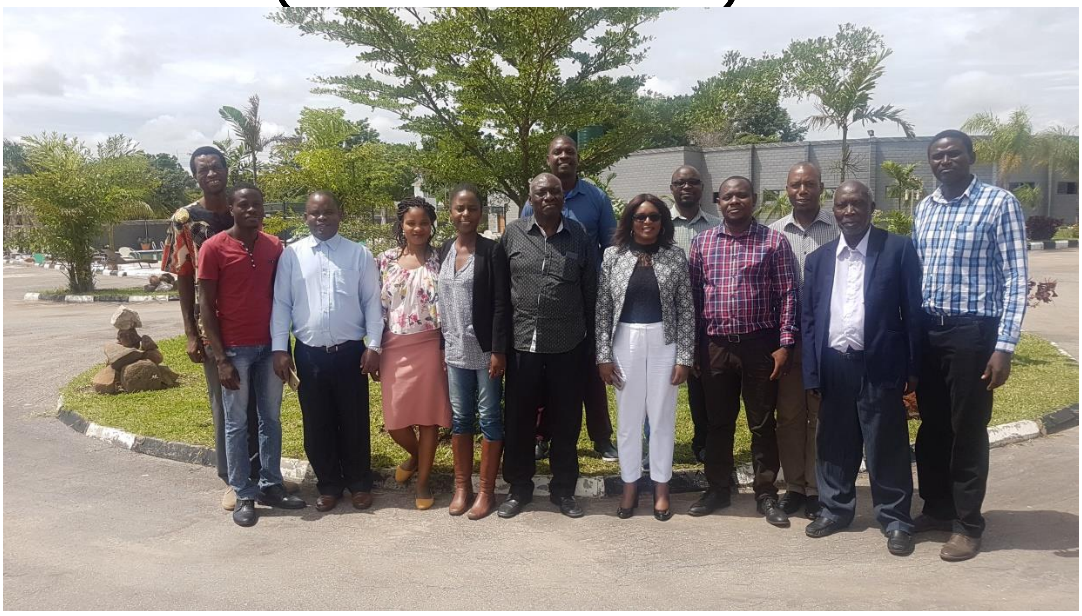
EU- UNEP AFRICA LOW EMMISIONS
DEVELOPMENT STRATEGIES

AFRICA-LEDS

REPUBLIC OF ZAMBIA

MINISTRY OF LANDS AND NATURAL RESOURCES

EU-UNEP AFRICA LOW EMISSIONS DEVELOPMENT STRATEGIES MODELLING, PLANNING AND IMPLEMENTATION PROJECT (AFRICA LEDS PROJECT) FOR ZAMBIA



Climate Change and Natural Resources Management Department
P.O. Box 50694
Mulungushi House
Lusaka

EU- UNEP AFRICA LOW EMMISIONS DEVELOPMENT STRATEGIES

AFRICA-LEDS

Contents

List of Tables

List of Figures

List of Plates

TERMS/ACRONYMS

AFOLU	Agriculture Forest and Other Land Use
ANR	Assisted Natural Regeneration
CCNRMD	Climate Change and Natural Resources Management Department
CEEEZ	Centre for Energy Environment and Engineering Zambia
COP	Conference of Parties
CSO	Central Statistical Office
DIA	Development Impact Assessment
DoE	Department of Energy
EU	European Union
FD	Forestry Department
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHGs	Green House Gases
I-JEDI	International Job and Economic Development Impact
IPCC	Intergovernmental Panel on Climate Change
KNUST	Kwame Nkrumah University of Science and Technology
LEAP	Long-range Energy Alternatives Planning
LEDS	Low Emissions Development Strategy
MLNR	Ministry of Lands and Natural Resources
MNDP	Ministry of National Development Planning
NAMAs	Nationally Appropriate Mitigation Actions
NDC	Nationally Determined Contribution
NREL	National Renewable Energy Laboratory
NRSC	National Remote Sensing Centre
SLCPs	Short-Lived Climate Pollutants
UNEP	United Nations Environment Programme
ZARI	Zambia Agriculture Research Institute
ZIPAR	Zambia Institute for Policy Analysis and Research
ZMD	Zambia Meteorological Department

STATEMENT FROM THE GOVERNMENT OF THE REPUBLIC OF ZAMBIA

Through the European Commission-UN Environment (EC-UNEP) Africa Low Emission Development Strategy (LEDS) Project, Zambia has had the opportunity to maximize on its innovative modelling capacity where, both climate change and socio-economic aspects were derived simultaneously to inform technical and policy decisions. This modelling investment will also inform policy-makers on what climate mitigation actions can be implemented in support of Zambia's Nationally Determined Contributions (NDCs) and where socio-economic benefits can be derived. This is very timely as we continue to strengthen climate change policy structure for low carbon development and climate action. The LEDS Project also enabled local expertise in this field to be harnessed and further strengthened inter-ministerial and public-private collaboration. The Government of Zambia, through the Ministry of Lands and Natural Resources wishes to thank the EC and UNEP for their timely support.

Honorable Jean Kapata, M.P

MINISTER OF LANDS AND NATURAL RESOURCES

EU- UNEP AFRICA LOW EMMISIONS DEVELOPMENT STRATEGIES

AFRICA-LEDS

A. TECHNICAL REPORT

1. COUNTRY CONTEXT

Zambia's emissions are still low compared to those of developed countries and emerging economies. However, the country endeavors to develop and implement mitigation programmes that have complementary adaptation co-benefits and in line with the country's development priorities. In order to ensure effective and sustained greenhouse gas inventory reporting, the GHGs inventory management system has been established. The country aims to promote investments in climate resilient and low carbon development pathways in order to generate co-benefits and provide incentives for addressing climate change more effectively. The Ministry responsible for Lands and Natural Resources is the lead institution in overseeing the implementation of climate change projects and programmes in Zambia and reports to the Steering Committee of Permanent Secretaries.

The Ministry, through the Climate Change and Natural Resources Management Department, in conjunction with the UN Environment had been engaged in the Programme called "EU-UNEP Africa Low Emissions Development Strategies Modelling, Planning and Implementation" or the Africa LEDS Project. The focus of the programme was to enhance the capacity of local experts to enable them support the country in modelling Low Emission Development Strategies. In Zambia, the aim of the project was to establish an analytical decision framework to forecast the cumulative socio-economic and climate impact of implementing Zambia's NDC objectives. The project sought to inform the establishment of optimal policy trajectories that can maximize climate objectives and socio-economic priorities simultaneously in NDC implementation in Zambia. The project had two components:

- the operational level; and
- the strategic level

Zambia's participation in the Africa LEDS project at operational level culminated into strategic level to inform policy-makers.

The operational level was an analytical modelling structure comprising relevant software and hardware technologies, and a team of modelers with relevant technical capacity to conduct the extrapolation.

In order to achieve the projects' objectives, the Low Emissions Development Strategy Technical Working Group (LEDS-TWG), made up of modelers from various sectors was formally appointed by the Ministry of Lands and Natural Resources (Annex I). Meanwhile, the Strategic level (policy makers) was a harmonized policy decision-making structure across relevant line ministries and institutions.

