accordance with UNDP rules and regulations. Determination of the amount of subsidy to a particular project will be made on the basis of an economic and financial analysis, prepared by the developer/private sector, which would include the equity capital, loan and subsidy as inputs to determine the optimum internal rate of return (IRR) that makes the project attractive to the developer. When several developers are competing for a project site, the winner will be the one requiring the lowest subsidy.
The grant funds for FS/BP and investment subsidy will support a minimum of 4 projects for a total sum of $ 200,000. Disbursements of these funds would be made in tranches as per a set of established benchmarks and the scheme will be designed and in accordance with UNDP rules and regulations. The proposed international part-time Chief Technical Adviser will draft a procedures manual governing the disbursement of the grant/subsidy funds within the first six months of project start.

Operationalising the FSM

The FSM will constitute a "risk minimisation" mechanism, as discussed above, and the non-grant funds of $ 1.5 million will be deposited with the Central Bank of Benin; its concurrence was secured during implementation of the PPG. The funds themselves will be managed by the Central Bank, assisted by a management committee consisting of representatives of the Ministry of Finance, Ministry of Energy and UNDP.
The FSM will cover IPPs against the risk of SBEE not fulfilling its financial obligations, as outlined in the Power Purchase Agreements, towards developers for electricity already supplied to the SBEE. Under the circumstance that SBEE does not credit the IPP for energy already provided, the latter solicits the support of the Management Committee with a view to resolving the issue with SBEE. Hopefully, a satisfactory resolution of the issue will be found through an acceptable payment schedule. If, however, SBEE is unable to pay the IPP, then the latter solicits the fund managers to step in and make payment under the FSM, based on the non-performance of contractual

obligations under the PPA. In order not to deplete the funds under the FSM, its management will endeavour to enter into an agreement with CEB/SBEE on a repayment schedule. Only when all avenues for reaching a payment schedule acceptable to the concerned parties (developer and SBEE) cannot be reached, the Management Committee will determine the amount of payment that needs to be made to the developer and request the Central Bank, in writing, to release the necessary funds.

Exit Strategy: Upon completion of the project, any remaining funds under the FSM will be transferred to the Ministry of Energy, which will then act as fund manager until such time that a continuation of activities related to biomass gasification for electricity generation will no longer require financial support from the FSM.

The table below presents the anticipated disbursements from FSM.

Project Year	Available funds in FSM ($)	Electricity Generation (MWh)	Payment due by SBEE to IPPs for energy produced ($) – at 20.3 US Cents/kWh	Anticipated default rate by SBEE (%)	Anticipated payment by FSM ($)
1	1,500,000	-	-	-	-
2	1,500,000	3,067	622,601	30	186,780
3	2,500,000	24,528	4,979,184	25	1,244,796
4	4,000,000	24,528	4,979,184	20	995,837
5	5,000,000	24,528	4,979,184	15	746,878
Cumulative payment over 5-year project period					3,174,291
6	5,000,000	39,420 (for 5 MW total installed capacity)	8,002,260	10	800,226
7	5,000,000	39,420	8,002,260	10	800,226
8	5,000,000	47,304 (for 6 MW total installed capacity)	9,602,712	10	960,271
9	5,000,000	47,304	9,602,712	10	960,271
10	5,000,000	55,188 (for 7 MW total installed capacity)	11,203.164	10	1,120,316

Box 2 below provides a snapshot of how the energy component of the FSM will be set up and operate:

Box 2: FSM and Capital Subsidy Snapshot

Financial Support Mechanism

Purpose: (1) **S**upport project developers vis-à-vis lending institutions by minimising financial risks.

(2) Provide assurance of payment to developers for energy supplied in case of default by SBEE.

Initial Capitalisation: $ 1.5 million ($ 1.3 million from GEF and $ 0.2 million from UNDP).

Funds Host/Manager: Central Bank of Benin.

Lifetime: Minimum duration of 15 years, equivalent to duration of PPAs signed between SBEE and IPPs.

Disbursements, whenever required: Initial contribution ratio to be maintained, i.e. 80% from GEF and 20% from UNDP.

Operationalising FSM: Recruitment of a consultant with financial engineering background and experience mid-way through Year 1 of project to draft regulations.

Worst case scenario: In the worst case scenario, if SBEE were to pay nothing to the developers, the $ 1.5 million from the FSM would barely cover 4 months of guarantee. Hence, the argument provided to mobilise additional resources for the FSM. Also, the probability that the FSM would get depleted in 3 months would be low, as remedial measures would kick-in as soon as SBEE starts falling behind on payments to IPPs. Moreover, IPPs would be encouraged to develop their own financial instruments with private insurance providers and in case of default of payment by SBEE, the FSM will step in as "subordinated insurance" to reimburse that portion of default not covered by the IPPs' own insurance companies.

Capital Subsidy

In addition, non-FSM project funds in the amount of $ 200,000 will be set aside to promote biomass gasification-based electricity generation by supporting the preparation of feasibility studies/business plans (FS/BP) and providing an upfront investment subsidy for biomass gasification projects. This capital subsidy, including the grant for FS/BP preparation and investment grant, will constitute no more than 25% of the total project cost and will have an upper limit of $ 50,000 per project, with a total of $ 200,000 for the 4 gasifier systems.

The mechanism for re-investment of partial energy proceeds into sustainable biomass enhancement

Biomass production is an environmental service classified under the supply services according to the Millennium Ecosystem Assessment (MEA). In addition to the biomass availability (see table 3a. Availability of Agricultural Residues), the IPP's needs in term of biomass are (i) regularity in biomass supply with good calorific value, (ii) quality of biomass (e.g. no rocks mixed with the biomass that could degrade the gasifiers). The project will implement a financial mechanism, based on re-investment of partial energy proceeds of IPP, that will support the maintenance of environmental service (biomass production) while answering IPP's their needs in term of biomass supply (sustainable quality and quantity in the long term).

When IPPs will negotiate for the PPA, they will sign for both the FSM (described previously) and a local biomass-enhancing fund (LOBEF). The LOBEF will finance:

- Investments in sustainable agriculture practices (e.g. organic fertilisation or agroforestry) and trainings of farmers to disseminate good practices around the biomass power plants. The objective is to increase crops productivity (and then residues quantity) of farmers while protecting soils (maintaining fertility).

- Trainings of farmers and collectors (villagers who have carts and donkeys) on biomass quality: biomass collecting, sorting, storage, etc. based on the technical specifications of the IPPs (to be written at the beginning of the investment).
- Training and technical assistance provided to local entrepreneurs linked to the project, such as briquetting businesses. The technical studies performed during the PPG show that the 20 sawmills in the 4 pilot sites of the project (2 sawmills in Kalalé, 6 in Djougou, 6 in Savalou, and 6 in Dassa-Zoumé) produce a total of 527 tons of sawdust every year. The managers of the sawmills have the willingness to give more value to this "waste", by developing new products such as briquettes. These briquettes can be used by the IPPs.
- Other micro-projects proposed by local stakeholders. These micro-projects will support the maintenance of environmental services in the pilot sites. For instance, the SSF could co-finance the implementation of the Forest Management Plan (FMP) of the surrounding forests[17].

The IPPs will contribute each year at a rate of 5% of their income (total turnover) received from SBEE. This rate of 5% is acceptable for the private projects developers (arguing also that the financial mechanism contributes to biomass production enhancement and answers IPP's needs) and will not threaten the business opportunity. These costs will be internalized by IPP. This financial mechanism will generate an appropriate sum of $ 223,750 per year[18], which will fuel the LOBEF. This specific fund will finance specific concrete actions through annual micro-projects submitted by local stakeholders (farmers, community based organisation, forest management committee, NGO, etc.). Example of actions financed could be: production of organic fertilizer, reforestation in agroforestry, equipment for fire protection, briquetting, etc. Actions collectively proposed by at least 3 actors could be 70% co-financed and individual actions could be 50% co-financed. Communes, local agents of the Ministry of Environment and NGOs will support the communities to formulate the micro-projects. The FSM board will manage the LOBEF and will organise once a year a call for micro-projects. A committee, composed by the Ministry of Finance, SBEE, Ministry of Environment, Ministry of Agriculture, INRAB, UNDP, local authorities, ONG and communities representatives, will meet once a year in order to select the most appropriate to be financed by the LOBEF.
The micro-projects will be checked against the following criteria: (i) proximity with the biomass based power plants, (ii) actions that aims at enhancing biomass quantity and quality through sustainable ways, (iii) actions in line with the SDACs, PDCs and FMP (assessment performed at the initial stage of the project), (iv) income-generating activities that are viable and environmental friendly.
During project implementation, a specific manual of procedures for the disbursement of the CT for micro-projects will be drafted before the launching of this activity.

Country ownership: country eligibility and country drivenness

Electricity generation through biomass gasification of crop residues, which has not been the focus of much attention to date, is one of the important mitigations options that the Government of Benin wishes to pursue for reducing greenhouse gas emissions in the country. In this connection, the Second National Communication to UNFCCC submitted in June 2011 showed that in 2000, GHG emissions from agriculture and forestry constituted 68% of the total while those from energy had substantially increased to 30% from 1.84% in 1995. In absolute terms, the total emissions in 2000 were 63 million tons of CO_2, an increase of 30% from the 1995 reference year, with the agricultural sector contributing 55% and the energy sector contributing 45%, while the country's net absorption capacity had decreased from 17 million tons of CO_2 in 1995 to 13 million tons of CO_2 in 2000. This

[17] The analysis performed in the PPG showed that the Forest Management Fund (FMF) lacks sufficient and recurrent funding to really meet their objective of financing activities of the FMP.

[18] The project targets the installation of biomass-based electricity plants, which will produce 22,045 MWh per year. Assumption is made for a kWh price at 0,203 USD. Hence, if the IPPs re-invest 5% of their energy proceeds, the LOBEF will be fuelled each year by 223,756 USD.

net absorption capacity has further decreased to 10 million tons of CO_2 in 2005, thus showing a disturbing trend. Also, the 2003 "Energy Policy and Strategy" document underscores the necessity to, among others, ensure protection of the environment with focus on management of the national energy system through improved development of natural resources and a reduction in the negative impacts of energy on the environment, and energy use in the rural areas for income-generating activities and to reduce the rural exodus towards urban areas. Thus, the project is in line with national priorities and will contribute to meeting the objectives of the Government on global warming, and energy development.

Design principles and strategic considerations

The project will promote a market-driven approach to encourage the participation of the private sector to generate electricity through gasification of unutilised (nuisance) crop residues. In line with GEF requirements, "the emphasis will be upon developing policies and regulatory frameworks that provide limited incremental support to strategically important investments", such as investment in investment in renewable energy electricity generation, allowing the country to move towards energy independence and increased energy security in an environmentally and climate-friendly way.

As the law presently stands, the private sector in Benin is allowed to generate electricity either for self-consumption and/or for sale to CEB or SBEE and/or for operating isolated mini-grids. Further, the "host country willingness to adopt favourable policies and to follow through on the initiatives" was demonstrated by the Government through the adoption of the guiding document entitled "Strategy Document for Poverty Reduction, 2012 -2015" that articulates the importance "to focus on interventions related to the rational use of forestry resources and a continuation of the improved cook stoves programme, promotion of renewable energy. Implementation of rural electrification will be conducted through dissemination of the successfully-tested decentralized model". Thus, the project will assist the Government to realize the objectives of the Strategy, design and adopt regulations and provide investment support aimed at promoting electricity generation through biomass gasification.

Project objective, outcomes and outputs/activities

The Ministry of Energy is the central body responsible for, among others, the design, formulation, and implementation of the Government's policy regarding development, supply and utilisation of energy at the national level. As such, it is entrusted with the responsibility of putting in place policy, plans and programmes that govern the promotion and rational utilisation of energy resources, development of renewable sources of energy and to participate in the promotion of energy sources respectful of the environment. To achieve this, it relies on its Directorate for Energy and can count on the support of other Government Ministries and Department, including the Ministry of the Environment.

This project aims to pioneer a functioning an effective market for the widespread use and commercialisation of agricultural biomass gasifiers in Benin via four interrelated components: 1) development of an appropriate policy, institutional, legal and regulatory framework; 2) a business-friendly climate providing crucial catalytic incentives to promote investment in biomass-based electricity generation; 3) sustainable land and forest management at the commune level; and 4) increased capacity/awareness of stakeholders and private sector investors to adopt agricultural biomass gasification for electricity generation to capitalise on the economic and environmental benefits that it provides. It will focus on agricultural biomass-based gasification technology development and utilisation to substitute for forestry-based biomass and imported fuel used by the majority of Beninese households for domestic or business use. This is proposed to be achieved through the participation of the private sector at both electricity generation level and, in some cases, at the electricity distribution and sale level, as well. This programme will not only benefit household consumers and businesses, but will also connect financial institutions,

technical training and local/women organisations to promote the establishment of an agricultural residue supply chain (Fig. 4) to develop the biomass gasification market.

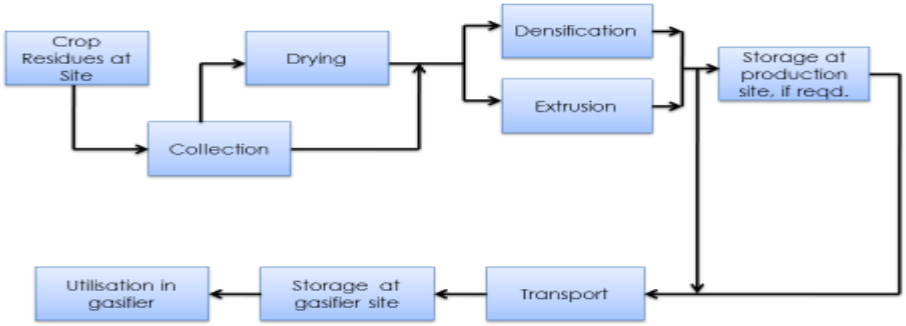


Fig. 4: Crop Residue to Gasifier Biomass Supply Chain

Source: World Bank, 2009.

The project will also establish a Financial Support Mechanism (FSM) with the Central Bank of Benin to support private investors in case of default of payments due to them from CEB/SBEE for electrical energy already supplied. It will also directly support private investors utilising biomass gasifiers to establish isolated mini-grids with an initial grant for preparing a feasibility study/business plan and, eventually, an upfront investment subsidy in order to jump-start the market. Disbursements from the FSM and of project grants will be made according to a set of criteria to be developed during project implementation.

The Ministry of Energy, as the Government Agency directly responsible for energy development, will be entrusted with implementation of the present project. In doing so, it will work very closely with other Government Agencies, private sector and NGOs to ensure that the participation of the full range of stakeholders is secured and effective.

The biomass market in Benin is essentially dominated by non-renewable biomass, using active deforestation to produce fuelwood. Farmers barely take advantage of their residues, with some 45% left unused in the field, with the balance used as soil fertiliser, fodder and to build fences around homes. Hence, the project will promote the utilisation of the "waste" renewable biomass from agriculture and forestry residues; it will not resort to non-renewable biomass, obtained from cutting trees (active deforestation), as the availability of renewable biomass is largely sufficient to meet the needs of gasifiers over the next 20 – 25 years. It will also ensure that efficient gasifiers are introduced in the country in order maximise on the use of agricultural biomass, while avoiding any potentially negative environmental effects associated with gas cleaning prior to its combustion. Finally, it will create income generating opportunities by having local farmers commercialize their residues and sell them to the gasification plant to be used for electricity generation.

The project consists of four components as outlined below. It is recognised that on-the-job training will be provided by the recruited consultants, both local and international, during the normal course of their support to the relevant project activities and a communication strategy formulated to inform stakeholders on project implementation. This will be in addition to Components 1 and 2 that, respectively, deal with capacity development on policy/regulatory and financial issues required by Government and private investors.

On the gender dimension with regard the utilisation of agricultural biomass for electricity generation and sustainable forest and land management, women constitute an important human capital, even if most of them happen to be in the informal sector. In fact, women are present and active in all development sectors and, mainly,

in the agricultural sector from farming to harvesting, post-harvest transformation and commercialisation, as well as in animal husbandry. As such, the project will seek to achieve gender equality through the empowerment of women to fully participate in all project activities and specifically those related to capacity development under the various components. This will be achieved through working, for example, with NGOs and Women's organisations like Ofedi and Nature Tropicale in Cotonou, PISOL and BCA-ONG in Calvi, ASPRO-GH in Bohicon and APIC in Parakou.

