STAPLE CROPS PROCESSING ZONEs (SCPZs): Promoting Sustainable Agricultural Value Chains.




GHG Emissions Reduction Methodological Note.

African Development Bank

August2023

CONTENTS

1) Overview of the SCPZ programme

In Togo, Senegal and Guinea, the Agricultural and Land Use Change and Forestry (LUCF) sectors are the two main drivers of GHG emissions. These two sectors account for more than 80% of the total GHG emissions in these countries. Under BAU emission levels, it is projected that this figure could reach as high as 90% in 2030. The Staple Crops Processing Zone Programme (SCPZ) will reduce climate change vulnerabilities and GHG emissions within the agricultural value chains within the 3 countries. GHG emissions reduction will be achieved through promotion of climate resilient agricultural practice and adoption of renewable energy technology.

2) Climate mitigation sources: baseline, calculations and results

Greenhouse Gas emissions impacts for the SCPZ have been estimated based on the following emissions and abatement source on which the project will achieve climate mitigation impacts. The baseline is the emissions which would have occurred in the absence of the below activities:

2.a. Baseline, calculation and result for new solar installation

Abatement by new solar installations that will displace Diesel for a total capacity of **2.59 MW** on solar irrigation systems and **14.69 MW** on solar PV systems for lighting and processing.

Baseline1: In the absence of this activity, energy (MWh) would be generated using Diesel for lighting and processing agricultural products in the Agro Industrial Parks, resulting in emissions. Having renewable energy instead will help avoid those emissions. The baseline emission is the amount of CO_{2eq} that would have been produced through generation of same amount of energy (MWh) by the Diesel generator as with the substituted capacity by the renewable energy system.

Calculation method1: The amount of emission reduction is estimated ex-ante using the Diesel emission factor (tCO_{2eq}/MWh) that provides the amount of GHG emission (tCO_{2eq}) per unit of Energy (MWh) produced. The formula is

Emissions by Diesel (in tCO_{2eq}) = Energy Generated by Diesel (in GJ) x Emission Factor of Diesel (in tCO_{2eq}/GJ). The Emissions Factor of Diesel per kg CO2/GJ is 0.074.

Mitigation Result1: This item resulted in emissions reduction in the tune of **348,320 tCO2eq** over the lifetime of the assets.

2.b. Baseline, calculation and result for biogas digesters

Abatement by Biogas digesters with a total cumulated volume of **24,577 cubic meters** across all 3 countries

Baseline2: In the absence of bio-digesters, feedstock and waste will be randomly dumped in the nature, generating methane. Having bio-digesters in place is a better way of collecting this methane contained in waste and feedstock that would have otherwise ended up directly disposed in the atmosphere. The baseline is the amount of CO_{2eq} that would have been discharged directly in the atmosphere, in the absence of digesters.

Calculation method2:

(i) Evaluating volume of direct discharge of methane in the atmosphere: This was done through assessing the amount of feedstock and waste (feedstock-m3/yr) that would be produced and disposed annually in the nature instead of being used in digesters based on data gathered from authorities on the field in March 2022. By multiplying this amount of feedstock with a model uncertainty of 94% and the methane concentration factor of each feedstock (CH_4-m3/feedstock-m3), we could estimate the amount of methane that would have been annually discharged in the atmosphere without the activity. The formula that resulted to estimating the amount of Methane that would have been dumped in the nature is:
Amount Methane annually discharged by feedstock (CH_4-m3/yr) = Amount feedstock annually disposed (feedstock-m3/yr) * model uncertainty factor (0.94) * Methane concentration factor in feedstock (CH_4-m3/feedstock-m3).

(ii) Evaluating the mass of methane: Given that climate mitigation is measured by the mass of CO_{2eq} and not the volume of CO_{2eq} in the atmosphere, to make things comparable we have assessed the mass of the methane that corresponds to the volume of methane that would have been discharged directly in the atmosphere without the activity. This simple exercise is achieved by multiplying the volume of the gas (m^3) by its density (kg/m^3), where the density of methane is a chemical known constant which is 0.67 kg/m^3. This resulted in assessing the total mass of methane that would have been without the activity dumped in the atmosphere and that amount is **28,501 tCH_4**.