1.1 SCOPE OF WORK

Following the LEDS modelling project inception for Zambia and identification of a project team (see plate 1), priority activities were outlined to form the basis for the scope of work and a tentative schedule as outlined in Table 1.

Table 1: Outline of activities under the LEDs modeling project in Zambia

TASK	DATE
Data collection on energy off grid, sustainable agriculture and forest enhancement and regeneration	9-13 July 2018
Baseline analysis	16-21 July 2018
Development of enhanced IJEDI: data collection on energy off grid, sustainable agriculture and forest enhancement and regeneration	23-28 July 2018
Development of linkages with LEAP	31 July-4 August 2018
Remote support by NREL	August-Nov 2018
In-country technical training	21st to 22nd March 2019
In-country workshop to present integrated results	Mid-June 2019
Publish report	July 2019

Plate 1: Workshop on baseline data establishment

2. ACHIEVEMENTS – MODELLING ACTIONS

The LEDS Technical Working Group (TWG) for the Operational level of the project identified tools and models from existing ones, which have been applied in data analysis and reporting, and these included:

i. Jobs Economic Development Impact (JEDI) model;
ii. Long-range Energy Alternatives Planning System (LEAP) model; and
iii. Development Impact Assessment (DIA) tool.
iv. Agriculture, Forest and Land Use (AFOLU)

The JEDI model and DIA tool were developed by the National Renewable energy Laboratory (NREL) of the United States. The JEDI model estimates the socio-economic impacts of a projects' investment. The JEDI is an excel based input-output (I-O) model which quantifies economic impacts for energy development and operation scenarios (e.g. Wind, Solar PV, hydro, geothermal) and non-energy impacts from scenarios such as land-use change or household income. Results of using this model of assessment are threefold, that is; direct, indirect and induced. The results include number of jobs created, earnings, GDP and economic output.

The DIA is a process for evaluating the likely economic, social, and/or environmental consequences of a LEDS action or set of actions, or one or more development goal. The DIA provides a framework for understanding, ahead of time, what types of impacts a particular development may have on a community, thus allowing time for avoidance or mitigation of any adverse effects of a proposed development[1]. It provides a framework for considering both negative and positive effects of an action through application of data, models, analytical approaches, and experiences to anticipate outcomes. DIA can be applied at local and national level to support decision- making.

The LEAP is an integrated, bottom-up, scenario-based modelling tool that is used to track energy consumption, production and resource extraction in all sectors of an economy. It can be

[1] Edwards, M.M., 2000. Community Guide to Development Impact Analysis. Wiscousin Land Use Research Progrm: Program on Agricultural Technology Studies. Madison, WI

used to account for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks. In addition to tracking GHGs, LEAP can also be used to analyse emissions of local and regional air pollutants, and short-lived climate pollutants (SLCPs) making it well-suited for this particular analysis which has climate change connotations.

The AFOLU analysis tool aids the reporting requirements and design of climate policy actions for the agriculture, forestry and other land-use sectors[2]. The AFOLU has been used to support preparation of the NAMAs and NDCs in Zambia.

This report is been prepared to provide information results from modelling scenarios for the three NAMA Concepts that have been prioritised for implementation in Zambia's agriculture, forestry and energy sectors. It is expected that the results of the modelling actions will support the Strategic level (policy-makers) in decision making. The three NAMAs under consideration are: Energy (off-grid), AFOLU (sustainable agriculture) and AFOLU (natural forest enhancement- natural regeneration).

The data used was obtained from the respective ministries and institutions as actual or raw data which was then synthesized to a form suitable for use in the selected tools and models. In cases where data was unavailable, a baseline was established; assumptions based on observed trends were made; and tools and models were used to make projections of variables up to 2030.

The format of writing includes a general introduction, baseline and mitigation scenario description for the selected NAMAs, presentation of the JEDI/I-JEDI, LEAP and AFOLU results, barriers and barrier removal strategies. The report also includes a conclusion which will provide a reflection based on results obtained.

2.1 ENERGY (OFF-GRID)

2.1.1 Baseline and mitigation scenarios

Baseline setting for rural areas under energy (Off Grid) was characterized by use of biomass for cooking, in the form of firewood and charcoal; lighting, through use of kerosene, dry cells and candles, petrol and diesel engines; and prime moving equipment for maize milling, water pumping for human consumption, animals and irrigation in target areas. Research undertaken

[2] www.fao.org/in-action/micca/resources/tools/ghg/en/

revealed that the total population in the project area in 2018 was 43,750 people and the number of households was 8,750 giving an average household size of 5 (five) people. In terms of energy use, an estimated 720 candles were used per annum (running time of 3 hours per day for each candle) and 96 dry cells were used per annum per household. One candle was assumed to consume 80 watts while one dry cell was assumed to consume 2 watts.

Cooking was the most important energy demanding activity in households. The main device used for cooking in the selected areas was the traditional firewood cook stove. Each household consumed about 10 kg of firewood per day. The total quantity of firewood consumed by households in the project area was 31,937.5 tonnes per annum which translated into 495.1 thousand GJ[3] per annum in 2018. In a business-as-usual scenario and the assumption being that consumption growth rate of firewood is 3 per cent per annum; the energy demand will be 525.2 thousand GJ in 2020; 608.9 thousand GJ in 2025; and 705.9 thousand GJ in 2030. Figure 1 provides an illustration of the trend in a business-as-usual scenario for cooking energy.

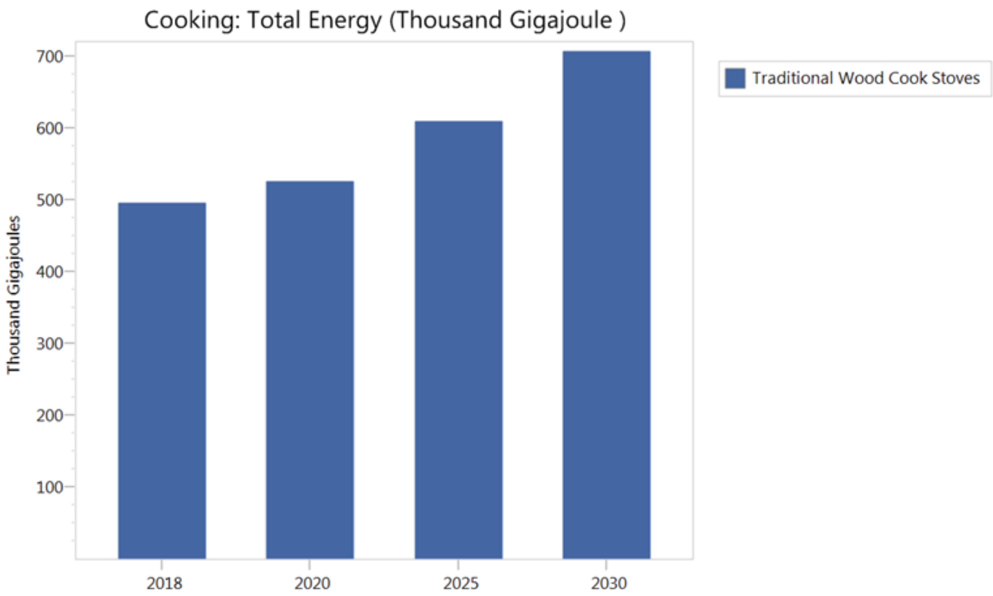


Figure 1: Trend of firewood consumption from 2018 to 2030

Figure 1 shows that without any intervention, energy demand (in the form of firewood) continues to increase from 2018 to 2030[4]. This in turn puts pressure on the depleting

[3] Giga joules (unit of energy measure)
[4] Based on LEAP results

woodlands/forests and corresponding reduced carbon sinks.