Component 1: Policy, institutional, legal and regulatory framework for biomass electricity generation

Outcome 1: **Streamlined and comprehensive market-oriented policy and legal/regulatory framework for biomass electricity generation by Independent Power Producers.**

established.

Outcome 1 will remove legislative and institutional barriers, at national and local levels, which currently hamper integrated approaches and private sector investments in biomass electricity generation. At all levels, from ministerial and agency (SBEE) to villages and communes, capacity will be strengthened – in terms of skills and competencies, integrated working practices, planning and implementation. The expected outputs under this component are:

- Appropriate policy and legal/regulatory framework established and operationalised for (a) biomass electricity generation, and (b) establishment and implementation of a mechanism for re-investment of energy proceeds into community lands conservation.

The project will review the Government's "Strategic Plan for Energy Sector Development" of October 2009 to determine the issues that act as barriers to the private sector playing a role in electricity generation from biomass gasifiers in the country. Following this, the project will develop a policy document outlining the remedial measures that are necessary and propose a legal/regulatory framework that will guide private sector investment in biomass gasifiers. The project will then seek the Government's approval to operationalise this whole set of documents.

The electricity production will depend on the sustainable biomass supplied by the farmers in the neighbour of the power plants (economics of gasifiers depends on the distance of biomass sources). Promotion of SALM practices and SFM activities will lead to an increase of biomass production (see under component 2). Hence, a common vision between stakeholders is needed and common challenges between users of the natural resource shall be discussed. Meetings hold locally will be organised. Through a participatory approach, rules for biomass utilization will be defined, as well as the establishment of a financial mechanism to sustainable the production of biomass. This mechanism will be based on payment for the biomass supply provided by SLFM in the commune territory – payment from the IPPs based on sharing benefit scheme of the energy proceeds. A Local Biomass Enhancing Fund (LOBEF) is fuelled by IPPs and will finance every micro-projects which contribute to sustainable land and forest management in the commune.

- Technical report on grid capacity requirements to enable feed-in for grid-connected renewable energy systems followed by development of an updated grid code, as well provision for isolated mini-grid options. This report will define the parameters that the biomass gasifier plants connected to the grid/mini-grid have to meet to ensure safe, secure and proper functioning (stability) of the system, whenever they get connected/disconnected either due to operational requirements or in cases of electro-mechanical faults.

- Established procedures and standardized PPAs for the introduction of a transparent procurement process in the selection/award of biomass-based electricity supply agreements by private developers/IPPs.

Procedures and regulations will be developed regarding a transparent and competitive process on how sites will be awarded to developers and a standardised PPA will be formulated for use for sale of energy contracts between the developer and SBEE.

- Setting up of a one-stop shop for issuance of construction licenses and permits to private RE developers. The one-stop-shop will be the custodian of all information that a potential developer will need prior to making an application, all applications forms and required documentation that need to be submitted in support of an application, any fees to be paid, advise developers if any additional documentation is required and provide a final decision on the outcome of an application. This will obviate the need for the developer to personally visit several Government offices for necessary clearances and speed up the approval process.

- Methodology developed for a joint environmental, economic and financial evaluation of biomass plants in line with government regulations and policies. Criteria and guidelines will be formulated for technical evaluation of projects and an excel programme will be developed to undertake economic and financial analyses, and to determine feed-in/consumer tariffs that would be the subject of discussions with developers.

- Capacity developed within SBEE, local banks and key national actors such as Ministries of Energy, Agriculture, Development and Finance to appraise renewable biomass projects for PPAs and lending. Training will be provided to the local stakeholders on how to utilise the criteria and guidelines developed under the project to technically appraise projects, determine the appropriate feed-in/consumer tariff to be allocated to a given developer and develop local technical capacity to support construction, operation and maintenance of gasifiers.

Component 2: Promotion of investment in biomass-based electricity generation through appropriate catalytic financial incentives available for project investors.

Outcome 2: **Increased investment in clean energy technologies and low-carbon practices in the agro-forestry waste sector.**

The expected outputs are:

- Financial Support Mechanism established and capitalised to support private investment in biomass plants. This will include, among others, drafting the general rules and regulations establishing the FSM, seeking any approval that is required by Government authorities for its establishment and outlining the process to be followed to solicit other donors to further capitalise the FSM.

- MOU signed with Central Bank of Benin setting out the objective, funding mechanism and administration rules governing its participation as fiduciary agent of the FSM. The MOU will outline the responsibilities of the Ministry of Finance, Ministry of Energy and UNDP as joint managers of the FSM, of the Central Bank as the custodian of the funds and spell out the conditions that need to be met for disbursement of funds to project developers under the FSM.

- Financial and other incentives to be provided to project developers/Independent Power Producers (IPPs). These will include: reduction/elimination of import duties/taxes on equipment and spare parts, income tax holiday for a specific duration, simplification of foreign exchange regulations, simplifying EIA procedures for biomass gasifier plants, etc. All these will be operationalised by the Ministry of Energy in consultation with other Government Departments.

- Documents confirming financial closure (Power Purchase Agreements, where applicable) with identified investors.

- Reports confirming completion of construction of at least 4 MW of on-/off-grid biomass-based power plants by IPPs at various sites by end of project.

During the course of the scheduled project mid-term review, an assessment of the FSM will be undertaken to ensure that it is performing as planned, including the gradual decrease of the investment grant and its eventual phase-out over time. The mid-term review will also ascertain the level of support, if any, that future project

developers may require beyond completion of the project, while capitalising on the momentum that it has generated.

Table 5 below provides a list of potential projects selected on the basis of discussions with various local authorities, bearing in mind the selection criteria listed above. These projects constitute a preliminary list that may be subject to change on the basis of additional information to be submitted by the potential investors during project implementation. Figures for agricultural residues are provided for 2012 – 2013; an analysis of figures for prior years shows a similar trend regarding the availability of residues. These data show a pretty consistent availability of agricultural residues for gasifier-based electricity generation. However, in the unlikely circumstance that there will be a forecasted reduction in agricultural biomass residues, all 4 Communes have sufficient unutilized land for Acacia plantations to supplement any shortfall in biomass resources.

Table 5: Location and Capacity of Gasifier-based Electricity Generating Plants

No.	Basic data	Djougou	Savalou	Kalalé	Dassa-Zoumé
1	Total amount of crop (wet agricultural) residues, tons	82,370	264,858	446,256	79,723
2	Amount of crop residues available for electricity generation, tons	35,420	113,889	191,889	42,959
3	Potential generation capacity (if all residues were utilised), MW	18.6	34	57.6	12.9
4	Proposed installed generation capacity, kW	600	1,000	2,000	400
5	Expected annual electricity production, MWh	3,679	6,132	12,264	2,453
6	Population	266,522	144,814	168,520	112,118
7	Main economic activities	Agriculture, livestock and fishing.	Agriculture, livestock and fishing.	Agriculture, livestock and fishing.	Agriculture, livestock and fishing.
8	Availability of SBEE main grid/isolated grid.	Yes	Yes	Yes	No
9	Potential Investors[19]	1. Euro Négoce 2. Société Dangoté	1. Satarem 2. Waio SA	1. AF Power 2. Ajavon et Fils	1. Groupement Hydrochina Kunming 2. MIERT International.

The potential generating capacity that can be installed at each of the above sites by far exceeds the proposed installed generating capacities. The reasons for choosing such a conservative generating capacity for the pilots relate to the following:

- The only solid experience with gasifiers in Benin is the 40-kVA plant operating at the Songhai Centre for the last 2 years. The two others installed at Gohomey and Sekou stopped operation after only one year. Hence, potential project investors with whom discussions were held during the PPG felt that it would be wise to limit

[19] Short descriptions on potential investors is provided in an Annex.

themselves to smaller pilots first, despite the fact that Euro-Négoce plans to bring on line a 6 MW plant in early 2016. Proceeding this way, they felt, would enable them to accumulate sufficient experience prior to embarking upon larger installations. Once sufficient economic, financial and technical experience has been accumulated over a couple of years, they would feel confident to build upon that to add additional units to increase the generating capacity at these 4 sites and elsewhere.

- Starting with "smaller" gasifier plants between 400 kW and 2 MW would enable SBEE to test how well private power developers are observing the grid code concerning electricity generation and make the necessary adjustments, where necessary, before larger generating units get connected to the main grid/isolated grid in the future. Gasifier electricity generating plants will operate as base-load plants, unlike hydropower generation that can operate either base or peak load, and their coming in and out of synchronism with the grid needs to be well understood by SBEE System Control Engineers in order to avoid instability in the grid.

Component 3: Land use and sustainable forestry management and implementation.

Outcome 3: **Integrated land use, sustainable forest management and natural resource management provide social benefits and sustain biomass for electricity production.**

The Component 3 will support the long-term management of land and forest resources. Under this component, stakeholders will implement the fire management strategy, rehabilitate degraded forests, plant trees, enhance agro-forestry and implement sustainable agricultural practices. These activities will provide multiple services and benefits, including water flows supply, lands and biodiversity conservation. The project will also supports communities adjacent to forests in the development and implementation of income-generating activities. The activities will be based on previous realization such as participatory management plan. The project will support a biomass-monitoring system within the Commune that will provide information for measuring the success of SLFM efforts, the increase of agricultural productivity, the availability of biomass and for designing an innovative financial mechanisms based on sustainable biomass supply. The key lands conservation & SFM outcome under this component of the project will include management for conservation and sustainable use by communities of 14,000 hectares of lands. This global objective has been determined during the PPG with the national and local authorities and includes 9,000 hectares of lands managed with conservation agriculture practices, 3,000 hectares of forest managed sustainably and 2,000 hectares of reforestation. These sustainably managed lands are representative of several globally important and rich eco-geographical zones of Benin. In addition, the wider landscape within Commune's territory will also be managed for productive uses in a more sustainable way aiming equally at improving livelihoods. Key associated climate change mitigate benefits under this component includes avoidance of ~1,019,030 t CO2 emissions over 20 years through SFM, reforestation and avoided land degradation.

In terms of execution of the activities, the outputs 3.1 and 3.2 will be executed by a consulting firm, which will be recruited through a tender process. The outputs 3.3 and 3.4 will be executed by an NGO that will be contracted at the inception of the project.

The expected outputs are:

- **Integrated Land Uses Management Plans (ILUMPs) are adopted in the four communes and strengthened the local institutional framework.**

SDACs exist at the commune level but are too general. Specific land uses plans, called Integrated Land Uses Management Plans (ILUMPs), need to be designed and local agents need to be trained to SLFM. The project will support land use planning (in each target commune) using WOCAT[20] tool with an overall vision for management and use of lands, incorporating community based sustainable natural resource management, agricultural

[20] WOCAT (World Overview of Conservation Approaches and Technologies) is an established global network of Soil and Water Conservation (SWC) specialists, contributing to sustainable land management (SLM).

production, livestock breeding, ecotourism and renewable energy production. The project will ensure that a mapping is completed of all targeted areas under sustainable forestry management as well as agricultural lands under SLM in collaboration with CENATEL. This mapping will also include livestock corridors. More specifically, the global benefits concerned under this output pertain to local policy barriers to land uses planning, natural resources co-management and community-based forestry with an integrated approach. To overcome the perceived mismatch between authorities and the needs of the local communities, the project will particularly focus on establishing a dialogue through a participative approach.

Moreover, as states in the Forestry Master Plan (2012), there is a need to strengthen capacities of local authorities for effectively integrating SLFM in the planning tools at the Commune level. Workshops will be organised in order to train technical staff of the Communes and to develop inter-sectoral collaboration (Agriculture / Forestry / Energy). The project will support capacity development of decentralized staff of Ministries of Agriculture (CARDER) and Environment (DGFRN), Communes and Community leaders through all aspects of the implementation of the SLFM at the local level. In particular, local agents of the Ministries will be supported and trained for forests surveillance, data collection and also forest law dissemination at the local level. This will include the development of working relationships between the Ministries relevant to land uses, natural resource and energy production.

Activities will be: (i) lobby and promote the implementation of the decrees of the forestry law 2013-01, (ii) develop a strategic document (ILUMP) for implementation of SLFM at the commune level, (iii) establish land use and forest management plans (including zoning and mapping of forest areas) for all targeted woodlot areas, (iv) develop an integrated database for monitoring of land uses, productivity of crop and biomass availability, (v) trainings of local staff. A specific study on gender inequalities in land uses will be performed and will seek to identify levers to empower women in the forestry and agriculture sectors. A geographical information system (GIS) of plantations will be developed with the following information: name of the landowner, commune, district, village, GPS data, surface area of plantation, species planted and year of plantation and of the main intervention. This Monitoring Scheme will use the data collected during project activities, and establish baseline values and regular monitoring of simple indicators. A community-based biomass monitoring scheme will be developed through an initial consultancy and participatory involvement of all the stakeholders (village committees, eco-guards and local agents of DGFRN and CADR). The scheme will use appropriate methods and technologies (e.g. easily observed or measured indicator, mobile phones) to allow local site staff (eco-guards and agents) and villagers to carry out regular surveys and report results to a centrally coordinated scheme. The monitoring will be carried out in collaboration with existing schemes of the CADR.

- **Fire management practices are operational over 3,000 ha in the Classified Forests in the neighbour of the biomass plants.**

The project, in close collaboration with the Adaptation Project (which is implemented in synergy with this project) will support the update and the implementation of the Participatory Forest Management Plans (PFMP) of the four pilot sites. It will also design and implement the strategy for wildfire management.

The project will support the implementation of the PFMP by organising the delegation of annual work plans to local NGOs. NGOs will be selected through a tender and selected according to the following criteria: (i) expertise in sustainable forestry intervention, (ii) knowledge of the pilot zones and (iii) experience in working with local communities. The DGFRN will be responsible of the monitoring of the implementation of the annual work plans.

The fires strategy and action plans will be develop in partnership with INRAB and the CERF (discussion hold during the PPG and convention to be signed at the beginning of the project) and will include (i) the situation description (reference assessment), (ii) the measures required to sustainably manage and control forests fires, (iii) the responsibilities of each stakeholders, (iv) a detailed work plan and budget. Each plan will be validated by stakeholders during meetings, before its official approval by authorities.

Actions plan will include (i) information workshops, (ii) management of early fires, (iii) establishment of firebreaks, (iv) set up of a pedagogic plots, (v) monitoring of the fire at the commune level.

The project will then support the implementation of the actions plan, in coordination with:

(i) The CARDER, which will have the responsibilities of informing villagers through the design of technical guide sheets for establishment of firebreaks, opening of early controlled fires, selling of biomass to the IPP (instead of burning it), etc.

(ii) The SCEPN, which will have the responsibilities of supporting population in fire management and in monitoring of the impacts of fires. It will support the organisation of communities to fight against fire.

(iii) The civil society, which will inform through radio communication the population for the lightening of the early fires.

Fire management also includes organisational support and capacity building for communities. A committee will be established in each village in order to manage the forest fires. It will be formed by community leaders during the development of the participatory plans. The committee will benefit from a learning and capacity building process. It is expected that each community leader will act as a multiplier of knowledge within his own community, disseminating the principles for the sustainable management of fires.

- **Woodlots are established over 2,000 ha in order to provide sustainable biomass and incomes.**

The project will support the establishment of 2,000 ha of woodlots across the four pilot districts. The objective is to decrease the pressure on forest (due to biomass energy consumption), to develop an income generative activity for landowners and to improve degraded lands.

During the PPG, it has been assessed that wood biomass cannot be used by gasifiers in the short term because forests are under pressure. That's why agricultural biomass has been preferred for biomass supply of the gasifiers. However field surveys performed during the PPG show that waste wood is also available in quantity: 31 tons of waste wood are available in Kalalé each year. In Djougou, these are 71 tons per year. In Savalou, 303 tons per year. And in Dassa Zoumé, 91 tons per year. All of them (496 tons of wood per year) are wood residues from the trees plantations and transformation that have difficulties to find a market nowadays, and that could be used in the future by gasifiers.