(iii) Evaluating the corresponding CO2eq emission: The latest IPPCC report provides the 100-year GWP of methane which is 28 times CO_{2e}. The NDCs of the 4 beneficiary countries was however based on 100-year GWP of the 4^{th} assessment, which is more conservative. To evaluate the corresponding CO_{2eq} emission we have used the conservative factor 25 times CO_{2eq} to align with countries NDCs. Formula is: Resulting Emission (tCO_{2eq}) = methane mass (tCH4) * 25 (tCO_{2eq}/tCH_4) which resulted annual direct discharge of **477,392 $tCO_{2\,eq}$. (a).**
This amount is the baseline emission on this item.

(iv) Deducting emissions from the activity itself: Once methane is collected in the digesters, it will not be released in the atmosphere as in the baseline, rather it will be used to generate electricity. The conversion of methane to electrical energy necessitates combustion of methane first which is achieved through the chemical reaction:

$CH_4 + 2O_2 \rightarrow CO_2 + 2\,H_2O$

The mass of CO_2 that results from this reaction is known since the chemical law of Lavoisier discovered in 1789, also known as "The Law of Conservation of Mass". Lavoisier discovered that mass is neither created, nor destroyed in chemical reactions. It is therefore known since then that 16 grams of methane when completely burned produces 44 grams of CO2. This means that 19,095 tCH_4 when completely burned will produce 19,095 * (44/16) tCO_2, which is equal to **52,513 tCO_{2eq} (b)** as emissions from the activity itself.

Mitigation Result2: without the activity, there would have been 477,392 tCO_{2eq} dumped annually in the atmosphere. With the activity, there would be (c) = (a) – (b) = **424,879 tCO_{2eq}** less in the atmosphere every year.

2.c. Baseline, calculation, and result for displacing diesel with biogas

Abatement by displacing Diesel using Biogas as a Renewable Energy source for electricity generation.
Baseline3: In the absence of this activity, energy (MWh) for additional electricity needs would be generated using Diesel engines, resulting in emissions. By using Biogas instead of Diesel for generating this energy, the emissions that would have resulted from Diesel combustion are avoided. The baseline emission is the amount of CO_{2eq} that would have then been produced through generation of same amount of energy (MWh) by the Diesel generator as with the substituted capacity by the renewable energy system. Since the emissions for the combustion of CH4 have already been accounted in emission source 2 above, the emissions for the combustion of methane are therefore not counted twice.

Calculation method3: The amount of emission reduction on this item is estimated ex-ante using the Diesel emission factor (tCO_{2eq}/MWh) that provides the amount of GHG emission (tCO_{2eq}) per unit of Energy (MWh) produced. The formula is:

Emissions by Diesel (in tCOeq) = = Energy Generated by Diesel (in GJ) x Emission Factor of Diesel (in tCO_{2eq}/GJ). The Emissions Factor of Diesel per kg CO2/GJ is 0.074.

Result3: This item resulted in emissions reduction in the tune of **11,968 tCO_{2eq}** per year.

2.d. Baseline, calculation and result for sequestration by agro forestry

Carbon sequestration by Agro-forestry practice with trees planting (Cashew, Mango, Coffee and Woodlot) for a total of 30,365,000 trees that will be planted across the 3 countries to reduce forest degradation.

Baseline 5: In the absence of this activity, 40,000 Ha of land will not be used for planting trees. Many scenarios are possible for the same land in the absence of the project, which could be used by owners for bush fire or uncontrolled collection of biomass as fuel for cooking. The use of land for growing trees will result in avoiding emissions on each Ha of land managed, with a combined effect of sequestration by new trees and avoidance of emissions that could have come from unsustainable practice.

Calculation method 5: The amount of emission reduction is estimated ex-ante using the FAO EX-Ante Carbon- balance Tool which is based on the 2019 Refinement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Result 5: Based on the entries made in Annex22b_1, Annex 22b_2 and Annex 22b_3 a total of 5,743,266 tCO2eq will be avoided starting from year 5.

2.e. Emissions from roads construction and rehabilitation:

To the emissions reductions that will be achieved by these 5 abatement sources, emissions will happen as a result of access roads maintenance and construction of new roads. These emissions have also been estimated and deducted from the abatement achieved by the 4 sources above.

Baseline 6: Negative abatement. In the absence of constructing or rehabilitating access roads, emissions from the construction or rehabilitation of access roads will not be there, so the baseline for this item is 0 tCO_{2eq}. Construction and rehabilitation of access roads will generate certain levels of emissions through the lifetime of those roads, estimated per km and per type of road.