The mitigation options that had been selected involved the implementation of off- grid mini hydros and solar PV as means to reduce carbon emissions. The mini hydros under consideration included Kasanjiku (640kW), Zengamina (700kW)- an existing plant and Chipota (200 kW). The solar mini-grids are Lunga (300kW) and Chunga (200kW).

On account of the coming on stream of the mini-grids in 2020, households are expected to switch from candles and dry cells to electricity in accordance with the following penetration levels: 2020 - 50%; 2025 - 80%; and 2030 - 100%, respectively.

Hydro power can support cooking and it is assumed that households will gain access to two-burner cook stoves at rates of 50% (2020), 80% (2025) and 100% (2030) over the project period. In areas where solar PV mini-grids will be set up, it is assumed that households will switch to improved firewood cook-stove at 10% in 2020, 20% in 2025 and 30% in 2030.

2.1.2 I-JEDI results for energy off-grid

The JEDI-Zambia was used to estimate the jobs and economic impacts of installing the three mini hydro projects, while the I-JEDI was used to estimate impacts of installing the mini solar PV grids. The input data required for the model included: construction cost for materials, equipment; annual operations and maintenance expenditures for replacement parts, personnel; and the portion of expenditures made within the country of analysis. The investment costs and size of plants data were obtained from the Department of Energy. The capital cost breakdown of small-scale hydro projects in Africa (IRENA/GIZ, 2012) study was used to make estimates for required data. Cost breakdown estimation for solar mini grids was done based on IRENA Solar PV costs in Africa for 2016 and Kuby Renewable Energy reports. Assumptions on percent of expenditures made in Zambia were obtained from previous work on similar projects in Zambia.

The jobs and economic results due to implementation of the three mini hydro and 2 solar PV projects are summarized in Table 2 and 3 respectively.

Table 2: JEDI-Zambia Jobs and economic results for mini hydro

Project	Investment	Size	Number of jobs	GDP (ZMW)

name	cost (ZMW)[5]	MW	Construction phase	O&M phase	Construction phase	O&M phase
Kansanjiku hydro	98.73m	0.64	1017	106.6	32.7m	2.8m
Zengamina hydro	35.69m	0.7	311	38.4	10m	1m
Chipota hydro	17.59m	0.2	40	6.1	1.7m	0.2m

Table 3: I-JEDI and economic results for solar PVs

Project name	Investment cost (US$)[6]	Size (MW)	Number of jobs		GDP (US$)	
			Construction phase	O&M phase	Construction phase	O&M phase
Lunga PV	0.478m	0.3	116	4.7	110,750	3,941
Chunga PV	0.4m	0.2	141	3.9	230,262	3,298

According to Table 2, Kasanjiku, a mini-hydro plant of 0.64MW with an investment cost of ZMW98.73million (US$8.3m) would support about 1,017 local jobs (full-time equivalent for a year) and generate over ZMW32.7 million in local economic activity during the construction period. Once in operation, this project would continue to impact the district. Over 106 jobs (full-time equivalent for each year of operation) would be supported. The total annual local economic activity supported by ongoing operations would be ZMW2.8 million.

Similarly, Zengamina and Chipota mini-hydros of sizes 0.7 and 0.2MW and investment costs of ZMW 35.69m and ZMW 17.59m, respectively would support 351 (311+40) jobs during construction and 44.5 (38.4+6.1) during O&M phases collectively. In terms of GDP during the construction phases, Zengamina would generate about ZMW 10Million and Chipota would generate ZMW 1.7million. Once in operation, Zengamina would generate ZMW 1million and Chipota ZMW 0.2million in GDP from annual local economic activities.

Table 3 shows the results for the solar PV projects that were assessed using I-JEDI. Lunga solar mini-grid plant of 0.3MW with an investment cost of US$0.478million would support about

[5] JEDI-Zambia was formulated in our local currency (ZMW)
[6] I-JEDI as an international model uses US$ currency

116 local jobs (full-time equivalent for a year) and generate over US$110,750 in local economic activity during the construction period. When in full operation, this project would continue to impact the district and surrounding areas. Over 4 jobs (full-time equivalent for each year of operation) would be supported. The total annual local economic activity supported by ongoing operations was US$3, 941.

Chunga solar mini-grid plant of 0.2MW with an investment cost of US$0.4million would support about 141 local jobs (full-time equivalent for a year) and generate over US$230, 262 in local economic activity during the construction period. When fully operational, the project would continue to impact the district and surrounding areas. Over 3 jobs (full-time equivalent for each year of operation) would be supported. The total annual local economic activity supported by ongoing operations was US$3, 298.

2.1.3 I-JEDI results for implementation of cook-stoves (including LEAP)

With the cook-stove uptake assumptions made, the LEAP model was used to determine the evolvement of energy demand trends and GHG emission in the project areas during the period 2018 to 2030. The number of cook-stoves was determined using LEAP and then imported into I-JEDI for socio-economic assessment.

The input data for use in the I-JEDI included information on the expenditures and the local context (based on current trends in Zambia). Figure 2 illustrates the cook-stove scenario input data and how this is linked to the LEAP. Figure 3 shows the I-JEDI tab where LEAP data are imported.

Cookstove Scenario - Zambia

			Click for help ?
Country	Zambia		
Dollar Year	2010		
Cookstove Scenario Type	Conventional to efficient		
			Click to view LEAP scenario
	Will this use the LEAP scenario in the "LEAP-Cookstoves" tab?	Yes - Import LEAP Scenario	LEAP
	What year would you like to import?	2021	
	Cumulative or Annual	Annual	
Populate with Defaults			
Installation/Single Event		% Manufactured in Zambia	% Purchased or spent in Za
Number of new cookstoves purchased (LEAP)	11		
Cost of new cookstoves ($2010 USD)	$ 1,410	10%	90%
Transportation expenses for cookstoves ($2010 USD)	$ -		0%
Disposal of old cookstoves ($2010 USD)	$ -		0%
Total	$ 1,410		
Ongoing		% spent in Zambia	
Annual change in charcoal expenditures ($)	$ (4,375,800)	100%	
Change in stove maintenance expenditures	0	100%	
Total	$ (4,375,800)		
Click to view results			

Figure 2: I-JEDI inputs for the cook stove scenario

Variable: Indicators: Indicator (Cookstoves)													
Scenario: Mitigation	If dollars are imported from LEAP I need to know where the dollar year would be listed and the format												
Branch: Indicators\Cumulative Efficient Cook Stoves	< - macro detects if word "efficient" is in this cell; otherwise uses the electric scenario												
Region: Region 1													
Branches	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Annual Added Efficient Cook Stoves	-	23.00	24.00	11.00	12.00	12.00	13.00	14.00	14.00	15.00	16.00	17.00	18.00
Cumulative Efficient Cook Stoves	-	23.00	47.00	58.00	70.00	82.00	95.00	109.00	123.00	138.00	154.00	171.00	189.00
Import LEAP Scenario													

Figure 3: I-JEDI data on cookstoves in the LEAP scenario

The cook-tove scenario has two phases, the implementation and on-going. The implementation phase for transitioning from firewood to efficient cook-stoves was estimated at US$1,410 and the on-going expenditure changes was US$ (-4, 375,800) (Figure 2). To go to the "LEAP" scenario, there was a LEAP sign in the top right side of the tab.