This output will focus on specific fast growing plantations to produce sustainable wood in the long term and improve the incomes of local communities. Indigenous fast-growing trees will be planted on under-productive agricultural lands or degraded forests to supply the Rural Wood Market. It was further confirmed through interviews with farmers and landowners that there is available land for woodlot establishment and that there is an interest for producing and selling biomass to the future gasifier plant. Technical assistance provided by the project will support landowners to plant indigenous species as biomass fuel stock. Land tenure arrangements in the chosen communes are supportive of such activities: the new Land Tenure law in 2013 promotes valorisation of degraded lands, and the Rural Land Tenure Plan (RLTP) is facilitated (see section A.1).

The species selected for piloting were chosen based on the following characteristics of tree species which are suitable for wood fuel production:

- Grow quickly, yield a high volume of wood quickly, and require minimum management time.
- Water extraction rates that are suitable for local agronomic conditions.
- Coppice or sprout well from shoots.
- Have dense wood with low moisture content.
- Produce little and non-toxic smoke.
- Produce wood that splits easily and can easily be transported.
- Yield other products or services for the household.
- Produce wood that does not spit or spark when burning.

The species selected are easy to establish and could easily be planted by direct sowing with good seed. The species are ecologically friendly within the climatic environment of the target area. The selected species are: *Acacia auriculiformis, Cassia Senna siemea, Eucalyptus camaldulensis, Filao*.

As already stated, the gasifiers implemented during the project will be supplied by agricultural biomass. The trees plantations of the output 3.3 have the objective to meet the high demand of wood in the country (Akouehou, 2013). Thus the main market for the plantations will be crafts and the Rural Wood Market. As regards the quantity of wood produced in the plantation, total biomass produced will be about 102,000 tons with conservative estimate. The rotation of the plantation is calculated for 8 years, which means a potential of 12,750 tons of sustainable wood harvested every year and available for the wood markets.

However, when the plantations will be harvested (7 years after the first trees plantation), the waste produced during the harvesting of the plantation could be sold to the IPPs. Indeed the gasifiers will be a new market for the landowners. With an estimation of 10% of waste, the plantation supported by the project can supply about 1,275 ton of biomass per year.

The Songhai gasifier plant has been analysed during the PPG: 40 kVA consumes 48 tons of wood per year. This is equivalent to about 1 ha harvested every year. During the project, 4 MW will be installed. This means a potential need of 3,840 tons of wood per year[21].

In conclusion, the plantation would produce about 1 ton of waste wood every year, which is about a third of the biomass needed by the gasifiers installed during the project. As IPPs will create a new market for waste biomass, it can be expected that the waste wood will be sold to the IPPs. Thus the project will support the IPPs to define contract will landowners and sawmills in order to purchase only waste wood from sustainable managed forests (i.e not from illegal cutting or collecting in the forest).

Table 6: Projected wood production across the 4 pilot communes

Species	Climate conditions	Biomass produced	References
Acacia auriculiformis	1000 à 1500 mm	28,000 tons	56 to 65.8 tons per ha. Fonton H. N. et al. 2001. Etude dendrométrique d'Acacia auriculiformis A Cunn. Ex Benth en mélange sur versol au Bénin Biotechnol agron. Soc. Envon. 2001. 29-37.
Acacia mangium	2000 à 2500 mm	60,000 tons	120 to 130 tons per ha. F. Bertnhard-Reversat, D. Diangana et M. Tsatsa. 1993. Biomasse, minéralomasse et productivité en plantation de Acacia mangium et Acacia auriculiformis. Bois et forêts des Tropiques n° 238, 4ème trimestre 93.
Gmulina arborea	900 à 1200 mm	10,000 tons	21,3 to 27,3 tons per ha. M. Boulet Geracourt. 1997. Monographie de Gmelina arborea. Revue Bois et Forêts des Tropiques, n° 172, Mars-Avril 1997.
Tectona grandis	1200 à 1500 mm	4,000 tons	8 to 15 tons par ha. Ganglo C. J. 1999. Bois et forêts des tropiques, 1999, N°261(3)

Under this output, the project will identify and train a total of 1,000 households (potential private land owners) in the four pilot communes for woodlot establishment (minimum 2,000 hectares). Land owners will be two types:

[21] According to the Songhai Centre, 30 kg of wood (*Acacia auriculoformis*) allow the functioning of the gasifier during 1 hour. The gasifier functions 8 hours a day and 200 days a year.

the small landowners willing to diversify their incomes through a new activity, larger landowners willing to produce biomass for a new market.

Activities under this output will involve: 1) Training all communities/woodlot managers on new land tenure (law n°2013-01) regulations and SFM best practices, including use of specified tree species and optimal ecological yield from such species; 2) Technical support provided to all woodlot owners on tree nursery management as an entrepreneurial activity with target to plant over 5 million seedlings; 3) Dissemination of over 5 million tree seedlings to woodlot owners; 4) Establishment of simplified woodlot management; and 5) Contracts signed between woodlots owners and gasifier plants for feedstock supply with the waste wood.

The above-mentioned plantation arrangements for the corresponding tree species in the target areas have taken into account several factors including the ecological suitability of the locations; human settlements; household land sizes and security of tenure; economics of land utilization; status of forestry development in the commune; and the most importantly the available land that can be converted to tree planting.

Generally, trees require minimum inputs after planting compared to agricultural crops. However, weeding and protection against grazing, trampling and browsing by animals and destruction by fires is important for optimum yields. In particular, protection against bushfires will be important in the Kalalé area where *Acacia auriculoformis* will be planted. Activities implemented under output 3.2 will support the fire management and then contribute to the protection of the plantations. The growth patterns of the chosen species are based on planted acreage per year with estimated tree coverage of 2,500 trees per hectare at spacing of 2 metres by 2 metres. The gasifier plants piloted under component 2 will be located in the vicinity of the woodlots.

As such after eight to ten years, it is expected that most of these sprouts will have attained the required diameter and therefore will be ready for harvest and supply to the gasifier plants. Within the simplified management plan of the plantation, it will ensure that every eight to ten years, the demarcated section will be ready for harvesting. As noted in Table 6, the project assumes biomass stocks of 102,000 metric tons of wood are available for utilization (which would otherwise come from deforestation under a BAU scenario).

In terms of sustainability of the plantations, woodlots will be established on private lands. Landowners will be technically assisted by the communal staff in charge of the environment and the protection of the nature (RCEPN = *responsables communaux de l'environnement et de la protection de la nature*). The project will support the landowners in the plantation of the woodlots (trainings, nurseries), but will also support the RCEPN (training). After the project is closed, the RCEPN will monitor the plantations and keep assisting the landowners, as they are doing for the other private plantations. Moreover, as the project will promote fast growing trees, first incomes from the plantation will come in year 8, which is a strong motivation for good management of the plantation.

- **New methods and techniques of agro-ecology (conservation farming practices) are implemented over 9,000 ha and reduce lands degradation and increase lands productivity (agricultural harvests and residues).**

Extensive and poorly managed and regulated agriculture is a barrier to the achievement of all other land management functions. Promotion of Conservation Agriculture (CA) as a key SLM approach/technology in agriculture dominated landscapes has been prioritized.

This output will support the introduction of Sustainable Agricultural Land Management (SALM) practices among the farmers through a capacity building process including pilot land plots, training, technical assistance to the farmers and investments for the adoption and dissemination of sustainable farming techniques. The process will be driven by the WOCAT tool implemented in output 3.1. In the Collines department, this output will be implemented in partnership with the GIC, which is now carrying out a study on agroecology techniques in the region and supporting 3 staff for advising farmers (project financed by AFD).

During the PPG, existing experimentation of SALM practices have been assessed: (i) Soil fertility management with Mucuna, Ashynomenae and Stylosanthes, (ii) agroforestry with Acacia, Moringa, glyricidia and Anterololium, (iii) water management techniques and techniques to retain soil moisture, (iv) soil fertility

management (mulching, improved fallows and composting), (v) Management of transhumance through livestock corridors (migration of livestock herders) and establishment of transhumance management committees, (vi) reforestation of river catchments.

All the stakeholders expressed the need of capacities building to sustain the implementation of these practices. A training programme will be organized for at least 3,000 farmers in SALM practices for reducing soil erosion. The training plan will be developed in collaboration with the INRAB, universities and farmer's organisation. The learning cycle will be sustain by monitoring in the field both by CADR and by a local NGO that will be also trained by INRAB.

The learning cycle in agro-ecology seeks to improve the capacity of participants to promote agro-ecological practices, by reinforcing both their knowledge (technical aspect) and their skills (methodological aspect). It will consist of both theoretical and practical sessions, in planetary and working groups' sessions. Efforts will be made to organize participative and dynamic training sessions. Very comprehensive documents (with illustration and simple texts) will be given to the participants for dissemination in the communities.

Pilot demonstrative land plots will be established for two purposes: (i) organising practical training in the field and (ii) producing scientific knowledge for capitalisation on SALM techniques in the commune.

Based on first results of these pilot plots, investments for material and equipment for the implementation of soil management techniques on a large scale will be done on plots of groups of farmers. Criteria for selection of farmers will include: motivation to take a leadership role in the process of dissemination of SALM techniques in his community, availability of time, geographic and social representation, focus on the weakest segments of the population (women, unemployed groups).

Trainings on good cultivation techniques will raise average yields compared to current level (according to CIRAD, experimentation of soil fertility management with organic matter increase maize yield from 250 to 1000 kg per ha in North Benin). This is expected to increase revenues of farmers from main crops. The increase of yield for crops under SALM will be measure through field survey and reported to the Monitoring Scheme and will, as a consequence, increase the production of biomass.

Table 7: Projected biomass residues production across the 4 pilot communes (estimated with the CARDER data, 2014)

	Djougou	**Savalou**	**Kalalé**	**Dassa**
Amount of crop residues (in tons)	161,945	373,635	7,300,122	117,195
Increase of crop residues (in tons)	32,389	74,727	1,460,024	23,439
Total amount of crop residues after the year 3 (in tons)	194,334	448,362	8,760,146	140,634

Component 4: Outreach and results dissemination programme aimed at sustaining a growing market for biomass gasification.

Outcome 4: **Outreach programme and dissemination of project experience/best practices/lessons learned for replication throughout the country/region.**

Outcome 4 will include the promotion and dissemination of good practice and replication of successful integrated approaches and private investment in renewable energy sector.

Although some pilot projects have generated some excellent local level knowledge, such knowledge is not accessible and tapped by practitioners and affected people. Capacities development and tools for dissemination of lessons learnt (document, guidebooks, field visits) will be supported by the project.

The expected outputs are:

- National Plan to implement outreach/promotional activities targeting domestic (and international) investors. This will include the preparation of promotional materials, briefing sessions with investors who are already active in the biomass gasifier field in the country and, potentially, organising road shows to attract foreign investors.
- Capacity development of concerned Ministries/Institutions to monitor and document project experience. On-the-job training will be provided by international/local consultants to some 50 stakeholders on how to monitor, record/document project experience.
- Published materials (including video) and informational meetings with stakeholders on project experience/best practices and lessons learned. These materials, in electronic form, will be posted on the project website and will be widely disseminated throughout the region and to other countries planning to implement similar activities.

Key indicators, assumptions and risks

Indicators

Key indicators of the project's success will include:

- Indirect post-project GHG reduction (with replication over next 10 years of project influence) of 2,561,507 tons of CO_2.
- 76,651 MWh of electrical energy produced through biomass gasification by project end.
- Investment of $ 21 million expected from additional installation of 20 MW of biomass gasifiers for electricity generation over 10 years of post-project influence.
- Some 500 green jobs created in biomass gasifiers, sustainable forest and land management.
- At least 50% of the jobs created are for women.
- Over 5,000 rural households and small commercial/industrial enterprises connected to electricity services by project end.
- Some 30 stakeholders trained to monitor, promote and develop the market for biomass-based electricity generation.
- Number of Integrated Land Uses Management Plans (ILUMPs) adopted at the commune level.
- Decrease of number and impacts (surface burnt) of fires in the managed forests.
- Number of women participating in the fires management.
- Number of hectares of reforested lands.
- Number of hectares under Sustainable Agricultural Land Management (SALM) practices.
- Number of women trained on SALM practices.
- Financial Support Mechanism established to facilitate investment in biomass gasification for electricity generation.
- Project experience, best practices and lessons learned documented, published, presented at international conference and available on website.

Detailed indicators are provided in the Project Results Framework below. The table below details the indicators for SLFM outputs and outcomes.

INDICATOR	EXPLANATORY NOTE
1. Number of Integrated Land Uses Management Plans (ILUMPs) adopted by pilot communes	▪ ILUMPs are a key tool for ensuring the success of the project strategy, and the planinication of the land uses at the commune level. ▪ The greater the number of plans that are developed and adopted by communities early in the project the greater are the chances of the project objective being realised – both with respect to the forest and land conservation aspects and the biomass based power development aspects.
2. Carbon stock enhancement in forests effectively managed	▪ Classified forests have management plans, but are not effectively managed. The project will support the implementation of an effective fires management strategy. The other actions of the management plan will be implemnted by the Adaptation Project. ▪ During the inception of the project, forest inventories will be performed in each commune. This initial data collection in the field will give the initial biomass stock (and then the carbon stock) of the forest. The "business-as-usual" (BAU) scenario is a yearly decrease of this stock at a conservative rate of 1.2 tCO2 per ha per year (conservative estimation from FAO and the WOCAT – see note below). This rate will be specified thanks to the forest inventories). ▪ As the project sites cover 3,000 ha of forests, and according to the BAU scenario this stock would loose 3,600 tCO2 every year without the project. Thus, with the project implementation, this is a total of 72,000 tCO2 saved during the 20 years lifetime. ▪ At the end of the project, data from forests inventories will be collected and compared to data at the beginning of the project. Then the indicator of Carbon stock enhancement will be calculated. Finally, project scenario (biomasse / carbon stock) will be compared to the BAU scenario. A global stock enhancement indicator will be calculated.
3. Number of hectares under Sustainable Agricultural Land Management	▪ At least 3,000 farmers will be trained for SALM practices implementation. Through a partnership with INRAB and CARDER, farmers's plot under SALM will be monitored. Data (plot, surface, type of SALM practices implemented) will be referenced in a database. ▪ This indicator is easy to track as it will be verified with the database at the commune level and the project's documents.
4. CO2 sequestration with woodlots plantation	• Trees will be planted at large scale in the pilot sites, mainly in woodlots. Surfaces of trees plantation will be monitored (GPS localisation) by the Monitoring and Evaluation team (and reported in the database), and corresponding tCO2 will be calculated. • The data of biomass production are provided in table 6. With the estimation of a plantation of 500 ha of Acacia, 500 ha of Acacia mangium, 500 ha of Gmulina arborea, 500 ha of Tectona grandis and with a rotation of 8 years, the total CO2 sequestration is 29,351 tCO2 per year. Thus a total of 587,030 tCO2 during the 20-year lifetime.

Assumptions

The assumptions are outlined in the Project Results Framework below.