Calculation Method 6: In total 148 km of access roads will be constructed while 472 km of access roads will be rehabilitated. The emissions factor for new roads is 48.4 tCO_{2eq}/km while the emission factor for rehabilitation is 109.6 tCO_{2eq}/km. The formula for estimating negative abatement from road construction and rehabilitation activities is:

Emissions stemming from road construction activities (tCO_{2eq}) = Road emission facto (tCO_{2eq}/km)* length (km).

Result6: All road construction and rehabilitation activities will generate 58,894 tCO_{2eq}/km which have been deducted from the emission´s reduction from sources 1 to 5 to arrive at the final emission´s reduction of the SCPZ programme.

3. Methodology and applicability

3.a. Methodology for abatement by new solar installations

The Methodology chosen for calculating impacts achieved by new solar installations is the CDM methodology AMS-I.A. The methodology scope comprises renewable electricity generation units, such as solar photovoltaic, hydro, wind and renewable biomass that supply electricity to individual households/users or groups of households/users.

3.b. Methodology for abatement by biogas digesters

The methodologies for the analysis of the biogas energy generation are at two levels. At the level of the biodigester plants and at the level of the use of the biogas directly for electricity generation. According to Ammenberg et al (2017)1 due to differences in for example, geographical scope, time perspectives, feedstock, ecological aspects, impacts on climate change and energy potential, there several and divergent methodological approaches for estimating biogas potential and result. Cuellar et al (2008)2 offered a very simplified approach for calculating biogas potential by multiplying the values of for the amount of biogas energy that can be produced per animal unit (defined as 1000 pounds of animal) or the biomethane yield per dry matter content on total solids (TS) per day and the number of animal units generating the feedstock. This analysis refined this methodology by introducing discharge rate since the livestock have different discharge rates (tonne/yr) and available manure as feedstock for the digester.

Assumptions:

For the evaluation of potential feedstock, information from each country was collected during a field mission in March 2022.

Based on discussions held with the farmers and livestock owners, it was that the following percentage of the livestock headcount can be used for bio digestion:

1. Guinea – 2%
2. Senegal- 2.5%
3. Togo – 10%

Estimation of Biogas Potential:

The biogas energy potential was calculated using values for the amount of biogas energy that can be produced per animal unit (defined as 1000 pounds of animal) per day and the number of animal units in

[1] Ammenberg, J et al (2017). Systematic assessment of feedstock for an expanded biogas production —A multi-criteria approach. https://www.diva-portal.org/smash/get/diva2:1156008/FULLTEXT01.pdf

[2] Amanda D Cuellar ´ 1 and Michael E Webber, Cow power: the energy and emissions benefits of converting manure to biogas. stacks.iop.org/ERL/3/034002 or https://iopscience.iop.org/article/10.1088/1748-9326/3/3/034002

the US Information from Ammenberg (2017)[3] on biomethane yield and suitability for anaerobic digestion for each feedstock was averaged and multiplied by the average discharge and the estimated number of livestock or human beings available per year for the annual biogas generation.

An average digester volume per cubic meter of biogas generation estimated from IRENA (2016) ranged from about digester volume of 2 m^3 to 3 m^3 per 1 m^3/day of biogas generation. Following volume estimation by Idan (2012)[4]. Without any specific choice of biodigester designs, the estimated digester volume for this project was conservatively done by annualizing a 5.2 m^3 biogas generation per 1 m^3 of digester volume and dividing it by the annual potential generation.

Estimation of Net CO_2 Equivalent Emission Reduction (tCo_2eq/Yr)

For the estimation of the net equivalent carbon, the annual biogas generation were a model uncertainty factor of 94% and methane conversion factor for each feedstock following SGC (2012) was used to estimate the methane gas available each year as 28,501,014m^3/yr. Following IPCC [5] conversion methodology of methane from m^3 to kg the conversion factor converts the volume of CH_4 to a weight measure and is the density of methane at 20°C and 1 atmosphere, where 0.67 Gg/10^6 m^3 (1 Gg = 10^6 or 670000 kg/1,000,000 m^3 or 0.67 kg/1 m^3). This results in 19,095,679 kg/yr and conversion of the kg to tonne (1 kg = 0.001 tonne) results in avoided atmospheric methane emission of 19,095tCH_4. Biogas is a low-carbon, climate mitigation technology. According to the Fifth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), the global warming potential (GWP) of methane over 100 years period of time is 28 times that of CO2 (IPCC, 2014)[6]. Based on this, the CO_2eq equivalent emissions from direct discharge into atmosphere is 424,879 tCo_{2eq}.