The bottom left side showed the "Import LEAP scenario" in Figure 3. A cumulative number of 180 efficient cook-stoves would have been adopted by end-users by 2030 in the project areas as shown in the figure.

The implementation phase for transitioning from firewood to electric cook-stove was estimated at US$5,513 and the on-going expenditure change was US$ (-17, 105,400).

Table 4: Jobs and economic impacts of cookstoves implementation in the project area

	Implementation	On-going
FIREWOOD TO EFFICIENT COOKSTOVES (ICS)		
Number of jobs	0	16
Earnings (US$)	-4	-19,656
GDP (US$)	-131	2,394,860
Output (US$)	-4	-19,656
FIREWOOD TO ELECTRIC COOKSTOVE		
Number of jobs	0	62
Earnings (US$)	-14	-76,837
GDP (US$)	-510	9,361,726
Output (US$)	-14	-76,837

Results in Table 4, show that the transitioning from firewood to efficient cook-stoves had negative results. During the implementation phase, the number of jobs was negligible with US$ (-4) in earnings, US$ (-131) in GDP and US$ (-4) in GDP.

Sixteen (16) jobs would be created in the on-going phase. The earnings and output would be US$ (-19,656), while the earnings would be US$2, 394,860. It should be noted that the estimated values are sensitive to cost and based on assumption about the local context.

Table 4 also shows that the earning in the implementation phase was US$ (-4). This means that some activities were still taking place during this phase but were not significant enough to result in more earnings. The earnings in the on-going phase were negative (US$-19, 656). This means that, the earnings made in the support sector (e.g. agriculture, manufacturing, finance, etc. shown in Figure 4) were more than those within the cook-stove sector thus resulting in a negative total.

Other results of I-JEDI assessment presented information on jobs, and earnings by industry. The implementation phase had no jobs recorded in any of the industries as a result of this investment. The on-going phase showed some negative impact throughout the supply chain but some induced impacts were positive and greater than the negative impacts in direct and indirect jobs (Figure 4).

Implementation Phase				
Jobs				
	Direct	Indirect	Induced	Total
Agriculture	0	0	0	0
Mining and Extraction	0	0	0	0
Utilities	0	0	0	0
Construction	0	0	0	0
Manufacturing	0	0	0	0
Sales	0	0	0	0
Transportation and Warehousing	0	0	0	0
Information	0	0	0	0
Finance, Professional, and Business Services	0	0	0	0
Education and Health Care	0	0	0	0
Other	0	0	0	0
Total	0	0	0	
Ongoing				
Jobs				
	Direct	Indirect	Induced	Total
Agriculture	0	-82	79	-3
Mining and Extraction	0	-2	1	-1
Utilities	0	-3	2	-1
Construction	0	-1	3	2
Manufacturing	-63	-23	34	-53
Sales	0	-22	80	59
Transportation and Warehousing	0	-6	7	2
Information	0	-1	2	1
Finance, Professional, and Business Services	0	-24	20	-4
Education and Health Care	0	-5	17	12
Other	0	-5	7	3
Total	-63	-174	253	

Figure 4: Jobs presented by industry for implementation and on-going phases for firewood to efficient cookstove transition

The GHG emissions associated with the business-as-usual and mitigation scenario of the cook-stove project implementation were generated in LEAP and are shown in Figure 5.

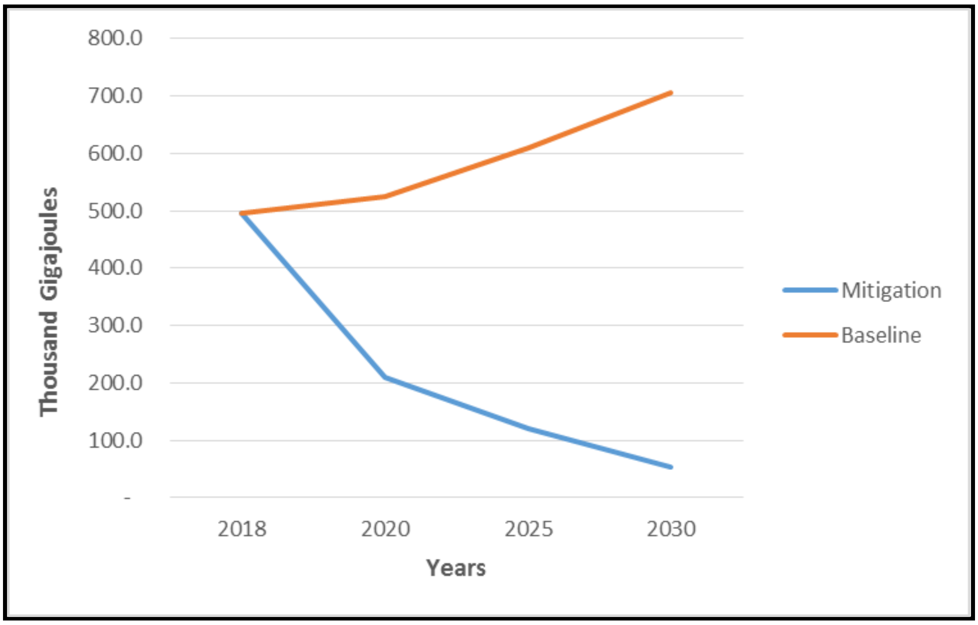


Figure 5: Baseline and mitigation scenario for total energy demend

Figure 5 shows the baseline curve (red) increasing with continued use of firewood from 2018 to 2030. In 2018, the total energy demand stood at 495.1 thousand GJ. The energy demand is at 525 thousand GJ in 2020, 608 thousand GJ in 2025, and 709 thousand GJ by 2030 in a business-as-usual scenario. Following the introduction of improved cook-stoves, the total energy demand decreases from 495.1 thousand GJ in 2018 to 210 thousand GJ in 2020. There is further reduction to 121 thousand GJ in 2025 and 53 thousand GJ in 2030 (figure 6).