Risks

The project presents some risks which are discussed in the Table 8 below:

Table 8: Risks, Rating and Impact/Mitigation Approach

Risks	Rating (Probability of Occurrence)	Impact/Mitigation Approach
Policy and Regulatory: Reluctance in some quarters of the Government to introduce the necessary supporting policies and regulations.	Moderate	If this risk were to materialise, it would seriously affect project implementation. However, this is very unlikely the first sentence says it, as the Government of Benin is strongly motivated to provide access to modernised energy services to the large rural and peri-urban population that utilises fuel wood/charcoal for cooking and is driven by its plans to reduce the massive deforestation that accompanies the use of forestry resources. Hence, it will ensure that all Government Institutions (Ministries/Departments/Directorates, etc.) get on board to put in place a conducive policy and an enabling regulatory framework for biomass gasifier promotion and development. This will also be in line with its December 2003 "Energy Policy and Strategy" and the updated October 2009 "Strategic Plan for Energy Sector Development".
Economic/Financial: Non-availability of credit to promoters of biomass gasifiers.	Moderate	The project will work with local lending institutions to develop their capacity to understand and appraise gasifier projects for lending. In addition, the Financial Support Mechanism will contribute towards minimising risk exposure on the part of lenders.
Financial: Poor investment climate.	Moderate	The fact that Benin ranks 135 out of 189 economies on protecting investors and 169 out of 189 on enforcing contracts, as per the WB/IFC "Doing Business 2015" publication, provides insights into the difficulties that project developers may face. With this in mind, the project will put in place a Financial Support Mechanism that will be directed at minimising the financial risks that both project developers and lenders may face in doing business targeting biomass gasifiers.
Technology: Likelihood of gasifiers of inappropriate design and/or of poor quality introduced in the country.	Moderate	In order to avoid technology pitfalls, the project will establish network arrangements with other countries that have several years of experience with biomass gasifiers, like Brazil, Cambodia, China, India, etc. This will ensure that only successful models of gasifiers will be introduced and mistakes made elsewhere are not repeated. In addition, the project will bring in trainers from these countries to train Beninois technical personnel in high-quality installation, operation and maintenance of gasifiers.
Strategy: Village level commitment to change and adopt new agricultural methods is not sufficient for the	Moderate	Project success will depend in very large part on changes in people's behaviour in rural villages. It is necessary to demonstrate the effectiveness (social, financial and environmental) of alternatives in the short and long-term to convince people to change long-held habits. Most rural villages operate at extreme levels of poverty and people may be

widespread adoption.		unwilling to try new approaches when their basic livelihood needs are not being met. Participatory planning and decision-making processes as well as capacity building and organizational support will mitigate the risk of certain stakeholders restraining from participating in project implementation at least temporarily. Besides, pedagogic plots, trainings and visits to experimental farms are key activities to promote changes in rural areas.
Political: Land conflict and conflict among traditional / religious groups	Moderate	In order to avoid land ownership and use conflicts (in particular in the sacred forests), the project will be implemented through participatory processes, consensus building and conflict resolution and capacity building, with the underlying agenda of pre-empting conflict that could otherwise undermine project success. It will also work in close relationship with the GEF-UNDP Project entitled "Incorporation of Sacred Forests into the Protected Areas System of Benin" which generates useful results. Moreover, the recently adopted land tenure law reduces significantly the potential land conflicts as it improves the Rural Land tenure Plan, recognizing the customary rights ("Rural certificate").
Environmental/ Climate Change.	High	There are multiple environmental risks (e.g. decrease in the availability of agricultural biomass due to land degradation, reduced rainfall/water flows, drying up of watershed areas due to a change in climatic conditions) that can negatively affect agricultural output and result in a reduction in crop residues, thus negatively impacting on the biomass supply chain. This risk will be mitigated by introducing appropriate water management techniques in agricultural production, like drip irrigation and boreholes.
Overall	Moderate	

Financial modality

The project is aimed at policy development, capacity building, technical assistance and the provision of financial incentives to catalyse private sector investment in gasification of agricultural biomass for electricity generation. A major part of GEF resources will be allocated to promote investment in gasification/electricity generation under a Financial Support Mechanism to (i) Support project developers vis-à-vis lending institutions by minimising financial risks and (ii) Provide assurance of payment to developers for energy supplied in case of default by SBEE. Grant co-financing will be provided to support the installation of 4 gasifiers in the country. No loan or revolving-fund mechanisms with GEF funds are considered appropriate, and, therefore, grant-type funding is considered as the most suitable to enable successful delivery of the project outcomes.

Cost-effectiveness

As indicated above, SBEE (Benin Electricity Power Corporation) purchases power in bulk from CEB (Benin Electricity Community) at 10 US Cents/kWh. However, since 2006, CEB has been unable to supply the agreed amount of electricity to SBEE due to the energy crisis and this has resulted in SBEE operating its own costly gas turbines to generate electricity (e.g. at 69 US Cents/kWh in 2014 at Mariagleta) to supply the main grid. In addition, there are several villages that are not connected to the main grid and are served by isolated mini-grids

that burn imported diesel fuel to generate electricity at the high cost of 40 US Cents/kWh, and that too for normally only 6 hours per day.

Introduction of biomass gasifiers for electricity generation to replace these isolated diesel generators can bring down the cost of generation to US Cents 20.3/kWh, as per a UEMOA feasibility study. This demonstrates the cost-effectiveness of generating electricity from biomass gasifiers in the off-grid areas of the country, compared to the alternative of utilising imported diesel fuel for that purpose.

It can be argued that that utilisation of solar and wind energy to generate electricity in these isolated mini-grids (very limited hydro sites are available in these remote villages) in lieu of biomass-fired gasifiers could provide a lower per unit emission abatement cost. However, Benin does not yet have any experience with grid-electricity generation from solar or wind in replacement of diesel fuel; hence, it is very difficult to determine generation costs in real-life situations, unlike the case of gasifiers where one installation at Songhai has been operating since 2012 and has provided valuable operational technical as well as economic/financial data.

During the 15-year lifetime of the biomass gasifiers, a total of 1,094,253 tCO_2 will be avoided, which means an investment of $ 3.50 of GEF funds per tCO_2. When the momentum generated by the project is factored in, resulting in the installation of additional gasifiers, an estimated 1,287,720 tons of CO_2 will be avoided in terms of both direct and indirect post-project emissions, and this translates into an abatement cost of $ 2.40/tCO_2 of GEF funds.

GHG Reduction

The project is expected to be approved in time to commence activities during the first half of 2016. Under this assumption, gasifier installations would reasonably commence some 12 months after project start and may take between 12 to 18 months to complete. The 400 kW unit at Dassa-Zoumé and the 600 kW at Djougou would likely get completed in 12 months after start of construction and be commissioned in July 2017, while the larger 1 MW unit at Savalou and the 2 MW unit at Kalalé could take 18 months to be completed, with their commissioning date being January 2018.

As per the above scenario and generation data provided in Table 4, Dassa-Zoumé and Djougou would generate 1,227 MWh and 1,840 MWh in 2017, respectively, while Savalou and Kalalé would still be under construction. Following that, Dassa-Zoumé and Djougou would annually generate 2,453 MWh and 3,679 MWh, respectively. Savalou and Kalalé would be commissioned in January 2018 and would annually generate 6,132 MWh and 12,264 MWh, respectively. Electricity generation from these 4 gasifier plants over the 5-year project period is summarised in Table 9 below.

By project completion, some 76,651 MWh would have been generated and an annual generation of 24,498 MWh would be sustained over an expected 15-year projected life of the gasifiers installed under the project and not allocating for additional gasifiers that could be installed utilising the momentum generated by the project. All the electricity obtained from this biomass gasifier generation, if not implemented, would have otherwise been obtained from thermal power stations burning of imported diesel fuel, with an emission coefficient of 0.875 tCO_2/MWh (Ref. Second National Communication to UNFCCC, June 2011).

Table 9: Electricity generation from gasifier plants installed under project.

Site / Year	Dassa-Zoumé, (MWh)	Djougou, (MWh)	Savalou, (MWh)	Kalalé, (MWh)

2015	-	-	-	-
2016	-	-	-	-
2017	1,227	1,840	-	-
2018	2,453	3,679	6,132	12,264
2019	2,453	3,679	6,132	12,264
2020	2,453	3,679	6,132	12,234
Total	8,586	12,877	18,396	36,792
Grand Total	**76,651 MWh**			

Consequently, during the 5-year project period, almost 67,070 tons of CO_2 (76,651 MWh x 0.875 tCO_2/MWh) would have been avoided as a direct result of biomass gasifier electricity generation under the CCM-3 component.

However, these biomass gasifiers will continue avoiding 21,436 tCO_2 (24,498 MWh x 0.875 tCO_2/MWh) annually during their remaining 12 – 13 years of useful life, providing a net avoidance of (21,436 tCO_2 x 12.75 years) 273,309 tCO_2. When one looks at the 15-year lifetime of the biomass gasifiers earmarked for installation during the project period, they would have cumulatively avoided (67,070 + 273,309) 340,399 tCO_2.

Including the associated sustainable forest and land management the project, an additional 50,951 tCO_2 will be avoided every year: 3,600 tCO_2 for classified forest management (output 3.2), 29,351 tCO_2 for trees plantation (output 3.3) and 18,000 tCO_2 for conservation agriculture (see table 6 and indicators description for full details). Thus during the 15-year lifetime of the biomass gasifiers, a total of 1,094,253 tCO_2 will be avoided.

Moreover, GEF funding should be viewed as creating the conditions to jumpstart the biomass gasifier market for electricity generation in the country that would help to galvanise both the government and the private sector. This implies that there would be significant potential in further "indirect" GHG reduction once the market has reached cruising speed.

Finally, under the assumption of the great interest generated in biomass gasifier electricity generation during project implementation and given the conducive environment for investment in biomass gasifiers that the project would have created, it is highly likely that some additional 20 MW of biomass gasifier electricity generation would be built over a post-project period of 10 years, exceeding by several times the total capacity installed during the 5-year project implementation period. Thus, the indirect post-project emission reduction estimates related to only the additional biomass gasifiers over their 15-year lifetime – on the basis of a conservative policy scenario and a GEF causality factor of 80% (top-down approach) -- can be estimated at 1,287,720 tons of CO_2 avoided in terms of both direct and indirect post-project emissions. In the case of the bottom-up approach, with a replication factor of 3, the indirect post-project emission avoided would be 965,790 tons of CO_2. Table 11 below summarises the direct and indirect total CO_2 emissions reduction during implementation of the project and beyond.

In broad terms previous experiences across the GEF UNDP portfolio of projects show that working with local communities is generally cost effective because they are the direct beneficiaries of the project. The component 3 (LD and SFM) of the present project will operate in the communes that have been identified as very high potential for biomass-based electricity generation during the PPG phase. The underlying objective is to use present and future (ex: IPPs) private investor resources and experience as leverage and to expand the integrated approach while bringing additional funding from GEF, UNDP and co-financers, as well as operational partnerships. This is

clearly more cost-effective than starting from scratch.

Key global environmental benefits will be achieved through the project activities implementation of the component 3:

- Sustainable Agricultural Land Management (SALM) practices: At least 9,000 ha will shift from conventional practices to SALM practices (residue management, mulching, soil and water conservation techniques) under the project implementation. According to the World Bank[22], these SALM practices allow the sequestration of 4 tons of eCO_2 / ha / year. Experience from the Kenyan Agroforestry Carbon Project show annual rate of sequestration equal to 2 tons of eCO_2/ha. Then, with a conservative approach, we consider that the adoption of the SALM practices in Benin will allow a sequestration of 2 tons of eCO_2/ha/year.
- Sustainable Forest Management (SFM): At least 3,000 ha of forests will be better managed with the implementation of PFMP and bushfires management strategy. According to the FAO and the WOCAT, SFM allow a reduction of 1.2 to 2 tons of eCO_2/ha/year in long term. Other research programmes state much larger sequestration results in the first years of SFM implementation. As a conservation approach, we consider that SFM implementation can result in aboveground carbon accumulation of 1.2 tons of eCO_2/ha/year.
- Reforestation: At least 2,000 ha of degraded lands will be reforested to supply power plants with renewable biomass. This will lead to the production of 102,650 tons of renewable biomass. To estimate the total aboveground biomass on the site, we use a Biomass Expansion Factors (BEF) from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4: Agriculture, Forestry and Other Land Use. Then total dry wood biomass produced is 128,313 tons. Assuming 50% of the wood biomass (per MT) is carbon therefore, 64,156 tons of carbon will be sequestered in the produced biomass. As the Molecular Ratio of CO_2/C is 44/12 (= 3.66), then the plantation will stock 234,812 tCO_2 when mature. As plantations get mature after 8 years, we can estimate that the project will sequester 29,351 tCO_2/year.

Tables 10 and 11 below summarise the global environmental impacts, including direct and indirect total CO2 emissions reduction, achieved during implementation of the project and beyond.

Table 10: Project GHG emission reduction impacts

Time-frame	Direct project without replication (15-year gasifier projected life).	Indirect post-project (top-down) with replication (based on an additional 20 MW of biomass gasifiers over next 10 years of project influence).
Total CO_2 emissions reduced (tons) (CCM-3)	340,399	1,287,720
Total CO_2 emissions reduced (tons) (LD-3)	270,000	450,000
Total CO_2 emissions reduced (tons) (SFM-1)	494,272	823,787
TOTAL	**1,104,671**	**2,561,507**

[22] Tennigkeit and al, 2009, Agricultural Carbon Sequestration in Sub-Saharan Africa: Economics and Institutions. Washington DC: World Bank.

Table 11: Other impacts of the Project

Other impact for component 3 (LD & SFLM)		
Target population at the community level	72,766 inhabitants	$26 / villager
Hectares of restored agricultural lands (conservation farming practices), of SFM, and of reforestation	14,000 ha	$133 / ha

During the PPG exercise, several considerations pertaining to the cost-effectiveness of the project strategy were analysed. First of all, the project will ensure a cost effective approach to SLFM by working with communities, local leaders, local NGOs, and other key stakeholders which have a vested interest in the good stewardship of the proposed land conservation areas. Experiences across the UNDP/GEF portfolio show that partnerships with communities involved in the management of land and forest are generally a cost-effective approach. This is because surrounding communities depend to a certain extent, on the resources contained in forest for their livelihood and it is in their interest to adopt measures to improve the ecosystems' function and services.

Sustainability

From a technical point of view, the viability of implementing electricity generation projects through biomass gasification has been proven in several countries, both small and large, like Brazil, Burundi, China, India, Indonesia, Paraguay, Philippines, Seychelles, Vanuatu, etc. In Benin itself, the biomass gasifier installed in 2012 at the Songhai Centre has been to date running a 40 kVA generate to produce electricity 8 hrs/day to supply its factory producing plastic bags; along the way, it has accumulated some 3 years of experience in operation and maintenance. Admittedly, two small gasifiers installed in the early 2010s in Gohomey (40 kVA) and Sekou (25 kVA) private individuals stopped operation after approx. one year, in both cases due to maintenance problems. These 2 set-backs provided valuable "lessons learned" to Songhai and has resulted in Euro-Négoce, a private company, embarking on building a 6-MW single-unit gasifier plant to operate on agricultural biomass at Kandi (located in the north-eastern part of the country, 650 km from Cotonou) to supply the SBEE grid; commissioning of this plant is expected around the first semester of 2016. This project, it is expected, will accelerate the process of biomass gasifier electricity generation (i.e. to have many more "Kandis") to remedy the difficulties that the country faces to meet the ever-increasing electricity needs of its population, especially those in the rural areas where only 2% have access to electricity services. Hence, the project will bring a new paradigm shift that will facilitate investment in agricultural biomass electricity generation through gasifiers on the part of private investors. By addressing the non-technical barriers that impede the implementation of such activities, the project will assist in creating a sustainable niche through strengthening the policy, institutional, legal, regulatory and operational capabilities of the key national institutions, supporting the development of national capabilities and disseminating information. These efforts should ensure the long-term sustainability of biomass electricity generation through gasifiers in the country.

Furthermore, the project will support the integration of local industries into the biomass gasification sector. This will be achieved through the provision of focused support to local engineering firms/specialised engineering workshops for construction, installation, operation, maintenance and repair of equipment. With the increase over time in electricity generation through biomass gasifiers, it is envisaged that such efforts will intensify with opportunities being created for additional players to provide such services.

Besides, sustainable income-generating options will be developed, including trees plantation production; all these will be coordinated under the ILUMP. These activities in turn will reduce human pressure on natural resources (in particular reducing fire risks). Sustainable agricultural practices implementation and integration will also contribute to better management of available land.

As regard the financial sustainability, this project will demonstrate that integrated approach model can produce tangible benefits for communities while maintaining the flow of environmental services from the ecosystems on which they depend. A Financial Mechanism will be set up and fuelled by payment from the IPPs based on sharing benefit scheme of the energy proceeds. This Local Biomass Enhancing Fund (LOBEF) will collect about 220,000 USD per year and will co-finance local activities for sustainable forest management and income generating activities. The results and impacts on local communities of sustainable economic activities carried out in the project site will provide the stimulus to create new businesses and enterprises, increase demand for public and private services and promote the establishment of new agricultural and artisanal industries.