Methane is the combustible component of biogas. This is expressed by Equations (1) as

$CH4 + 2O_2 \rightarrow CO_2 + 2H_2O$. (1)

That is to say burning CH_4 results in CO_2: $CH_4 + 2O_2 \text{->} CO_2 + 2\ H_2O$. This illustrates that the combustion of one mole of methane produces one mole of carbon dioxide. Expressing the conversion in mass basis using molecular weights shows that 16 g of methane produce 44 g of CO_2 (Cuellar et al., 2018). Expressing the conversion in tonnes[7] indicates that burning 16 tonnes of CH_4 yields 44 tonnes of CO_2 and burning 100 tonnes of CH_4 yields 100 tonnes x 44/16 = 275 tonnes of CO_2; and burning 1 tonne CH_4 yields 2.75 tonnes CO_2.

[3]Ammenberg, J et al (2017). Systematic assessment of feedstock for an expanded biogas production —A multi-criteria approach. https://www.diva-portal.org/smash/get/diva2:1156008/FULLTEXT01.pdf

[4]Idan, J.A . 2012. "Financing Waste to Energy in Africa". United Nations University-Institute for Natural Resources in Africa (UNU-INRA) Visiting Research Seminar Series. June 28, 2012. UNU-INRA.

[5]ENERGY 1.96 - IPCC - Task Force on National Greenhouse. https://www.ipcc-nggip.iges.or.jp/public/gl/guidelin/ch1ref7.pdf

[6] IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. Pp 87. https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

[7]GAS IS DIRTY ENERGY. burning methane (CH4) generates carbon dioxide (CO2), CH4 leaks & CH4 is 105 times worse than CO2 as a greenhouse gas (GHG). https://sites.google.com/site/gasisnotcleanenergy/gas-is-dirty-energy

3.c. Methodology on abatement by displacing diesel generators using biogas

The climate mitigation impact when substituting Diesel with Biogas which combustion has already been accounted for is the emissions avoided by the baseline. The Baseline is explained in section 2. Methodology is same as AMS-I.A.

3.d. Methodology on sequestration by agro-forestry

FAO EX-Ante Carbon- balance Tool which is based on the 2019 Refinement of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

3.e. Methodology used for deduction of emissions by roads rehabilitations and construction

The Impacts of road construction and rehabilitation have been estimated using the methodology described at:

https://www.adb.org/sites/default/files/publication/28555/estimating-carbon-footprints-road-projects.pdf

4. Baseline's description

The baseline is the counterfactual, it is the quantity of GHG that will be emitted if the project does not take place. This has been estimated looking at what would happen if each of the activities would not take place.

- For solar and biogas to electricity, the baseline is the emissions that would occur if Diesel generators would be used to supply the same amount of electricity that is supplied using respectively solar and biogas, thus the Diesel emission factor.
- For biogas digesters, the baseline is the amount of CH_4 that would be discharged in the atmosphere in the absence of the digesters and their corresponding CO_{2eq} that would be left in the nature if digesters are not used to capture the biogas for community usage.
- For Agro-forestry, the baseline is the amount of carbon that would not be sequestrated if the trees are not planted. We recognize that the estimate of impacts for agro-forestry are very conservative, given that the lifespan of some trees such as mango trees is 100-200 years.

5. Boundaries

- **Energy:** The solar systems in the SCPZ are small scale solar systems with the total capacity for each not exceeding 17.28MW. The solar systems will not be interconnected with any national facility and will be considered stand-alone in the undertaking area. In case of repair, maintenance or renovation, the primary objective will not be to restore the solar systems to their initial performance, therefore rehabilitation may lead to efficiency increase (for instance replacement of a broken solar panel with one that is more efficient). Purposes for end use include electricity demands for lighting, refrigeration, agricultural water pumps and processing of agricultural products by small farmers associations.

  The project boundary is the assets of each ESCO (Energy Service Company) and the physical site of the energy consumers. The assets of the ESCO include the solar generation systems and the local distribution line to farmers associations, solar pumping assets for agriculture. The agricultural site where the solar pumping will happen also belong to the project boundary.

  The purpose will not be electricity distribution to villages therefore no segmentation of the end users, and as a result the generous emission factor of 1 is not used. The business model will also not be self-generation therefore the generous emission factor of 0.8 is also not used. A conservative factor of 0.64 is used.