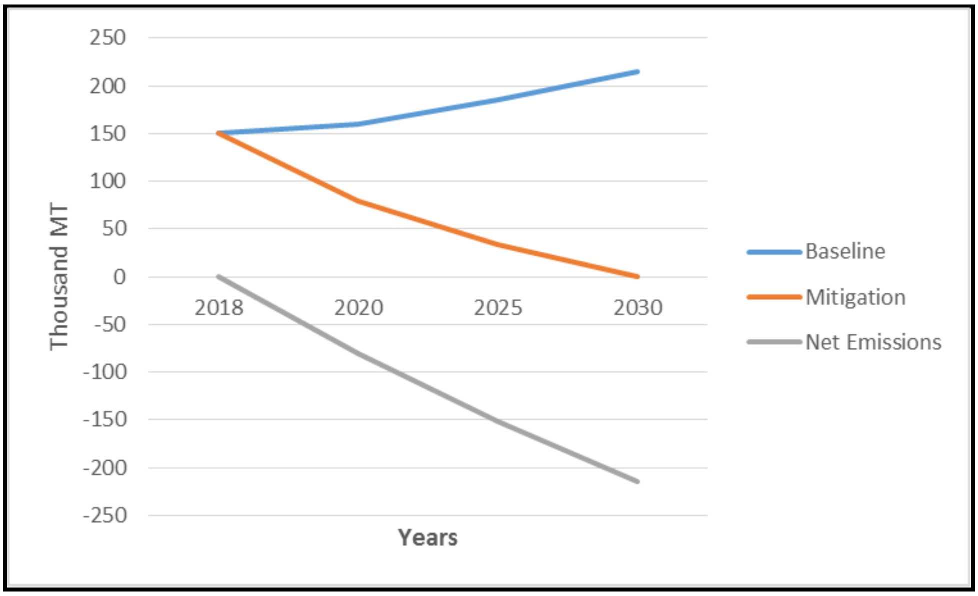


Figure 6: Baseline and mitigation total GHG emissions

Total GHG emissions as a result of the mitigation interventions are illustrated in Figure 6. Due to the mitigation actions, net emissions (grey line) will be -85 thousand MT[7] in 2020, -151 and -241 thousand MT in 2025 and 2030, respectively.

2.1.4 Barrier and barrier removal strategies for implementation

An evaluation of the consequences of implementing the cook-stoves was done by the Technical team. The barriers and barrier removal strategies for implementing these projects were identified.

Table 5: Barriers and barrier removal strategies

BARRIER	BARRIER REMOVAL STRATEGY
Low uptake of cook-stove by the rural community because of ✓ Cost: may be too high for the local communities. Price range between US$7 and 100; ✓ Cultural Aspects: Belief that certain dishes taste better when cooked on the traditional stove/fuel. ✓ Marketing: Marketing is not done adequately to potential customers	**Flexible payment term** such as pay-as-you-go (PAYG) on weekly or monthly basis to give the households time to find resources for next payment; Change of the individual's mindset/perception by providing information on new cooking devices. **Awareness creation** through community leaderships, churches and cooperatives explaining the technologies and their benefits. **Improve on marketing** by using means which the target population have access to such as community radio stations, local demonstrations, road shows etc

2.1.5 Socio-economic determination using DIA

Six potential socio-economic impacts were identified based on expert judgment and experience.

[7] Million tonnes

Table 6: Impacts of implementatating the cook-stove project in the selected aeas

Development objective	Impact
Health	Positive impact on the quality of indoor due to reduction in emissions from the stove when cooking; Reduction in incidences of respiratory problems in households as a result of improved indoor air.
Education	Time which was previously spent collecting firewood will be spared for studying and other economic activities
Gender Equality	Women and children will benefit from time spared and reduced burden associated with firewood collection and meal preparation
Climate	Improve local climate due to reduction in smoke emissions; improved adaptive capacity for both livelihood and the ecosystem
Food security	Positive impact on food security due to controlled or reduced harvest of the trees allowing more forest output such as caterpillars (vinkubala), wild fruits, mushroom, and honey
Increased economic activities	As a result of spared time, households stand a chance of engaging in other economic activities

Table 6 shows that the implementation of the cook-stove project has many positive attributes both on the environment and the well-being of the population in the project area. The type of economic activities could be in the sales, transport and warehousing, construction, information, education and health care or other industry (as shown in Figure 4).

2.2 SUSTAINABLE AGRICULTURE

2.2.1 Baseline and mitigation analysis

The baseline scenario assumed that there will be a continued inefficient use of inorganic fertilizers and a limited use of organic fertilizers in the absence of the intervention on sustainable agriculture through integrated crop and livestock farming.

The project will be implemented in Mpika (Muchinga Province), Petauke (Eastern Province), and Kalomo (Southern Province). The baseline maize production for the three districts is summarized in Table 7

Table 7: Baseline maize production for the 3 districts

District	Area (ha)	Production (ton/ha)
Kalomo	1000	2000
Petauke	3000	6000
Mpika	300	600

The production rate for all the three areas is 2 ton/ha. Other baseline information is D-compound fertilizer usage 200 kg/ha; and Urea-200 kg/ha. The cost of D-compound is $500/ton and Urea is $400/ton. The price of Maize is $180/ton. The cost of tilling is $45/ha. The cost of weed control is $90/ha.

The mitigation scenario involved promotion of sustainable agriculture which considered a number of practices to include; (i) development of green manure and cover crops for soil improvements, (ii) conservation tillage, (iii) use of organic manure, (iv) application of lime, (v) control of weed, and (iv) use of improved crop varieties.

Under mitigation, the production of maize in the three areas was expected to increase five-fold meaning Kalomo would be producing 10,000ton/ha; Petauke 30,000ton/ha and Mpika 3,000ton/ha at an average of 10ton/ha for the same area of land.

The assumptions for the mitigation scenario were

- Coated D-Compound usage is 120 kg/ha and coated urea usage is 140 kg/ha;
- Manure usage is 4,000 kg/ha;
- Legume (cover crops) usage is 5,000 kg/ha;
- Lime-1,500 kg/ha;
- Cost of coated D-compound is $500/ton;
- Cost of coated Urea is $500/ton;
- Cost of manure is $50/ton;
- Cost of Legume is $60/ton;
- Cost of lime is $100/ton;
- Cost of tilling is US$30/ha;
- Cost of weed control is US$90/ha;
- Cost of weed control is US$90/ha.

2.2.2 I-JEDI results for Sustainable agriculture

Agriculture is an on-going activity. The results obtained using I-JEDI were calculated as the difference between the baseline and mitigation scenarios. The jobs and economic impact results for Kalomo, Petauke and Mpika are summarised in Table 8.

Table 8: Socio-economic impacts of investing in sustainable agriculture for the 3 project areas

District	Number of jobs	Earnings (US$)	GDP (US$)	Output (US$)
Kalomo	2,094	2,521,628	4,717,628	7,523,998
Petauke	3,889	4,726,009	9,154,009	14,681,584
Mpika	840	1,024,781	1,991,381	3,217,430
Total	6,824	8,272,418	15,863,018	22,205,582

According to Table 8, an estimated two thousand and ninety four (2,094) direct, indirect and induced jobs would be created as a result of implementing the proposed sustainable agriculture activities in Kalomo. Further, an estimated US$2,521,628 in earnings; US$4,717,628 in GDP; and US$7,523,998 in outputs will be realized. Similarly, in Petauke, 3,889 jobs would be created with an estimated US$4,726,009 in earnings; US$9,154,009 in GDP; and US$14,681,584 in outputs realized. In Mpika, 840 jobs would be created with an estimated US$1,024,781 in earning; US$1,991,381 in GDP; and US$3,217,430 in outputs.