Replicability

The Project's potential for replicability throughout the whole country is very good, since it will adopt a bottom-up approach within the overall policy/investment framework that is envisaged to be developed to promote private sector-driven agricultural biomass gasifier electricity generation to supply both the main grid and isolated rural mini-grids. Technical assistance for barrier removal and institutional strengthening to be provided under the project will facilitate such replicability since it will create the required policy, regulatory, institutional and technical conditions to enable investor interest for the implementation of additional biomass gasifier electricity generation projects. Moreover, the lessons learned will be of great value to the neighbouring countries sharing similar resource base, should they wish to improve on their experience with the implementation of biomass gasifier electricity generation in their respective countries.

Scaling up

Some 75% of the population presently do not have access to electricity services; as an example, in 2008, only 27.1% of households in the country had access to electricity against a target of 33.7% established under the Millennium Development Goals. Over the next ten years, the grid in Benin will likely expand and more of the population will have access to electricity, albeit with frequent power cuts. Still, the national target for rural electrification of 36% by 2015 and 65% by 2025 is unlikely to be met - in 2008, the actual figure was 2.5% against a target of 6.6%. And where rural electrification is being undertaken, it is through expansion of the national grid or construction of diesel-based isolated mini-grids, rather than focus on renewable energy for electricity generation. This situation, therefore, presents a huge potential for replication and scaling up, utilising a sound business model involving a robust financial modality and guarantee scheme, coupled with a sound awareness/outreach programme, that will encourage private sector participation in electricity generation through gasification of biomass residues, as outlined earlier.

Coordination with other GEF-related initiatives

- The Project for Development of Access to Modern Energy (DAME), approved in 2009 by the World Bank, aims at improving the efficiency of existing power system, increasing the access to modern energy services, and to strengthen the capacities stakeholders in the energy sector. The project is supported by KfW, EIB, GEF, and FFEM (France FEM) for a total of $ 178 million.
- The Forests and Adjacent Lands Management Project (PGFTR) started in 2006 and aims at assisting Benin in laying the foundation for a collective, integrated system for managing ecosystems in its forests and adjacent lands. It results in 16 Participatory Management Plans developed, and 20 rural wood markets created. The project received an additional grant from the GEF in 2013 with the specific objective to (i) capacity building of the forest department, (ii) community-based management of forest, (iii) sustainable fuelwood production and marketing, and (iv) endowment of a conservation Trust Fund.

- The GEF UNDP Project entitled "Incorporation of Sacred Forests into the Protected Areas System of Benin" is contributing to the governmental effort to: (i) providing protected area status to 10 clusters of sacred forests in ecologically important regions of the country, (ii) supporting management and conservation activities of these forest remnants, by applying specifically designed and participatory management strategies, and (iii) promoting sustainable uses of natural resources around these forests in order to reduce exploitation pressures on the protected resources, sustain production of medicinal plants and materials, promote cultural and ecotourism activities and most important of all, improve the livelihood of surrounding communities.
- The GEF UNDP Project entitled "Integrated Adaptation Programme to Combat the adverse Effects of Climate Change on Agricultural Production and Food Security in Benin" aims at strengthening capacities of agricultural communities to adapt to climate change in four vulnerable agro-ecological zones in Benin.
- The regional GEF UNDP Project entitled "Enhancing the effectiveness and catalysing the sustainability of the W-Arly-Pendjari (WAP) protected area system" (2007-2013) aims at conserving biodiversity of the WAP complex with strong involvement of local communities.

During implementation of the proposed project, UNDP will ensure that the various project partners periodically meet to share information on progress in project activities and to avoid any duplication. These meetings may be organised in conjunction with meetings of the Project Board.

Other non-GEF-related Initiatives

- Benin is one of the 14 members of the Fonds Africain de Garantie et de Cooperation Economique (FAGACE – African Fund for Guarantee and Economic Cooperation) that is active in promoting both public and private investment in the various economic sectors in its member States. In discussions with FAGACE during the implementation of the PPG, it indicated its willingness to work with the private sector interested in investing in the area of utilising agricultural residues in gasifiers for electricity generation. Subsequently, in its letter of 6 November 2014 to UNDP, it confirmed that IPPs interested in investing in electricity generation through gasification of agricultural residues have the possibility to access loan guarantees from FAGACE against payment of certain fees. FAGACE already has an on-going agreement with SNV (an international not-for-profit development organisation based in The Netherlands) under which SNV can provide it with technical assistance.
- The World Bank implemented a $ 45 million "Project on Energy Services" during 2005 – 2008 aimed at accelerating, in a commercially viable manner, the utilisation of electricity for economic growth and social services, improving the quality of life in peri-urban and rural areas, improving governance and financial viability of the electricity sector, reducing deforestation and increasing the options available to households and small and medium enterprises to utilise renewable energy, etc. Activities implemented under this project included rehabilitation/strengthening of 161 kV transmission lines, improvement of the electricity distribution Cotonou, Porto-Novo and Seme and implementation of energy efficiency measures at 5 pilot administrative buildings.

  Upon completion of this project, a follow-up 6-year $ 70 million project entitled "Development of Access to Modern Energy" was initiated, again by the World Bank, in April 2010 to build upon the results obtained from the previous project and with focus on improving viability and effectiveness of access to energy services through further strengthening of the electricity transmission system, rehabilitating the SBEE distribution system, improving electricity access to the rural areas, contributing to sustainable management of the biomass energy sector and promoting efficient utilisation of energy in the various activity sectors of the economy. Potential synergies with the World Bank were discussed in Cotonou.
- PV-based mini-grids, kits, street lighting with energy-efficient LEDs: This 2-year ECOWAS-financed $ 5 million project commenced implementation in April 2013 and consists of the following activities:
  - Installation of mini-grids at Kpokissa (Zogbodomey) – 40 kWp; Tchatingou - 19 kWp; Tora I and II (Tanguiéta) - 12 kWp; Oké-Owo (Savè) - 30 kWp; Tandou - 16 kWp and Kabo - 44 kWp. Construction works

for all these mini-grids are presently on-going under the management and supervision of ANADER and the electricity generated would be for household use, e.g. lighting, radio, small appliances, etc.

- Several solar kits in the 50 – 100 Wp range presently being installed at, for example, Petinga (Cobly) and Niehoun.
- Replacement of existing street lighting with energy-efficient LEDs in Cotonou (123 units), Porto-Novo (160 units), Calavi (40 units), Tchaourou (160 units) and Toucoutouna (50 units).

➢ The Rural Electricity Supply Programme is financed by multiple donor agencies including the European Union (EU) Energy Facility, the German Federal Ministry for Economic Cooperation and Development (BMZ) as well as the French Development Agency (AFD). The objective is to enhance access to electricity to 105 rural villages, which also improves the living conditions of poorer sectors of the rural population. The programme will also utilise the GeoSim software in planning and formulating options for rural electrification.

➢ The Programme for Conservation and Management of Natural resources (ProCGRN), supported by the German Cooperation (BMZ / GIZ), aims at improving livelihood and incomes from agriculture and natural resources sustainable exploitation. Activities are located northwest, in Atacora and Donga departments. This project, started in 2004, supported the participative assessment of the forestry sector and the design of the recent Forestry Master Plan. In 2011, the Programme for Agriculture Promotion (ProAgri), which focuses on the revival of agricultural sector and value chains. Its objective is to increase the productivity and competitiveness of agricultural products, the improvement of cooperation between public and private sector, and the support to value chains. Main value chains are cashews, Shea nuts, cotton, rice and pulses. ProAgri will be implemented until 2017.

➢ The Project for Support to Communal Forests Management (PAGEFCOM), supported by the African Development Bank, aims at contributing to the sustainable management of forestry resources. Activities are located in 23 communes in the departments of Atlantic, Zou and Collines.

➢ The Fuelwood Project II (PBF II) supported by the African Development Bank, has the objectives to sustainably manage forest resources and to improve the balance sheet supply and demand of wood fuels and promoting alternative energy sources.

➢ The Project for Support to protection and development of Gallery Forests and Production of cartography (PAPDGFC) was launched in 2013 for 5 years and aims at reducing flooding of the Ouémé river thanks to a better conservation and management of Gallery Forests. The Project will also produce Geographical Information (GIS) in order to support a better management of forests and natural resources. This project is supported by UNDP, European Union and the National Institute of Geography.

➢ The Creation of Land Use Plans Project, funded by the Millennium Challenge Corporation, aims at clarifying the land rights and land use rights in partnership with municipalities. Hence, regulated land use rights should improve access to land resources, minimise potential for conflict, and promote economic development in Benin's rural areas through investment potential.

➢ The Climate project, financed by AFD and FFEM and implemented by France Expertise, is carrying out activities in the Collines department. A partnership will be signed at the inception of the project in order to develop synergies at the commune level during the implementation of the activities (in particular the Climate project will support 3 advisors in agroecology and will carry out studies in agroecology that will be useful for the present biomass project).

3. PROJECT RESULTS FRAMEWORK

This project will contribute to achieving the following Country programme Outputs as defined in CPAP or CPD:
Outputs: Institutions and the population are equipped to better manage natural resources, energy resources and quality of life.

UNDAF Outcome(s): By 2018, institutions and the target population in the communes ensure better management of the environment, natural resources, energy resources, quality of life, the consequences of climate change, crises, and natural crises and disasters.

Country Programme Outcome Indicators:
Indicator: By 2018, institutions and the target population in the communes ensure better management of the environment, natural resources, energy resources, quality of life, the consequences of climate change, crises, and natural crises and disasters.

Applicable GEF Strategic Objective and Programme: To promote investment in renewable energy technologies.

Applicable GEF Expected Outcomes: Total "avoided" GHG emissions from utilisation of agricultural crop residues for electricity generation through the gasification technology.

Applicable GEF Outcome Indicators: Avoided GHG emissions from utilisation of agricultural crop residues for electricity generation through the gasification technology (tons CO_2) and \$/t CO_2.

	Indicator	Baseline	End of Project Target(s)	Sources of Verification	Risks and Assumptions
Objective					
To introduce an integrated energy and ecosystems-based approach to sustainable biomass electricity generation in the country.	Emission reduction over the 15-year lifetime of gasifiers. Biomass-based electricity generation by project end.	GHG emissions in the electricity generation sector has increased from 48 million tons in 1995 to 63 million tons in 2000 and was estimated at 110 million tons in 2014. The present contribution of biomass in the electricity generation mix of the country is negligible.	Biomass-based electricity generation of 76,651 MWh by project end. Direct reduction of 67,070 tons of CO_2 over the 5-year FSP project life cycle. Subsequent generation of 24,498 MWh/year and reduction of 340,399 tons of CO_2 over the 15-year lifetime of the plants. Cumulative indirect	Project's annual reports, GHG monitoring and verification reports. Project final evaluation report.	Continued commitment of project partners, including Government agencies and investors/developers.

		No investment taking place in on-/off-grid biomass-based electricity generation.	GHG emission reduction of almost 1.3 million tons of CO_2 by 2035.		
	Integrated Land Uses Management Plans (ILUMPs) adopted.	No ILUMP are yet developed at the commune level in the country.	At least 4 ILUMPs for project sites have been successfully developed, adopted (endorsed) by communes and under implementation.		
	Emission reduction due to SLFM.	A loss of approx. 2,758 tCO_2 every year in the 3,000 ha of forest in the project sites.	Direct reduction of 659 030 tCO_2 due to implementation of SLFM activities.		
	Number of ha under SLFM practices.	No large-scale reforestation in the four communes. No lands restoration techniques implemented in the four pilot sites.	At least 9,000 ha are under SALM practices.		
	Over 5,000 rural households and small commercial/industrial enterprises connected to electricity services by project end. 500 jobs created in the		At least 200 jobs created for technicians to install, operate and maintain gasifiers and 300 permanent jobs for other operations.		

	gasifier/SFM/LD sub-sectors.				
Component 1: Policy, institutional, legal and regulatory framework for biomass electricity generation established.					
Outcomes					
Outcome 1: Streamlined and comprehensive market-oriented energy policy and legal/regulatory framework for biomass electricity generation by Independent Power Producers (IPPs).	Existence of adequate policy and regulatory framework.	None available at the present time.	Completed within 12 months of project initiation and approved by Government early in Year 2.	Published documents. Government decrees/laws.	Commitment of the various Government institutions.
Output 1.1: Appropriate policy and legal/regulatory framework established and operationalised for - *biomass electricity generation* - *re-investment of energy proceeds into community conservation (Mechanism for establishment of community trusts in all high residues/biomass potential sites; Benefit sharing schemes established between IPPs and communities for maintenance of ecosystems services).*	Existence of adequate policy and regulatory framework.	None available at the present time. No comprehensive document available at the present time. No benefit sharing scheme established and operationalized in the country.	Completed within 12 months of project initiation and approved by the Government early in Year 2. Completed within 3 years of project initiation and applied by stakeholders thereafter. At least $ 200,000 collected every year from the 3rd year of project.	Published documents. FSM and LOBEF reporting documentation.	Commitment of the various Government institutions. Cooperation of Government entities and private sector.
Output 1.2: Technical report on grid capacity requirements to enable feed-in for grid-connected renewable energy systems followed by development of an updated grid code, as well provision for isolated mini-grid options.	Upgraded grid code in place.	Not available at the present time.	Completed within 12 months of project initiation and approved by the Government early in Year 2.	Published grid code and instruction manual.	Commitment of the various Government institutions and project developers.
Output 1.3: Established procedures and standardized PPAs	Existence of standardised PPAs.	Not available at the present time.	Completed within 12 months of project	Published documents.	

for the introduction of a transparent procurement process in the selection/award of biomass-based electricity supply agreements by private developers/IPPs.	Investments in biomass gasification.		initiation and approved by the Government early in Year 2. Competitive bidding for concession areas completed by the end of Year 1. PPAs for at least 4 MW of biomass-based projects signed by the end of the second year after project start.	Documents awarding concession areas to private developers available. Signed PPAs available.	Continued investor interest.
Output 1.4: Setting up of a one-stop shop for issuance of construction licenses and permits to private RE developers.	Existence of one-stop shop.	Under the business-as-usual scenario, the average time to secure all required construction licenses and permits can take up to several years. None at the present time.	All construction licenses and permits are issued within 4-6 months of submission of documents.	Signed documents.	Continued investor interest.
Output 1.5: Methodology developed for a joint environmental, economic and financial evaluation of biomass plants in line with government regulations and policies.	Standardised methodologies available.	None at the present time.	To be completed within 12 months of project initiation and applied by Government thereafter.	Project documentation.	Cooperation of Government entities and staff.
Output 1.6: Capacity developed within SBEE, local banks and key national actors such as Ministries of Energy, Agriculture and Finance to appraise renewable biomass projects for PPAs and lending.	Capacity of stakeholders developed.	None available at the present time.	4 MW of projects evaluated/appraised by Government/Bank staff by the end of year 1. Six Government/Bank staff trained during first 12 months of project.	Project reports on total capacity of biomass projects appraised for development.	Concerned institutions willing to release staff for training.