The formulae used to quantify emission abatement for all solar installations in the SCPZ programme is:

ER = DE x EF

Where ER is Emission Reduction

DE is Distributed Energy

EF is Emission Factor.

- **Biogas digesters**: The project boundaries for the biogas digesters are the agro-industrial parks (Staple Crop Processing Zones). The agro-industrial parks will be equipped with biogas digesters amounting to a total volume of 24,577m3 . These digesters will be fed with feedstock and waste that would come from operating the agro-industrial parks. Without the circular approach taken for using this waste in the biogas digesters, the agro-parks would be sources of GHG emission.

- **Climate Smart Crops**: The project boundaries for the Climate Resilient Crops are the surface of land where the crops will be grown. This will be a total of a surface of 11,810 Ha for Guinea, a surface of 11,940 Ha for Senegal, and a surface of 15,428 Ha for Togo.

- **Agro-Forestry:** The project boundaries for Agro forestry is the surface of land where trees will be planted. The breakdown by type of trees across the 3 countries is as follow:

Country	Climate	Type of forest	Forested area	Total emissions avoided	Annex
Guinea	Tropical	Sub tropical dry forest	10,000	1,645,668	Annex 22B_1
Senegal	Warm Temperate	Sub tropical dry forest	20,000	3,291,336	Annex 22B_2
Togo	Tropical	Tropical dry forest	10,000	806,262	Annex 22B_3
Total GHG emissions avoided tCO2				5,743,266	

6. Analysis of climate additionality

The overall funded activity will result in a net emission abatement estimated ex-ante at 16,953,882 $tCO_{2\ eq}$ by 2050. The average annual avoided emission over the lifetime of the programme is about 6.2 million $tCO_{2\ eq}$. The construction and rehabilitation of access roads to the Agropoles will result in a negative abatement which is largely offset by the climate resilient agriculture activities, agroforestry, solar installations, and biogas digesters. The construction and rehabilitation of access roads will generate 1.2% of the GHG which be abated by the remaining programme activities. The programme therefore provides a strong climate additionality case.

7. Main assumptions in the formulae for calculation of ghg emission reduction

A) Solar assumptions

- Irrigation Hours using solar: 5 hours daily, every day.
- Hours for lighting and processing: 12 hours daily, every day.
- Hours for running Biogas equivalent Diesel power plants: 12 hours daily, every day.

B) Default values

- Emission factor of diesel as 0.0741tCO2/GJ
- Density of methane 0.67kg/m3
- tCO_{2eq} of tCH_4: 25 (consistent with countries NDC publications)
- Overall Technical efficiency on solar installations (Distributed energy/ (installed capacity*running time)): 80% (consistent with AMS-I.L technical losses of 20%)
- Emission factor for construction of new roads : 48.4 tCO_{2eq}/km

- Emission factor for rehabilitation of roads (widening and strengthening existing pavement) : 109.6tCO_2/km

8. MRV Protocol for ex-post verification of Emission reduction

The establishment of an MRV protocol is critical to effectively report progress on the emission reductions achieved through the project implementation. Measurement is needed to identify emissions trends, determine where to focus greenhouse gas (GHG) reduction efforts, track mitigation-related support, assess whether mitigation actions planned under NDCs or otherwise are proving effective, evaluate the impact of support received, and monitor progress achieved in reducing emissions. Reporting and verification are important for ensuring transparency, good governance, accountability, and credibility of results, and for building confidence that resources are being utilized effectively.

Under the SCPZ programme GHG emissions are to be tracked for the following activities:

1. Irrigation using small/ pico solar PV systems
2. Energy for lighting and processing using Solar PV
3. Energy for electricity using biogas
4. Use of waste for bio digestion
5. Agro forestry activities

The general approach to be used to monitor the GHG emissions avoided on a yearly basis will be through yearly surveys undertaken according to prescribed methodologies. For technologies like PV, given the large number of beneficiaries, the project developer (local contractor/ ESCO) will conduct yearly survey at sampled sites which will be representative of the overall population of beneficiaries to collect data on the reduction of the amount of diesel being used or the amount of energy being produced through pre-installed meters. The GHG emissions achieved during the reporting period will be extrapolated to estimate the GHG emission achieved for the installed capacity in the country for a given year.