The total economic impacts of implementing the proposed sustainable agriculture activities amount to 6,824 direct, indirect and induced jobs; US$8,272,418 in earnings; US$15,863,018 in GDP; and US$22,205,582 in outputs for Kalomo, Petauke and Mpika districts collectively. Implementation of the sustainable agriculture activities will result in a reduction of greenhouse gases through reduced loss of carbon sinks from agriculture expansion. The sustainable agriculture activities would also provide on-farm fuels from tree crops and farm residues. Assessment of data in AFOLU gave the estimated amount of GHG that would be reduced by implementing sustainable agriculture activities. The GHG emission reduction results are shown in Table 9.

Table 9: GHG emission reduction from implementing the sustainable agriculture activities in 3 project areas

Scenario/Year	2017	2020	2025	2030
Baseline emission(Gg)	1.55	1.69	1.94	1.99
Mitigation emission (Gg)	0.14	0.58	0.96	1.08
Total reduction potential	1.14	1.11	0.98	0.91

According to Table 9, implementation of the sustainable agriculture activities in the three districts would result in the total reduction potential of 1.11Gg of CO_2 eq in 2020. This is against a baseline emission of 1.69Gg CO_2 eq in a business-as-usual scenario for the same year, 2020. There would be a reduction of 0.98 and 0.91 Gg in 2025 and 2030, respectively.

2.2.3 Barriers and barrier removal strategies for implementing the project

A barrier analysis of implementing the proposed sustainable agriculture was conducted and barrier removal strategies were identified. The results are shown in Table 10

Table 10: Barriers and barrier removal strategies for implementing sustainable agriculture

BARRIER	BARRIER REMOVAL STRATEGY
Access to information	Increasing awareness: sensitization, workshops, radio
Lack of inputs, i.e. Fertilizer, management practices, etc.	Provision of resources for improved seed variety, Policy and enforcement of laws to compel existing fertilizer companies to gradually produce and import more efficient fertilizers. Use of site specific Fertilizer and crop recommendation
Access to capital	Provision of Group Loans
Current implementation of FISP	FISP[8] to incorporate Climate Smart practices
Lack of supportive incentives	Taxes rebuts on machines, improved fertilizers etc.

2.2.4 Socio-economic impacts assessment using DIA

Two potential socio- economic impacts for implementing the projects under sustainable agriculture were identified. These impacts were related to land tenure and revenue and have

[8] Farmers Input Support Program

been summarized in Table 11.

Table 11: Socio-economic impacts of implementing sustainable agriculture

Development objective	Impact
Land tenure	A negative impact is expected due to lack of tenure security for the farmers
Revenue/income	A marked increase in wealth and improved livelihoods among the beneficiaries

2.3 FOREST ENHANCEMENT AND NATURAL REGENERATION

2.3.1 Baseline and mitigation analysis

Without the mitigation project, it was assumed that assisted natural regeneration of forest areas which were being exploited by logging operations and charcoal production would not take place. The respective areas would either regenerate at a slower rate, most probably with lower productivity and biodiversity, or remain bare due to lack of protection. This would result in reduced carbon in the forest. Further, the traditional charcoal kilns as well as the traditional cook-stoves are inefficient and contribute to GHG emissions.

Mitigation options involve introduction of improved charcoal production kilns and agro-forestry which in turn enhances assisted natural regeneration (ANR) and provides additional sources of wood fuel from agroforestry tree crops. Assisted natural regeneration (ANR) involves a combination of forest and land use techniques that can be employed to restore degraded and deforested lands to more productive forests.

Improved kiln technology has demonstrated to be one of the most effective technologies to induce a significant positive impact on forest area, and to reduce deforestation. Improved agroforestry systems comprise of a range of technologies such as improved fallows, relay cropping, biomass transfer with nitrogen fixing plants that improve the agro ecosystem and support cost effective permanent agriculture and micro climate management.

The project involved forest enhancement and regeneration in Serenje District and is dubbed "Promoting Climate Resilient Community based Regeneration of indigenous forests in Zambia's Central Province, Serenje District". The project is being implemented by Government of Republic of Zambia with assistance from GEF.

In order to align the mitigation estimates for the project with the Third National

Communication for Zambia a decision was made to calculate the emissions based on IPCC 2006 guidelines.

The activity data for land cover by IPCC classification for Serenje district were land cover, by class, wood removal for timber logging and fuelwood and biomass burning by vegetation type. From 1995 to 2015 land for settlements, cropland, and grassland were observed to have increased by 25.1%, 55.8% and 25.6 %, respectively (Table 12). On the other hand, there was a reduction in land area in the same period for forest land, Wetland and fallow by 12.5%, 95.5% and 6.9%, respectively.

Table 12: Land cover by IPCC classification for Serenje District

No.	Land cover Class	AREA (HA) 1995	AREA (HA) 2015	Percentage Increase/Decrease
1	Settlement	293.67	367.20	25.1
2	Cropland	123,866.64	192,964.41	55.8
3	Grassland	279,812.52	351,515.52	25.6
4	Forests	700,862.76	613,401.21	-12.5
6	Wetlands	55,917.81	2,534.76	-95.5
7	Fallow (Forest Regime)	430.83	401.13	-6.9
	Total	**1,161,184.23**	**1,161,184.23**	

Between 1995 and 2015 the indigenous forests comprising Dry Evergreen Forest, Moist Evergreen Forest, Forest Woodland decreased by 13.5%, 13.3% and 12.2%, respectively. Other wooded land increased by 25.6% during the same period. In forest plantations, Eucalyptus and Pine reduced by 82.6% and 83.4%, respectively (refer to Table 13)

Table 13: Land cover by class

No.	Landcover Class	AREA (HA) 1995	AREA (HA) 2015	Percentage Increase or Decrease
***	**INDIGENOUS FOREST**			
1	Dry Evergreen Forest	43,659.54	37,757.47	-13.5
3	Moist Evergreen Forest	106,901.60	92,638.54	-13.3
4	Woodlands (Open Forests)	550,708.16	483,402.16	-12.2
5	Other wooded land	279,812.52	351,515.52	25.6
	Sub total	**981,081.82**	**965,313.69**	-1.6
***	**FOREST PLANTATIONS**			
6	Eucalyptus	18.15	3.15	-82.6556
7	Pine	6.14	1.02	-83.3876
	Sub total	**24.29**	**4.17**	-82.8407

In indigenous forests, wood removals for timber logging increased by 71.4%, 71.7% 71.7%, for Dry Evergreen Forest, Moist Evergreen Forest, Forest Woodland between 1995 and 2015. As regards Forest Plantations, wood removals for timber logging from Eucalyptus and Pine reduced by 115.4% and 82.7%, respectively during the same period (Table 14).