Component 2: Promotion of investment in biomass-based electricity generation through appropriate catalytic financial incentives available for project investors.					
Outcome 2: Increased investment in clean energy technologies and low-carbon practices in the agro-forestry waste sector.	Investment in biomass gasifiers in $$.	No comprehensive document available at the present time. Very little investment taking place at the present time.	Completed within 12 months of project initiation and applied by Government thereafter. $ 15 million invested in clean energy projects by project end.	Project documentation. Project reports.	Cooperation of Government entities. Continued interest of investors.
Output 2.1 Financial Support Mechanism established and capitalized to support private investment in biomass plants.	Financial Support Mechanism (FSM) established.	Not available at the present time.	Completed within 12 months of project initiation and applied by Government thereafter.	Project report.	Cooperation of Government entities and staff.
Output 2.2: MOU signed with Central Bank of Benin setting out the objective, funding mechanism and administration rules regarding its participation as fiduciary agent of the FSM.	Existence of MOU.	None available.	Completed within 12 months of project initiation and applied by Government thereafter.	Project documentation.	Cooperation of Government entities and staff.
Output 2.3: Financial and other incentives to be provided to project developers/Independent Power Producers (IPPs).	Existence of incentives.	No comprehensive document available at the present time.	Completed within 12 months of project initiation and applied by Government thereafter.	Project documentation.	Cooperation of Government entities.
Output 2.4: Documents supporting financial closure (Power Purchase Agreements, where applicable) with identified investors.	Financial closures completed.	Not presently available.	Completed within 12 months of project start.	Project reports.	Continued investor interest.
Output 2.5: Reports confirming completion of construction of at least 4 MW of on-/off-grid biomass-based power plants by IPPs at various sites by end of	4 MW of on-/off-grid biomass-based gasifier power plants installed.	No construction is being undertaken at the present time.	At least 4 MW of biomass-based power stations constructed by the end of project. 24,498 MWh of	Site visits and project reports.	Supportive institutional, legal and regulatory framework.

project.			electricity generated annually at project end.		
Component 3: Land use and sustainable forestry management and implementation.					
Outcome 3: Integrated land use, sustainable forest management and natural resource management provide social benefits and sustain biomass for electricity production.	a. Carbon stock enhanced in the forests. b. Number of ha under SALM practices. c. CO2 sequestration with trees plantation.	A loss of approx. 2,758 tCO_2 every year in the 3,000 ha of forest in the project sites. No large-scale reforestation in the four communes. No lands restoration techniques implemented in the four pilot sites.	a. At least an enhancement of 72,000 tCO_2 during the 20-year lifetime. b. At least 9,000 ha are under SALM practices. c. At least 587,030 tCO_2 sequestered during the 20-year lifetime.	Project's yearly reports. Project site visits and evaluation for verification Monitoring scheme.	Political support to the integrated approach at the commune level remains very high, supporting national level reforms (removal of barriers) and development of private investments.
Output 3.1: Integrated Land Uses Management Plans (ILUMPs) are adopted in the four communes and strengthened the local institutional framework.	Complete framework and plan available and operationalized. Biomass data are available for sustainable plan of the resource by the commune and for sustainable use by IPPs.	No such framework and plan is operationalized at the commune level. No comprehensive monitoring scheme exists at the present time.	Completed within 18 months of project initiation. At least 4 monitoring schemes providing sets of monthly data in each project sites.	Project documentation. Project Monitoring System.	Cooperation of Government entities, the communities and private sector.
Output 3.2: Fire management practices are operational over 3,000 ha in the Classified Forests in the neighbour of the biomass plants.	Number of hectares of forest covered by participative management plans and wildfire action plans.	Existence of Management Plan (without wildfire action plan) but no implementation.	At least 3,000 ha of forest are effectively managed.	Project reports. Baseline and follow-up surveys of rural livelihoods.	Continued interest of stakeholders.
Output 3.3: Woodlots are established over 2,000 ha in order to provide sustainable biomass and incomes for communities.	a. Number of hectares reforested. b. Percentage of the increase of households' incomes.	20,476 ha of degraded agricultural lands. No large scale reforestation in the four communes.	At least 3,000 ha of degraded lands are reforested. 20% increase in households' incomes.	Project reports. Project Monitoring System. Survey reports.	Continued interest of stakeholders.

Output 3.4: New methods and techniques of agro-ecology (conservation farming practices) are implemented over 9,000 ha and reduce lands degradation and increase lands productivity (agriculture harvests and residues).	a. Number of hectares under conservation farming practices. b. Number of km of livestock corridor created and operationalized. c. Increased of yield for main crops under SALM.	No SALM practices implemented at large scale in the four communes. 0 km of livestock corridors.	9,000 ha under conservation farming. At least 800 km of livestock corridors. At least 20% of yield increase for main crops under SALM.	Project reports. Training reports. Survey reports.	Communities will change behaviour and commit to new practices if provided with alternatives and support to implementation.
Component 4: Outreach and results dissemination programme aimed at sustaining a growing market for biomass gasification.					
Outcome 4: Outreach programme and dissemination of project experience/best practices/lessons learned for replication throughout the country/region.	Awareness about biomass gasifiers and their possibilities.	Lack of sufficient information to pursue programme.	Increased awareness among some 30 stakeholders in place to monitor, promote and develop the market for biomass-based electricity generation.	Project final report and web site.	Growth of programme will be sustained.
Output 4.1: National Plan to implement outreach/promotional activities targeting domestic (and international) investors.	Existence and implementation of plan.	No such plan available.	Completed within 18 months of project initiation.	Project documentation.	Expected expansion of programme.
Output 4.2: Capacity development of concerned Ministries/Institutions to promote, monitor and document project experience.	Existence and implementation of training programmes.	No capacity development programme.	30 Government staff trained by the end of project.	Project reports.	Designation of staff by relevant Ministries/ Institutions.
Output 4.3: Published materials (including video) and informational meetings with stakeholders on project experience/best practices and lessons learned.	Availability of information on project experience.	Lack of information on best practices and lessons learned.	Completed within 6 months of project end.	Project documentation and web site.	Continued interest of stakeholders.

Total Budget and Work Plan

Award ID:	00090776	**Project ID(s):**	00096384
Award Title:	Benin		
Business Unit:	BEN10		
Project Title:	**Promotion of sustainable biomass based electricity generation in Benin**		
PIMS no.	5115		
Implementing Partner (Executing Entity)	Ministry of Energy		

5115 Project Outputs	Fund ID	Resp. Party / Impl. Agent	Donor Name	Atlas Budgetary Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Amount Year 5 (USD)	Total (USD)	Notes
Outcome 1: Develop a set of regulations that will facilitate private sector investment in gasifier technology.	**62000**	Ministry of Energy	**GEF**	71200	International Consultants	25,000	25,000	25,000	25,000	20,000	120,000	a
				71300	Local Consultants	10,000	10,000	10,000	10,000	5,000	45,000	b
				71600	Travel	5,000	5,000	5,000	5,000	5,000	25,000	c
				74200	Publications	5,000	5,000	5,000	5,000	5,000	25,000	d
				72100	Contractual Services-Companies	5,000	5,000	5,000	5,000	5,000	25,000	e
				74500	Miscellaneous	5,000	5,000	5,000	5,000	5,000	25,000	f
				75700	Workshop	5,000	0	0	0	0	5,000	g
					Total Outcome 1	**60,000**	**55,000**	**55,000**	**55,000**	**45,000**	**270,000**	
Outcome 2: Introduce financial incentives to promote uptake of gasifier projects.	**62000**	Ministry of Energy	**GEF**	71200	International Consultants	25,000	25,000	20,000	20,000	20,000	110,000	h
				71300	Local Consultants	5,000	10,000	10,000	0	0	25,000	i
				71600	Travel	5,000	5,000	5,000	5,000	5,000	25,000	j

				72100	Contractual Services (FSM)	1,500,000	0	0	0	0	1,500,000	k
				72200	Equipment and Furniture	5,000	10,000	0	0	0	15,000	l
				72800	Information Technology Equipmt	5,000	5,000	5,000	0	0	15,000	m
				74500	Miscellaneous	2,000	2,000	2,000	2,000	2,000	10,000	n
				Total Outcome 2 (GEF only)		**1,547,000**	**57,000**	**42,000**	**27,000**	**27,000**	**1,700,000**	
	4000		**UNDP**	72100	Contractual Services-Companies	**200,000.00**	**0**	**0**	**0**	**0**	**200,000.00**	
				Total Outcome 2 (UNDP + GEF)		**1,747,000**	**57,000**	**42,000**	**27,000**	**27,000**	**1,900,000**	
Outcome 3: Support to commune for effective planning and implementation of SLFM.	**62000**	Ministry of Energy	**GEF**	71300	Local Consultants	20,000	20,000	20,000	20,000	0	80,000	o
				71400	Contractual Services–Individuals	10,000	20,000	40,000	40,000	40,000	150,000	p
				71600	Travel	6,000	6,000	6,000	6,000	6,000	30,000	q
				72100	Contractual Services-Companies	20,000	40,000	80,000	80,000	80,000	300,000	r
				72300	Material and goods	80,000	160,000	300,000	280,000	160,000	980,000	s
				72200	Equipment/Software	20,000	20,000	20,000	20,000	20,000	100,000	t
				72800	Information Technology Equipmt	0	20,000	0	0	10,000	30,000	u
				Total Outcome 3		**156,000**	**286,000**	**466,000**	**446,000**	**316,000**	**1,670,000**	
Outcome 4. Implement outreach/promotional activities and document project experience.	**62000**	Ministry of Energy	**GEF**	71300	Local Consultants	0	10,000	10,000	10,000	5,000	35,000	v
				71600	Travel	0	2,500	2,500	5,000	5,000	15,000	w
				74200	Publications	2,000	2,000	2,000	2,000	2,000	10,000	x
				Total Outcome 4		**2,000**	**14,500**	**14,500**	**17,000**	**12,000**	**60,000**	
Project Management	**62000**	Ministry of Energy	**GEF**	71400	Contractual Services–Individuals	34,520	34,520	34,520	34,520	34,522	172,602	y
	4000		**UNDP**	71400	Contractual Services–Individuals	45,000	45,000	45,000	45,000	45,000	225,000	y
			UNDP	74599	Direct Project Cost	15,000	15,000	15,000	15,000	15,000	75,000	z
				Total Management		**94,520**	**94,520**	**94,520**	**94,520**	**94,520**	**472,602**	
	Subtotal GEF					**1,799,520**	**447,020**	**612,020**	**579,520**	**434,520**	**3,872,602**	
	Subtotal UNDP					**260,000**	**60,000**	**60,000**	**60,000**	**60,000**	**500,000**	
	PROJECT TOTAL (GEF + UNDP)					**2,059,520**	**507,020**	**672,020**	**639,520**	**494,522**	**4,372,602**	

	Budget Notes
a	Partial costs of NR CTA and consultants for policy/reg. framework.
b	Policy and strategy documents, grid code, one-stop-shop.
c	International and domestic travel to project sites.
d	Diffusion of the law, Strategy document, criteria/procedures.
e	Methodology and computer programme for ecofin evaluation.
f	Miscellaneous
g	Inception workshop.
h	Partial costs of NR CTA and consultant for financial engineering for FSM.
i	Develop incentives to be provided to private investors
j	International and domestic travel to project sites
k	Financial Support Mechanism (FSM)
l	Equipment for business facilitation
m	Equipment for business facilitation
n	Financial Support Mechanism (FSM)
o	Local consultants for establishment of the ILUMPs
p	Project core (long-term): local community agents (to be recruited progressively). In the Colline department (Savalou commune), synergies will be establish with the 3 local advisors working with the GIC (financed by CILSS then AFD projects)
q	Domestic travel to project sites, workshops
r	Technical assistance for SALM techniques training and dissemination (collaboration with INRAB): support to costs of workshops, dissemination of guidebooks for farmers, installation of pedagogical plots, etc.
s	Equipment for trees plantation (nurseries) and forests protection. Material and equipment for the implementation of new soil management techniques.
t	Equipment for IGA in the communities.
u	IT for the project database creation and other uses: computers, printers, GPS, software.
v	Local consultant for communication plan
w	Domestic travels
x	Communication tools and material, website.
y	Project Personnel/management related cost.
z	Others projects costs.

Summary of co-financing:

Sources of Co-financing	Name of Co-financer	Type of Co-financing	Amount ($)
National Government	MERPMEDER through PAPDFGC (EU funded project)	In kind	**1,000,000**
		Cash	**3,500,000**
National Government	MERPMEDER through PAGEFCOM (AfDB funded project)	In kind	**1,000,000**
		Cash	**4,000,000**
National Government	ANADER	In kind	**250,000**
		Cash	**500,000**
National Power Utility	CEB (Electricity Community of Benin)	Equity	**15,000,000**
GEF Agency	UNDP	Grant/Cash	**500,000**
Total Co-financing			**25,750,000**

4. MANAGEMENT ARRANGEMENTS

The project will be implemented through the NIM execution modality by the Ministry of Energy as the National Implementing Partner (NIP). The Ministry will provide office space to the project team as part of its contribution. The Ministry will also assign a senior officer as the National Project Director (NPD) to: (i) coordinate the project activities with activities of other Government entities like the Ministry of Environment, Ministry of Agriculture, Communauté Electrique du Bénin (CEB), Société Béninoise d'Energie Electrique (SBEE), Commune of Kalalé, etc. (ii) certify the expenditures in line with approved budgets and work-plans; (iii) facilitate, monitor and report on the procurement of inputs and delivery of outputs; (iv) approve the Terms of Reference for consultants and tender documents for sub-contracted inputs; and (v) report to UNDP on project delivery and impact.

The National Project Director will be assisted by a Programme Management Unit (PMU – the same PMU will also implement the parallel project entitled "Strengthening the resilience of the energy sector in Benin to the impacts of climate change") headed by a Project Manager (PM) to be recruited through a competitive process. The PM will be responsible for overall project coordination and implementation, consolidation of work plans and project papers, preparation of quarterly progress reports, reporting to the project supervisory bodies, and supervising the work of the project experts and other project staff. The PM will also closely coordinate project activities with relevant Government and other institutions and hold regular consultations with project stakeholders. In addition, a Project Assistant (PA) will be recruited to support the PM on administrative and financial issues.

The Project Manager will be supported by an international part-time Chief Technical Adviser (CTA), short-term international and national experts/consultants who will support implementation of specific technical assistance components of the project. Contacts with experts and institutions in other countries that have already gained more experience in implementing projects dealing with biomass gasifiers for electricity generation, related policies and financial support measures are also to be established.

A Project Board, chaired by the Ministry of Environment will be established to provide strategic directions and management guidance to project implementation for both projects. It will consist of representatives of the relevant ministries and Government Departments/Directorates (Ministry of Energy, Ministry of Agriculture, Ministry of Development and other relevant Ministries) participating in the project, Association of Bankers, the UNDP Country Office, the National Project Director as well as representatives of the NGO community and women's groups (e.g. Association for the Promotion of Renewable Energy, National Organisation for Professional Training, National Confederation of Farmer Organisations, Songhai Centre, etc.). Representatives of the private sector may be invited to participate as observers.

Finally, the UNDP CO will provide specific support services for proper project implementation, as required, through its Administrative, Programme and Finance Units and through support from the Addis Ababa Regional Service Centre. Specific support services will include support for annual PIR review (project implementation review), mid-term review and terminal evaluation. An organigram representing the implementation arrangement is presented below.

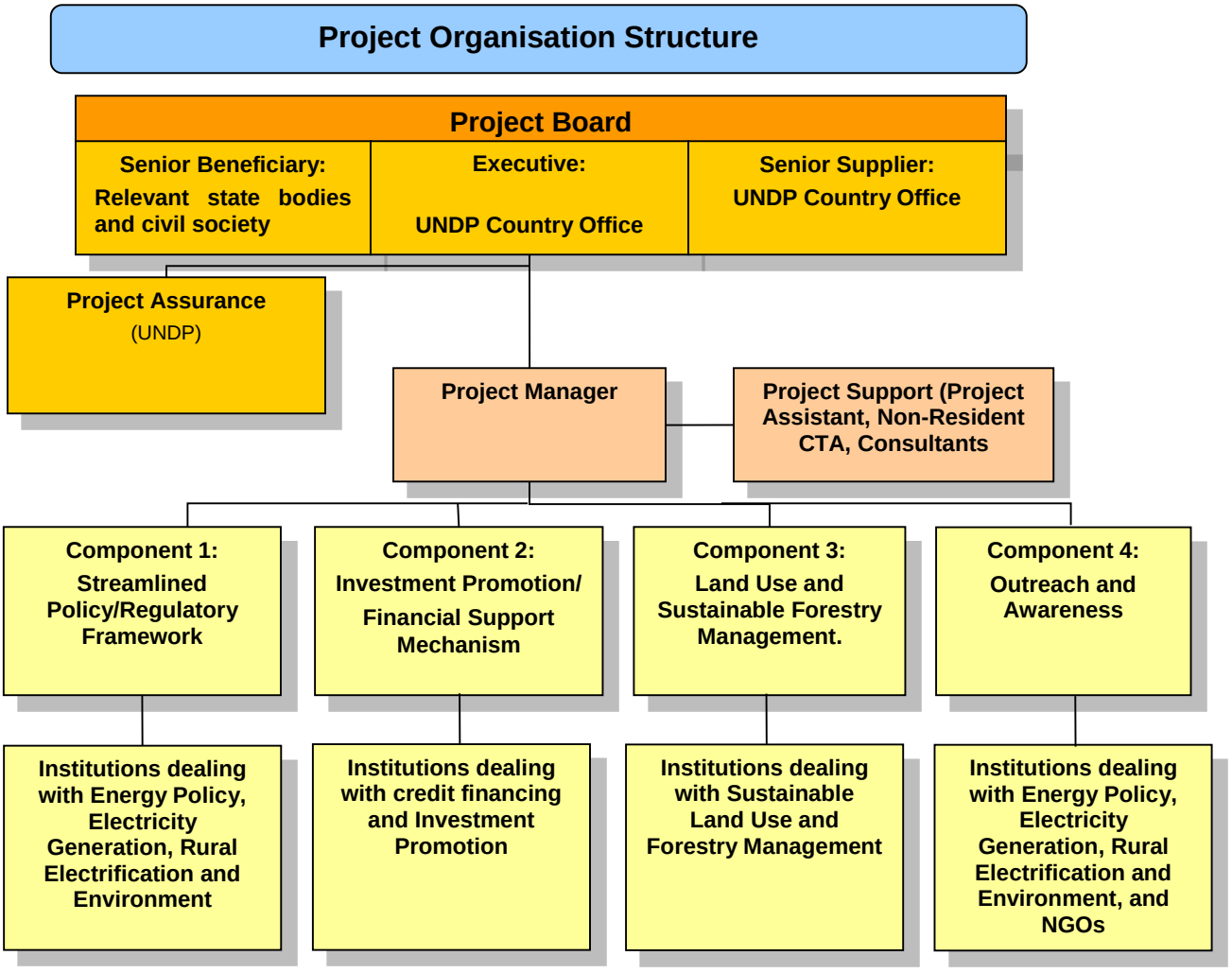
The Project Board has three roles:

Executive representing the project ownership to chair the group. For this project, the Resident Representative will assume the role of Project Board Executive.