The following MRV approach will is recommended for the above activity:

Activity	Measurement		Reporting	Verification
	Method	Data requirement		
1. Irrigation using small/ pico solar PV systems	Annual survey by the ESCO using the AMS-I.A methodology based on sample size representative of overall population of beneficiaries	Reduction in the amount of diesel used Amount of energy produce by system (through meter) KW installed	To Project Management unit prior to the end of each year	Cross check with annual GHG accounting undertaken by government of other organisations

2. Energy for lighting and processing using Solar PV	Annual survey by the ESCO using the AMS-I.A methodology based on sample size representative of overall population of beneficiaries	Amount of energy produce by system through metering Reduction in the amount of diesel used KW of PV installed	To Project Management unit prior to the end of each year	Cross check with annual GHG accounting undertaken by government of other organisations
3. Energy for electricity using biogas	Annual survey by the ESCO using the AMS-I.A methodology based on sample size representative of overall population of beneficiaries	Amount of energy produce by system through metering Reduction in the amount of diesel used Capcity of digestors installed (m3 and kW)	To Project Management unit prior to the end of each year	Cross check with annual GHG accounting undertaken by government of other organisations
4. Use of waste for bio digestion	Annual survey by the ESCO using the methodology outline in Section 3.b. of the Annex 22A- i.e. using IPCC conversion methodology of methane from m3 to kg the conversion factor converts the volume of CH4 to a weight measure and is the density of methane at 20°C and 1 atmosphere, where 0.67 Gg/106 m3 (1 Gg = 106 or 670000 kg/1,000,000 m3 or 0.67 kg/1 m3)	Volume waste used in bio digestor to estimate volume of methane gas not emitted in the atmosphere	To Project Management unit prior to the end of each year	Cross check with annual GHG accounting undertaken by government of other organisations
5. Agro forestry activities	Annual survey by Project Management Unit to estimate the amount of hectares under reduced degradation	Hectares of forested areas under agro-forestry management	To Project Management unit prior to the end of each year	Cross check with annual GHG accounting undertaken by government of other organisations

Annex to annex 22 a - summary of detailed calculations provided in the excel document provided.

GHG Accounting SCPZ

Color code:	**Technology**		
red cells: **Assumptions**	Solar PV for irrigation (MW):	2.59	
black cells: **Calculations**	Solar PV for lighting and processing (MW)	14.69	
	Volume Digesters (m3)	24,576.66	-
Assumptions			
Yearly irrigation hours (h)	1825		
Yearly hours for lighting and processing (h)	4380		
Yearly hours running Diesel equivallent biogas plants	4380		
Efficiency of solar PV systems	0.8		
Ratio tCH4/tCO2 eq avoided	25		
Country digesters ratio compared to overall programme	100%		
Energy Balance		**Annual**	
Annual solar energy generation for irrigation (MWh)		3,775	
Annual Solar energy Generation for lighting and processing (MWh)		51,475	
Annual Energy generation from biogas plants (MWh)		44,867	
Emissions Baseline			
Baseline 100% Diesel for solar irrigation and lighting (tCO2eq)		14,738	

Baseline methane discharge from bio-waste (tCO2eq)		477,392		
Baseline Diesel equivallent for biogas generators		-		
Baseline non sequestration by agro forestry (6 Years maturity)		5,743,266		
Baseline non sequestration by crops		-		
Baseline emissions including CRA and Agroforestry (tCO2eq)		**6,235,396**		
Abatement (Energy & Waste)		**Annual**	**2030 NDC (Ten Years)**	**Lifetime (25 Years)**
Abatement attributed to solar irrigation systems (tCO2eq)		1,007	5,035.35	5,035.35
Abatement attributed to solar lighting and processing systems (tCO2eq)		13,731	82,388.34	343,284.74
Abatement attributed to the proportion of bio-waste digested (tCO2eq)		424,879	2,549,273.20	10,621,971.68
Abatement attibuted to avoided diesel using biogas for electricity (tCO2eq)		28,715	172,289.67	717,873.61
Agroforestry abatement (Total Ha: 40,000)				
Baseline non sequestration by agro forestry (5 Years maturity)		5,743,266.00	5,743,266.00	5,743,266.00
Ex ante estimates abatement by roads construction and rehabilitation (tCo2eq)	-58894.4			
Total Estimated Emission Reductions		6,211,598	8,493,358	17,372,537
Total funding (USD)	**$271,703,524.59**			
GCF (USD)	**$102,790,987.64**			
Estimated cost per tCO2e	**$15.64**			
Estimated GCF cost per tCO2e	**$5.92**			