Table 14: Wood removal for timber logging

Land cover Class	AREA (HA) 1995	AREA (HA) 2015	Percentage Increase or Decrease
INDIGENOUS FORESTS			
Dry Evergreen Forest	12,446.40	21,332.68	71.4
Moist Evergreen Forest	2,354.31	4,043.42	71.7
Forest Woodland	319,064.03	547,979.02	71.7
FOREST PLANTATIONS			
Eucalyptus	1,505.30	3,242.43	115.4
Pines	60,229.22	110,049.89	82.7

TOTAL	**462,417.39**	**805,910.15**	**74.3**

In indigenous forests, wood removals for fuelwood (firewood and charcoal) increased by 70.9%, 71.2%, and 71.2% for Dry Evergreen forest, Moist Evergreen Forest, Forest Woodland between 1995 and 2015. As regards Forest Plantations, wood removals for fuelwood from Eucalyptus and Pine reduced by 114.8% and 82.2%, respectively during the same period (Table 15).

Table 15: Fuelwood (Charcoal & Firewood) removals

	1995	**2015**	
Land type	**Annual wood removal (m^3)**	**Annual wood removal (m^3)**	**Percentage Increase**
INDIGENOUS FORESTS			
Dry Evergreen Forest	12,270.11	20,968.84	70.9
Moist Evergreen Forest	2,320.96	3,974.46	71.2
Forest Woodland	314,545.00	538,633.00	71.2
FOREST PLANTATIONS			
Eucalyptus	1,483.98	3,187.12	114.8
Pines	59,376.17	108,172.94	82.2
TOTAL	**455,867.99**	**792,165.00**	**73.8**

Table 16 provides biomass burning in dry evergreen forest, Forest Woodland, other land and crop land (maize and rice).

Table 16: Biomass burning by vegetation type

	Land Area (Ha)					
Vegetation	**1995**	**1995 Rice**	**1995 Maize**	**2015**	**2015 Rice**	**2015 Maize**
Cropland	254.17	4.19	249.98	219.81	3.63	216.19
Cropland	7,287.62	120.25	7,167.3 8	39,814.5 9	656.94	39,157. 65
Cropland	0.90	0.01	0.89	0.78	0.01	0.77
Cropland	2,382.90	39.32	2,343.5	2,591.82	42.77	2,549.0

			8			6
Cropland	3,702.65	61.09	3,641.55	4,651.47	76.75	4,574.72
SUB TOTAL	**-**	**224.87**	**13,403.39**	**-**	**780.09**	**46,498**
Dry evergreen forest	1,645.97			1,423.47		
Dry evergreen forest	362.32			313.34		
Dry evergreen forest	0.96			0.83		
Dry evergreen forest	1.01			0.87		
Dry evergreen forest	109.44			94.64		
SUB TOTAL	**15,747.95**			**49,111.62**		
Forest Woodlands	38,615.03			253,682.54		
Forest Woodlands	33,112.47			72,103.55		
Forest Woodlands	108.00			226.85		
Forest Woodlands	6.36			25.40		
Forest Woodlands	13,844.01			9,499.50		
SUB TOTAL	**116,927.60**			**433,541.26**		
Moist evergreen forest	21.50			18.64		
Moist evergreen forest	11.75			10.18		
Moist evergreen forest	0.08			0.07		
Moist evergreen forest	1.66			1.44		
SUB TOTAL	**226,602.58**			**827,298.27**		
Other Land	12,626.32			13,733.32		
Other Land	10,827.09			11,776.35		
Other Land	35.31			38.41		
Other Land	2.08			2.26		
Other Land	4,526.71			4,923.58		
SUB TOTAL	**481,221.76**			**1,685,069.68**		
Other Wooded land	19,619.27			24,646.78		

Other Wooded land	16,823.57	21,134.67
Other Wooded land	54.87	68.93
Other Wooded land	3.23	4.06
Other Wooded land	7,033.77	8,836.21
SUB TOTAL	**1,003,595.34**	**3,422,238.20**
TOTAL AREA DISTURBED (BURNT)	**1,013,520.94**	**3,464,865.20**
TOTAL LAND AREA	**1,161,184.23**	**1,161,184.23**
% DISTURBANCES BY FIRE	**87.3**	**298.4**

Provided in Table 17 are GHG emissions and removals for Serenje by gas from forest land, crop land, settlements and rice cultivation.

Table 17: GHG emissions by for Serenje District for 1995 and 2015

	1995			**2015**			**Total 1995 (Gg)**	**Total 2015 (Gg)**	**Total 1995 (tons)**	**Total 2015 (tons)**
	Emissions (Gg) CO_2 e			Emissions (Gg)						
Total Emissions and Removals	-1371.4329	89.36553	31.565379	-748.894	235.996	94.66889	-1250.5	-418.2292962	-1.251	-0.418
1 - Energy	0	0	0	0	0	0	0	0	0.000	0.000
3 - Agriculture, Forestry, and Other Land Use	-1371.4329	89.36553	31.565379	-748.894	235.996	94.66889	-1250.5	-418.2292962	-1.251	-0.418
3.A - Livestock	0	0	0	0	0	0	0	0	0.000	0.000
3.A.1 - Enteric Fermentation	0	0	0	0	0	0	0	0	0.000	0.000
3.A.2 - Manure Management	0	0	0	0	0	0	0	0	0.000	0.000
3.B - Land	-1371.4329	0	0	-748.894	0	0	-1371.43	-748.8941805	-1.371	-0.749

3.B.1 - Forest land	-1373.2695	0	0	-750.731	0	0	-1373.27	-750.7307405	-1.373	-0.751
3.B.2 - Cropland	0.89848	0	0	0.89848	0	0	0.89848	0.89848	0.001	0.001
3.B.3 - Grassland	0	0	0	0	0	0	0	0	0.000	0.000
3.B.4 - Wetlands	0	0	0	0	0	0	0	0	0.000	0.000
3.B.5 - Settlements	0.93808	0	0	0.93808	0	0	0.93808	0.93808	0.001	0.001
3.B.6 - Other Land	0	0	0	0	0	0	0	0	0.000	0.000
3.C - Aggregate sources and non-CO2 emissions sources on land	0	89.36553	31.565379	0	235.996	94.66889	120.9309	330.6648843	0.121	0.331
3.C.1 - Emissions from biomass burning	0	72.997072	31.565379	0	219.0668	94.66889	104.5625	313.7356747	0.105	0.314
3.C.2 - Liming	0	0	0	0	0	0	0	0	0.000	0.000
3.C.3 - Urea application	0	0	0	0	0	0	0	0	0.000	0.000
3.C.4 - Direct N2O Emissions from managed soils	0	0	0	0	0	0	0	0	0.000	0.000
3.C.5 - Indirect N2O Emissions from managed soils	0	0	0	0	0	0	0	0	0.000	0.000
3.C.6 - Indirect N2O Emissions from manure management	0	0	0	0	0	0	0	0	0.000	0.000
3.C.7 - Rice cultivations	0	16.368458	0	0	16.92921	0	16.36846	16.92920961	0.016	0.017
3.C.8 - Other (please specify)	0	0	0	0	0	0	0	0	0.000	0.000
3.D - Other	0	0	0	0	0	0	0	0	0.000	0.000
3.D.1 - Harvested Wood Products	0	0	0	0	0	0	0	0	0.000	0.000