1. Senior Supplier role to provide guidance regarding the technical feasibility of the project. This role will be assumed by UNDP's Deputy Resident Representative

2. Senior Beneficiary role to ensure the realization of project benefits from the perspective of project beneficiaries. This role will be fulfilled by relevant line ministries, as well as regional and local government. To discuss the strategic issues of the project activities and its impact, and to ensure that best available international and national expertise is given due consideration in formulating the project strategy, the Project Board may decide to invite to its meetings other stakeholders.

3. Project Assurance: The Project Assurance role supports the Project Board by carrying out objective and independent project oversight and monitoring functions. This role ensures appropriate project management milestones are managed and completed. This role will be performed by relevant UNDP Benin Programme Managers.



Project implementation will be governed by the provisions of the present Project Document and Programme and Operations Policy and Procedure (POPP). UNDP Benin will maintain oversight and management of the overall project budget, utilizing a direct payment modality. UNDP Benin support services will be charged in accordance with

the Agreement between the NIP and UNDP for the Provision of Services by UNDP. Governance of the Project will be supported through annual work planning as well as reporting and monitoring the delivery of results and impact on the basis of the results framework. The annual work plans as well as progress reporting will be the responsibility of the project management and will be approved by the NPD in close consultation with UNDP.

In terms of execution of the activities, the outputs 3.1 and 3.2 will be executed by a consulting firm, which will be recruited through a tender process. The outputs 3.3 and 3.4 will be executed by an NGO that will be contracted at the inception of the project.

5. MONITORING AND EVALUATION

UNDP Benin will be responsible for monitoring and evaluation (M&E), including organizing project evaluations, approving annual implementation work plans and budget revisions, monitoring progress, identifying problems and suggesting remediating actions, facilitating timely delivery of project outputs and supporting the coordination and networking with other related initiatives and institutions in the country and in the region.

During implementation, proper care will be exercised to have adequate communication and co-ordination mechanisms in place to ensure that areas of common interest can be addressed in a cost-efficient way.

The project will be monitored through the following M&E activities. The M&E budget is provided in the table below.

Project start:

A Project Inception Workshop will be held within the first 2 months of project start with those with assigned roles in the project organization structure, UNDP country office and where appropriate/feasible regional technical policy and programme advisors as well as other stakeholders. The Inception Workshop is crucial to building ownership for the project results and to plan the first year annual work plan.

The Inception Workshop should address a number of key issues including:

a) Assist all partners to fully understand and take ownership of the project. Detail the roles, support services and complementary responsibilities of UNDP CO and RSC staff vis-à-vis the project team. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.

b) Based on the project results framework and the relevant GEF Tracking Tool, if appropriate, finalize the first annual work plan. Review and agree on the indicators, targets and their means of verification, and recheck assumptions and risks.

c) Provide a detailed overview of reporting, monitoring and evaluation (M&E) requirements. The Monitoring and Evaluation work plan and budget should be agreed and scheduled.

d) Discuss financial reporting procedures and obligations, and arrangements for annual audit.

e) Plan and schedule Project Board meetings. Roles and responsibilities of all project organisation structures should be clarified and meetings planned. The first Project Board meeting should be held within the first 12 months following the inception workshop.

An Inception Workshop report is a key reference document and must be prepared and shared with participants to formalize various agreements and plans decided during the meeting.

Quarterly:

- Progress made shall be monitored in the UNDP Enhanced Results Based Managment Platform.
- Based on the initial risk analysis submitted, the risk log shall be regularly updated in ATLAS. Risks become critical when the impact and probability are high. Note that for UNDP GEF projects, all financial risks associated with financial instruments such as revolving funds, microfinance schemes, or capitalization of funds are automatically classified as critical on the basis of their innovative nature (high impact and uncertainty due to no previous experience justifies classification as critical).
- Based on the information recorded in Atlas, a Project Progress Reports (PPR) can be generated in the Executive Snapshot.
- Other ATLAS logs can be used to monitor issues, lessons learned etc. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard

Annually:

- Annual Project Review/Project Implementation Reports (APR/PIR): This key report is prepared to monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements.

The APR/PIR includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of-project targets (cumulative)
- Project outputs delivered per project outcome (annual).
- Lesson learned/good practice.
- AWP and other expenditure reports
- Risk and adaptive management
- ATLAS QPR
- Portfolio level indicators (i.e. GEF focal area tracking tools) are used by most focal areas on an annual basis as well.

Audit Clause:

The project audit will be conducted in accordance with applicable UNDP audit policies.

Periodic Monitoring through site visits:

UNDP CO and the UNDP RSC will conduct visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the Project Board may also join these visits. A Field Visit Report/BTOR will be prepared by the UNDP CO and UNDP RCU and will be circulated no less than one month after the visit to the project team and Project Board members.

Mid-term of project cycle:

The project will undergo an independent Mid-Term Review at the mid-point of project implementation around September/October 2015. The Mid-Term Review will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the final half of the project's term. The organization, terms of reference and timing of the mid-term review will be decided after consultation between the parties to the project

document. The Terms of Reference for this Mid-term review will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Centre (ERC).

The relevant GEF Focal Area Tracking Tools will also be completed during the mid-term review cycle.

End of Project:

An independent Final Evaluation will take place three months prior to the final Project Board meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term review, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

The Final Evaluation should also provide recommendations for follow-up activities and requires a management response which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC).

The relevant GEF Focal Area Tracking Tools will also be completed during the final evaluation.

During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results.

Learning and knowledge sharing:

Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.

The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation though lessons learned. The project will identify, analyse, and share lessons learned that might be beneficial in the design and implementation of similar future projects.

Finally, there will be a two-way flow of information between this project and other projects of a similar focus.

Communications and visibility requirements:

Full compliance is required with UNDP's Branding Guidelines. These can be accessed at http://intra.undp.org/coa/branding.shtml, and specific guidelines on UNDP logo use can be accessed at: http://intra.undp.org/branding/useOfLogo.html. Amongst other things, these guidelines describe when and how the UNDP logo needs to be used, as well as how the logos of donors to UNDP projects needs to be used. For the avoidance of any doubt, when logo use is required, the UNDP logo needs to be used alongside the GEF logo. The GEF logo can be accessed at: http://www.thegef.org/gef/GEF_logo. The UNDP logo can be accessed at http://intra.undp.org/coa/branding.shtml.

Full compliance is also required with the GEF's Communication and Visibility Guidelines (the "GEF Guidelines"). The GEF Guidelines can be accessed at: http://www.thegef.org/gef/sites/thegef.org/files/documents/C.40.08_Branding_the_GEF%20final_0.pdf. Amongst other things, the GEF Guidelines describe when and how the GEF logo needs to be used in project publications, vehicles, supplies and other project equipment. The GEF Guidelines also describe other GEF promotional requirements regarding press releases, press conferences, press visits, visits by Government officials, productions and other promotional items.

Where other agencies and project partners have provided support through co-financing, their branding policies and requirements should be similarly applied.

Monitoring and Evaluation (M&E) Work Plan and Estimated Associated Budget.

Type of M&E activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time frame
Inception Workshop and Report	▪ Project Manager ▪ UNDP CO, UNDP GEF	Indicative cost: 15,000	Within first two months of project start up
Measurement of Means of Verification of project results.	▪ UNDP GEF RTA/Project Manager will oversee the hiring of specific studies and institutions, and delegate responsibilities to relevant team members.	To be finalized in Inception Phase and Workshop.	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on output and implementation.	▪ Oversight by Project Manager ▪ Project team	To be determined as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	▪ Project Manager and team ▪ UNDP CO ▪ UNDP RTA ▪ UNDP EEG	None	Annually
Periodic status/ progress reports	▪ Project Manager and team	None	Quarterly
Mid-term Review	▪ Project Manager and team ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost: 40,000	At the mid-point of project implementation.
Terminal Evaluation	▪ Project Manager and team, ▪ UNDP CO ▪ UNDP RCU ▪ External Consultants (i.e. evaluation team)	Indicative cost : 45,000	At least three months before the end of project implementation
Project Terminal Report	▪ Project Manager and team ▪ UNDP CO ▪ local consultant	0	At least three months before the end of the project
Audit	▪ UNDP CO ▪ Project Manager and team	Indicative cost per year: $ 3,000 (Total: $ 15,000)	Yearly
Visits to field sites	▪ UNDP CO ▪ UNDP RCU (as appropriate) ▪ Government representatives	For GEF supported projects, paid from IA fees and operational budget	Yearly

Type of M&E activity	Responsible Parties	Budget US$ *Excluding project team staff time*	Time frame
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US$ 115,000	

6. LEGAL CONTEXT

This document together with the CPAP signed by the Government and UNDP which is incorporated by reference constitute together a Project Document as referred to in the SBAA and all CPAP provisions apply to this document.

Consistent with the Article III of the Standard Basic Assistance Agreement, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner.

The implementing partner shall:

a) put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the project is being carried;

b) assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Project Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee established pursuant to resolution 1267 (1999). The list can be accessed via http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm. This provision must be included in all sub-contracts or sub-agreements entered into under this Project Document.

7. ANNEXES

Annex 1 – Offline risk log
Annex 2 – Terms of Reference
Annex 3 – Letters of Co-financing and Support from the Government
Annex 4 – Potential Investors in Biomass Gasification in Benin
Annex 5 – Signature Page

ANNEX 1: OFFLINE RISK LOG

#	Description	Date identified	Type	Impact & Probability	Countermeasures / Mgt response	Owner	Submitted, updated by	Last Update	Status
	Policy and Regulatory: Reluctance in some quarters of the Government to introduce the necessary supporting policies and regulations.	During PIF formulation.	Policy	P = 3 I = 3	If this risk were to materialise, it would seriously affect project implementation. However, this is very unlikely the first sentence says it, as the Government of Benin is strongly motivated to provide access to modernised energy services to the large rural and peri-urban population that utilises fuel wood/charcoal for cooking and is driven by its plans to reduce the massive deforestation that accompanies the use of forestry resources. Hence, it will ensure that all Government Institutions (Ministries/Departments/Directorates, etc.) get on board to put in place a conducive policy and an enabling regulatory framework for biomass gasifier promotion and development. This will also be in line with its December 2003 "Energy Policy and Strategy" and the updated October 2009 "Strategic Plan for Energy Sector Development".	CO to monitor.			
	Economic/Financial: Non-availability of credit to promoters of	During PIF formulation.	Policy	P = 3 I = 3	The project will work with local lending institutions to develop their capacity to understand and appraise gasifier projects for lending. In addition, the Financial Support	CO to monitor.			

#	Description	Date identified	Type	Impact & Probability	Countermeasures / Mgt response	Owner	Submitted, updated by	Last Update	Status
	biomass gasifiers.				Mechanism will contribute towards minimising risk exposure on the part of lenders.				
	Financial: Poor investment climate.	During PIF formulation.	Technical	P = 3 I = 3	The fact that Benin ranks 135 out of 189 economies on protecting investors and 169 out of 189 on enforcing contracts, as per the WB/IFC "Doing Business 2015" publication, provides insights into the difficulties that project developers may face. With this in mind, the project will put in place a Financial Support Mechanism that will be directed at minimising the financial risks that both project developers and lenders may face in doing business targeting biomass gasifiers.	CO to monitor.			
	Technology: Likelihood of gasifiers of inappropriate design and/or of poor quality introduced in the country.	During PIF formulation.	Operational	P = 3 I = 3	In order to avoid technology pitfalls, the project will establish network arrangements with other countries that have several years of experience with biomass gasifiers, like Brazil, Cambodia, China, India, etc. This will ensure that only successful models of gasifiers will be introduced and mistakes made elsewhere are not repeated. In addition, the project will bring in trainers from these countries to train Beninois technical personnel in high-quality installation, operation and maintenance of gasifiers.	CO to monitor.			
	Strategy:	During PIF	Operational	P = 3	Project success will depend in very	CO to			

#	Description	Date identified	Type	Impact & Probability	Countermeasures / Mgt response	Owner	Submitted, updated by	Last Update	Status
	Village level commitment to change and adopt new agricultural methods is not sufficient for the widespread adoption.	formulation.		I = 3	large part on changes in people's behaviour in rural villages. It is necessary to demonstrate the effectiveness (social, financial and environmental) of alternatives in the short and long-term to convince people to change long-held habits. Most rural villages operate at extreme levels of poverty and people may be unwilling to try new approaches when their basic livelihood needs are not being met. Participatory planning and decision-making processes as well as capacity building and organizational support will mitigate the risk of certain stakeholders restraining from participating in project implementation at least temporarily. Besides, pedagogic plots, trainings and visits to experimental farms are key activities to promote changes in rural areas.	monitor.			
	Political: Land conflict and conflict among traditional / religious groups.	During PIF formulation.	Environmental	P = 3 I = 3	In order to avoid land ownership and use conflicts (in particular in the sacred forests), the project will be implemented through participatory processes, consensus building and conflict resolution and capacity building, with the underlying agenda of pre-empting conflict that could otherwise undermine project success. It will also work in close relationship with the GEF UNDP	CO to monitor.			

#	Description	Date identified	Type	Impact & Probability	Countermeasures / Mgt response	Owner	Submitted, updated by	Last Update	Status
					Project entitled "Incorporation of Sacred Forests into the Protected Areas System of Benin" which generates useful results. Moreover, the recently adopted land tenure law reduces significantly the potential land conflicts as it improves the Rural Land tenure Plan, recognizing the customary rights ("Rural certificate").				
	Environmental/ Climate Change.	PIF Formulation	Operational	P = 4 I = 4	There are multiple environmental risks (e.g. decrease in the availability of agricultural biomass due to land degradation, reduced rainfall/water flows, drying up of watershed areas due to a change in climatic conditions) that can negatively affect agricultural output and result in a reduction in crop residues, thus negatively impacting on the biomass supply chain. This risk will be mitigated by introducing appropriate water management techniques in agricultural production, like drip irrigation and boreholes.	CO to monitor.			

P = Probability on a scale from 1 (low) to 5 (high). **I** = Impact on a scale from 1 (low) to 5 (high).

ANNEX 2: TERMS OF REFERENCE

1. Project Manager

Post title:	Project Manager (Full-time)
Office:	Project Management Unit (PMU)
Organisation:	Ministry of Energy
Duration of Employment:	One year with possibility of extension
Duty station:	Cotonou, Benin

II. Duties

- Lead, manage and coordinate the day-to-day activities of the PMU to be established within MAPF including administration, accounting, technical expertise, and actual project implementation and reporting;
- Lead the development of project design including preparation of consultants' and sub-contractors' terms of reference, identification and selection of national and international sub-contractors/consultants, cost estimation, time scheduling, contracting, and reporting on project activities and budget;
- Monitor and follow-up on the status of delivery by consultants, sub-contractors, etc.
- Coordinate activities of consultants including contract management, direction and supervision of field operations, logistical support, review of technical outputs/reports, measurement/assessment of project achievements and cost control;
- Assist in the design, supervision and outreach activities of the project;
- Provide technical support to discussions and development on electricity generation through biomass gasification;
- Act as a liaison/facilitator among the various stakeholders, including the private sector, international and national partners;
- Assume responsibility for the quality and timing of project outputs;
- Establish and maintain relationships and act as the key focal point with UNDP CO to ensure that all programming, financial and administrative matters related to the project are transparently, expediently and effectively managed, in line with established UNDP Rules and Regulations.
- Undertake other management duties that contribute to the effective implementation of the project.

III. Qualifications and Experience

Education:	• Master's degree or equivalent in engineering, economics, international development, social sciences, public administration or other relevant field.
Experience:	• Minimum of 5 years of experience in management, preferably in the energy field. • Proven ability to draft, edit and produce written proposals and results-focussed reports. • Proven experience working with Government, civil society, international organizations or donors in combination with the knowledge of economic and financial analysis, institutional, regulatory and policy frameworks. • Good knowledge of and experience with GEF Climate Change issues, operational modalities and familiarity with UNDP-GEF procedures would be an advantage; • Familiarity with UNDP rules, regulations and administrative procedures;

	• Prior knowledge and experience of the political, social and environmental factors and issues related to energy development and climate change mitigation in developing countries, preferably in Africa; • Experience in the use of computers and office software packages (MS Word, Excel, etc.)
Language Requirements:	• Excellent French and English, both written and oral.

2. Project Assistant

I. Position Information	
Post title:	Project Assistant (Full-time)
Office:	Project Management Unit (PMU)
Organisation:	Ministry of Energy
Duration of Employment:	One year with possibility of extension
Duty station:	Cotonou, Benin

II. Functions

Under the overall supervision of the Project Manager, the Project Assistant will:

- Support the activities of international/national experts, potential investors and sub-contractors;
- Provide administrative support re. typing, filing, arranging visas for international experts/sub-contractors, maintaining project's financial records, etc.;
- Administer project accounting as per UNDP procedures;
- Assist the Project Manager in organising workshops, meetings of the Project Board and other events.
- Assist in procurement of goods and services;
- Draft letters of invitation and agendas for meetings of Project Board/workshops;
- Prepare background information, briefing materials, reports, etc., as required;
- Draft minutes of meetings, monitor/follow-up on actions required.

III. Qualifications and Experience

Education:

- Higher education in economics, management, accounting, finance or other related field.
- Specialized training in finance is desirable

Experience:

- 3 years of relevant administrative, accounting and financial experience at national and/or international level.
- Experience in the usage of computers and office software packages (MS Word, Excel, etc.).
- Previous experience of working for nationally executed programme (s) funded by bilateral/multilateral organisations.
- Practical experience in procurement will be an asset.

Language Requirements:

- Excellent French and English, both written and oral.

3. Chief Technical Adviser (Non-resident)

Post title:	Chief Technical Adviser (Non-Resident)
Office:	Project Management Unit (PMU)
Organisation:	Ministry of Energy
Duration of Employment:	24 weeks (over a 4-year period) (30 days per year including 2 missions of 5 days. Contracts for 12 months, renewable based upon performance)
Duty station:	Home Office and Cotonou, Benin

II. Duties

Under the overall supervision of the National Project Director, the non-resident Chief Technical Adviser will:

- Work closely with the PM in coordinating and facilitating inputs of government agencies, partner organizations, scientific and research institutions, subcontractors, and national and international experts in a timely and effective manner;
- Provide guidance and assistance to the PM and project staff to ensure that the project activities conform to the approved project document;
- Assist the PM during the initial 2 months of the project, in the preparation of an "inception report" which will elaborate on the project Logical Framework Matrix and planned project activities, the 1st year Annual Work Plan and Budget, ToRs for key project staff, and an M&E plan;
- Assist the PMU in development of relevant ToRs and recruitment/mobilization of qualified national and international experts and organizations as needed to provide specific consultancy and engineering services;
- In close cooperation with the PMU and UNDP's Focal Point on Energy and Environment, and in consultation with the project partner organizations and stakeholders, prepare Annual Project Work Plans to be agreed upon by the Project Board (PB);
- Provide "on-the-job" technical guidance and mentoring to the PMU in order to strengthen their capacity to effectively implement the technical aspects of the project;
- Support the PM in reporting to the PB on the progress of project implementation and achievement of project results in accordance with the project's logical framework matrix;
- Support the PMU in project-related meetings, as required;
- Review reports of national and international consultants, project budget revisions, and administrative arrangements as required by UNDP/GEF procedures;
- Assist the PM in the development of a concrete Monitoring and Evaluation Plan at the outset of the project (within inception report);
- Support the PM in preparing project progress reports, information releases, as well as monitoring and review reports in accordance with UNDP/GEF monitoring and evaluation rules and procedures;
- Support the PM in the preparation and implementation of mid-term and final Independent Evaluation Missions (TOR's, identification and recruitment of appropriate candidates, organization of missions, joint field missions and discussion with evaluators, etc.);
- Support UNDP CO staff on their annual monitoring visits to project sites.

III. Qualifications and Experience

Education:	• Postgraduate degree in energy/renewable energy development.

Experience:	• Minimum ten years of experience in implementing electricity generation through biomass gasification projects, in combination with knowledge of economic and financial analysis, institutional, regulatory and policy frameworks; • Good knowledge of and experience with GEF Climate Change issues, operational modalities and familiarity with UNDP-GEF procedures would be an advantage; • Familiarity with UNDP rules, regulations and administrative procedures would also be an advantage; • Prior knowledge and experience of the political, social and environmental factors and issues related to energy development and climate change mitigation in West Africa, preferably in Benin; • Computer proficiency, especially related to professional office software packages; • Excellent drafting and communication skills.
Language Requirements:	• Excellent French and English, both oral and written.

4. Financial Engineering Expert

Post title:	Financial Engineering Expert
Office:	Project Management Unit (PMU)
Organisation:	Ministry of Energy
Duration of Employment:	10 weeks during Year 1 of project
Duty station:	Home base and travel to Cotonou, Benin

II. Duties

Under the overall supervision of the National Project Director, the Financial Engineering Expert will:

- Review the project document and Request for CEO Endorsement in detail in order to fully understand the overall project design and the rationale and expected role of the FSM.
- Discuss establishment of the proposed FSM with the Project Manager and Chief Technical Adviser.
- Meet with the Central Bank of Benin, the Ministry of Energy, potential project developers and other key stakeholders during a brief in-country mission to understand how similar funds, if any, in Benin are currently managed and to discuss the proposed design of the FSM.
- Identify potential donors for the additional capitalisation of the FSS. One of the project's targets is that $ 10 million has been capitalised in the FSM by project end.
- Based on the desk review and stakeholder consultations, and taking into account the experience with similar financial mechanisms in other GEF projects, design the FSM with a view of supporting the preparation of feasibility studies/business plans and partial investment for biomass-based gasifier systems;
- Draft a Memorandum of Understanding between the Central Bank of Benin and UNDP that defines how the FSM will be operationalised

III. Qualifications and Experience	
Education:	• An advanced post-graduate university degree in a subject related to climate finance, climate finance, environmental management and/or business administration.
Experience:	• At least 5 years of professional experience in designing financial mechanisms for climate change mitigation projects. • Strong knowledge on renewable energy, including renewable energy-based mini-grids. • Experience with banking and financial practices supporting renewable energy-based mini-grids would be an asset. • Prior knowledge and experience of the political, social and environmental factors and issues related to energy development and climate change mitigation in West Africa, preferably in Benin; • Computer proficiency, especially related to professional office software packages; • Excellent drafting and communication skills.
Language Requirements:	• Excellent French and English, both oral and written.

ANNEX 3: POTENTIAL INVESTORS IN BIOMASS GASIFICATION IN BENIN

1. CAJAF COMON: A Beninese private company (www.globenin.com) whose main activity focuses on the sale of food products. It was established in Sèmè- Kpodji and is located 16 km east of Cotonou, on the road of Porto Novo. It has an annual sales turnover of approx. $ 56 million and its contribution to the state coffers in terms of taxes amounts to 10 - 12%. While it is not involved in electricity generation and distribution at the present time, it plans to broaden the scope of its activities to include renewable energy technologies where it sees excellent business opportunities in the future.

2. Euro – Négoce: A private company (www.euronegoce.fr) which markets famous brands of electrical equipment of European and French famous origin. It is headquartered in France and has a representational office in Cotonou. It has an annual sales turnover of approx. € 18 million. It has been active in renewable energy in Benin over the last two years and is presently developing a 6 MW biomass gasifier power plant in Kandi, in the north of the country.

3. HYDROCHINA: A Chinese private company (www.hydrochina.com.cn), also known as Kunming Engineering Corporation (KHIDI), specialises in geological investigations, design, laboratory testing, consulting, construction supervision and general contracting of hydropower, wind power, solar power and municipal engineering projects, both in China and overseas. In Benin, where it has a representational office, it is presently implementing a feasibility study for wind electricity generation. Its annual sales is $ 60 million.

4. MIERT: A Beninese private company (www. goafricaonline.com) based in Cotonou that has implemented several rural electrification projects in Benin on behalf of ABERME. With an annual sales turnover of $ 1 million, it has also implemented several renewable energy projects in the country. Currently, it is implementing projects on biomass and PV, and is planning to extend its activities to neighbouring ECOWAS countries, like Burkina Faso.

5. West African Infrastructure Organisation (WAIO): A West African indigenous Energy, Construction, Oil and Gas service company (www.waio-online.com) that pools the expertise of experienced professionals to provide skilled services in all aspects of the industry group. WAIO has an office in Cotonou and is committed to providing robust solutions to the infrastructural challenges throughout the region. WAIO was established in 2008 and through its key staff and technical

partners both in West Africa and worldwide has in excess of 30 years of experience. Its annual sales turnover is $ 30 million.

6. SATAREM Africa: A private company (www.dangote.com) headquartered in Paris, France, it has an office in Cotonou. It was the first Company to introduce Waste to Energy in Africa. In order to secure sufficient "good quality waste" to maximise electricity output, SATAREM Africa is also implementing efficient and modern waste collection systems. It is also developing solar projects as it helps these countries to decrease their imported fuel consumption and makes good sense given the amount of solar radiation they receive. Its annual sales turnover is € 2.6 million.

7. DANGOTE GROUP: A private company (www.dangote.com) headquartered in Lagos, Nigeria, Dangote is a diversified and fully integrated conglomerate with Group turnover in excess of N450 billion (US$3 billion) in 2010. The Group's operations cut across a wide range of sectors in Nigeria and 14 other African countries. Current interests of the Group, which started as a trading company in 1978, include cement, sugar, salt, pasta, and real estate with new projects underway in the oil and gas, telecommunications, fertiliser and steel sectors. It four listed companies on the Nigerian Stock Exchange (NSE) and has established a Foundation that, as part of its Corporate Social Responsibility (CSR) interventions, is active in the areas of health, education and empowerment.

8. AF POWER: A US-based company (http://af-power.net) with an annual sales turnover of over $ 200 million, it intends to become a leading green power producer in the developing and emerging market with the objective of achieving a portfolio of power production in excess of 1,000 MW by 2020. AF POWER commenced operations in 2010 it response to the need for renewable energy, particularly in Africa and South America. It focuses on developing a portfolio of renewable power projects in the biomass, solar and wind sectors, but its primary emphasis has been on the development of biomass gasification power projects.

ANNEX 4: LETTERS OF CO-FINANCING AND SUPPORT FROM THE GOVERNMENT

Provided separately.

ANNEX 5: INTEGRATION OF THE GENDER ISSUE IN THE PROJECT

Below is the summary of the technical report on gender issue made during the PPG of the project.

In 1995 took place the fourth United Nations conference for women and since then, Benin has been really committed in reducing inequalities between men and women. The government signed several international conventions for gender equality. It also supported lots of national programs and implemented policies, such as the National Policy for Gender Promotion in 2009 that aims at facilitating access to decision-making for women. The key measures focus on education and illiteracy, women autonomy, and reduction of poverty. Nevertheless, inequalities in the energy and agricultural fields still exist, and these prevent women to get involved in socio-economic and political decisions.

I - Current situation

In the context of the biomass energy project, it is interesting to focus on the women weight in the socio-economic system and particularly in agriculture, management and decision-making. Gender is a great difficulty to undergo in the project but it also reveals great opportunities to improve women role promotion. Agriculture and food processing is an important sector in the Benin economy. Women have a major role since they can be found in all the rural economic activities. Women only represent 36% of the working farming population, against 60% for men. This repartition is linked with socio-economic and political determinants.

Economic key facts

Men and women work together in the farming system but they have different tasks. Women mainly dedicate to picking and harvesting and, to the commercialization of the crops, which is revenue generating. They also devote to process the raw materials. In this activity, the demand of labor force is high and it requires a great availability. Indeed, women use mainly traditional methods, because they have no access to mechanization or technology. The tasks are physically heavy and time consuming.

Despite the fact women are participating highly in this economic sector, they stay marginalized:

- Women have no economic independence from their husband and no way of financing
- Women have low access to land
- Women are not represented in the institutions linked to raw resources management
- Women involvement is not promoted in the local development plans

Social determinants

The marginal position of women in the economic system also results of the unequal repartition of the tasks in the household. Women are responsible for children care and education, but also for wood, water and food supply. Wood and water chores are taking time and often prevent women from having a proper job and girls from receiving a proper education. Women mainly focus on domestic issue whereas men can dedicate to develop their economic activities.

Women are also victims of violence and harassment that prevents them from being fulfilled socially.

Legal situation and institutions commitment

The 1990 Constitution promotes women and girls rights. But the dominant system is still patriarchal and enhances inequalities between men and women. Access to land, financing and decision weight is the main problem. There is a strong political will to integrate women and improve their socio-economic situation. But, despite the legal and institutional efforts, taking gender into account is still hard to be effective.

II/ Propositions to improve gender issues in the project

The goal of the measures implemented in the context of the local energy stations project is to:

- Limit the pressure on men, women and young people of the time taking tasks so they have time for activities that fulfill their own interests
- Relieve the weight of domestic tasks and improve women and girls life conditions

That is why the project is consistent with the gender issue.

The measures include:

- Taking into account practical needs of men and women. Relieving women from the burden of their domestic tasks will enable them to get free time and to reach self-fulfillment. Women therefore need access to technologies:

- Substitution energies should be developed and promoted to lower wood needs (gas stoves and improved stoves).

- The introduction of improved cook-stoves would enable to reduce the dependence on wood and hence, release women for the wood chore. This measure needs to be accompanied by sessions of formation to the use of these stoves.

- Developing sustainable activities and energy sources, resilient to climate change, on which men and women can build strong economic activities.

- Sustainable activities such as apiculture and sustainable energy sources such as biomass should be developed.

- A sustainable exploitation of biomass should be identified and promoted to involve equally men and women in the land management.

- Introducing gender issues in energy and land management legal frame, to promote the role of women in the process of decision-making. A special care should be taken to the implementation of this legislation.

- Improving the representativeness of women in decision institutions at both local and community scales would contribute in integrating them.

- Women leadership should be enhanced to improve their participation in decision-making.

- More particularly, in this project:

- Skilled women should be recruited and employed in the management team of the local energy stations and in the management of forest and lands

- Local management comities have to be renewed by including women.

- Educating people is a key condition to the success of the above measures:

- It is necessary to educate men and women to reforestation technics in order to lead a sustainable project.

- Users should be trained to the construction and utilization of technologies such as improved stoves.

- Men and women should be encouraged to the development of new revenue generating activities.

- Women education has to be highly supported so that they can get involved in the institutions and decision-making processes.

- It is finally mandatory to educate young people to the entrepreneurship, and leadership technics, prior to involving them in the project.