3.D.2 - Other (please specify)	0	0	0	0	0	0	0	0	0.000	0.000

Provided in Table 18 are GHG emissions from commercial wood and fuelwood removals from different forest classes. In 1995, the highest GHG removals (sink) occurred in Forest Woodland with -1212.9 Gg $CO_{2\ eq}$. followed by Other Woodland at -616.3 Gg $CO_{2\ eq}$. The least GHG removals occurred in Pine Plantations at -0.1 Gg $CO_{2\ eq}$. In 1995, the highest GHG emissions occurred in Forest Woodland amounting to 523.1 Gg $CO_{2\ eq}$., with 515.7 Gg $CO_{2\ eq}$. from fuel wood and 7.4 Gg $CO_{2\ eq}$. from timber logging. The least emissions occurred in Moist Evergreen Forest amounting to 4.2 Gg $CO_{2\ eq}$., with 4.1 Gg $CO_{2\ eq}$. from fuel wood and 0.1 Gg $CO_{2\ eq}$. from timber logging.

Table 18: GHG emissions and removals from different forest classes

	1995			**2015**		
Subcategories for reporting year	Annual emissions removals (Gg CO_2)	Emissions from commercial wood removals(Gg CO_2)	Emissions from fuel wood removals(Gg CO_2)	Annual emissions removals (Gg CO_2)	Emissions from commercial wood removals (Gg CO_2)	Emissions from fuel wood removals (Gg CO_2)
Dry evergreen	-96.2	0.3	19.5	-83.2	0.6	33.4
Eucalyptus	-0.5	0.1	4.4	-0.1	0.2	9.5
Forest woodland	-1212.9	7.4	515.7	-1064.7	15.3	883.1
Moist Evergreen	-235.4	0.1	4.1	-204.0	0.1	7.0
Other woodland	-616.3	2.0	138.6	-774.2	4.3	246.7
Pine Plantation	-0.1	1.4	94.5	0.0	3.0	172.3
Total	**-2161.4**	**11.2**	**776.9**	**-2126.1**	**23.5**	**1351.9**

Total GHG emissions Removals (Sinks) in Serenje reduced from 2161.4 Gg $CO_{2\ eq}$ in 1995 to 2126.1 Gg $CO_{2\ eq}$ in 2015. Total emissions increased by 87.5% from 910.9 Gg $CO_{2\ eq}$. in 1995 to 1707.9 Gg $CO_{2\ eq}$ in 2015. Net sink for Serenje reduced by 66.6% from -1250.5 Gg $CO_{2\ eq}$ in 1995 to -418.2 Gg $CO_{2\ eq}$ in 2015 (Table 19)

Table 19: Total GHG emissions and removals

Year	Annual emissions removals (Gg CO_2)	Total Emissions Gg CO_2 eq.)	Net Emissions (Gg CO_2 eq.)
1995	-2161.4	910.9	-1250.5
2015	-2126.1	1707.9	-418.2

Projected GHG emissions are provided in Table 20. The projections were made based on historical rates of increase in land-use change and wood removals.

Table 20: GHG emissions projection for Serenje District

Year	Annual emissions removals (million tonnes CO2 eq.)	Total Emissions (million tonnes CO2 eq.)	Net Emissions (million tonnes CO2 eq.)
1995	-2161.4	910.9	-1250.5
2015	-2126.1	1707.9	-418.2
2020	-2117.5	2115.7	-353.1
2025	-2108.9	2620.8	-298.1
2030	-2100.3	3246.6	-251.7
2035	-2091.7	4021.7	-212.5
2040	-2083.2	4982.0	-179.5
2045	-2074.8	6171.5	-151.5
2050	-2066.3	7645.0	-127.9

The project involved establishment of alternate coupe and shelterbelt strip system (ACOSSS) to promote sustainable forest wood harvesting for charcoal production. A total of 10,000 hectares would be demarcated into 5,000 hectare for coupe strips and 5,000 hectares for shelterbelt strips.

The business model would entail formation of 5 Cooperatives to occupy 200 hectares per strip. Once the first coupe strip is exhausted, the 5 Cooperatives will move to the next coupe strip until last coupe strip system is reached within the period of five years, After which the Cooperatives will return to the first alternate shelterbelt strip until the last shelterbelt strip is reached within the period of five years. Each Cooperative will have 2 Adam Retorts with a higher recovery efficiency and will produce 2285 tonnes of charcoal per year totalling 22, 850 tonnes per year.

2.3.2 I- JEDI results for Forest enhancement and natural regeneration

Jobs and economic impacts of investing and operating activities in forest enhancement and natural regeneration were assessed using the IJEDI and the results are presented in Table 21.

Table 21: Jobs and economic impacts for forest enhancement and natural regeneration implementation

	Single year	On-going
Number of jobs	84	-1
Earnings	$276,046	-$198,956
GDP	$1,213,546	-$198,956
Output	$3,373,457	-$2,523,579

Implementation of the project and activities under this project would result in 84 jobs in the implementation year. The earnings would be US$276,046; GDP US$1,213,546 and an output amounting to US$3,373,457. During the on-going phase, expenditure changes would be negative. The number of jobs according to Table 21 would be -1; earnings would be US$ (-198,956); GDP US$ (-198,956); and output US$ (-2,523,579). A breakdown of the sector jobs which account for the total is shown in Table 22

Table 22: Sector jobs breakdown

Sector	Single year	On-going
Agriculture	39	-27
Construction	1	-1
Manufacturing	4	-10
Sales and repair services	25	53
Transportation	2	-2
Information	1	0
Finance, Professional, and Business Services	5	-5
Education and Health Care	5	-7
Other	2	-2
Total	**84**	**-1**

The earnings realized were based on the economic activities in the different sectors.

According to the results in Table 22, 84 total jobs would be created in a single year. Once the project is in full operation, there would be more negative than positive jobs created giving a negative total of one (1) job. The sales and repair services sector is the only sector which shows a positive number.

2.3.3 Barriers and barrier removal strategy for implementing the projects

The barriers identified by the technical working group included policy and regulatory, institutional, financial, technical, social and cultural and market.

The TWG indicated that the country had adequate policies to support the implementation of the proposed projects but there were some gaps in the regulatory framework which needed to be addressed for the success of the project. The TWG highlighted the need for harmonization of the regulatory frameworks across sectors.

It was proposed that financing mechanisms and incentives be formally put in place to aid success of the project. The TWG proposed provision of subsidies, loans or grants which would encourage acquisition of the necessary technologies. Technical assistance would be required as the design and installation of the technology was still new.

It was also noted that target groups tended to prefer keeping the old and “inefficient” technologies over new ones due to social and cultural attachments. However a cultural shift through awareness creation, demonstration and illustration/explaining of benefits was required. It was also proposed that a market and distribution chain be formally defined for the purpose of extending the effects of the implementation.

The barriers and barrier removal strategies are summarized in Figure 7.

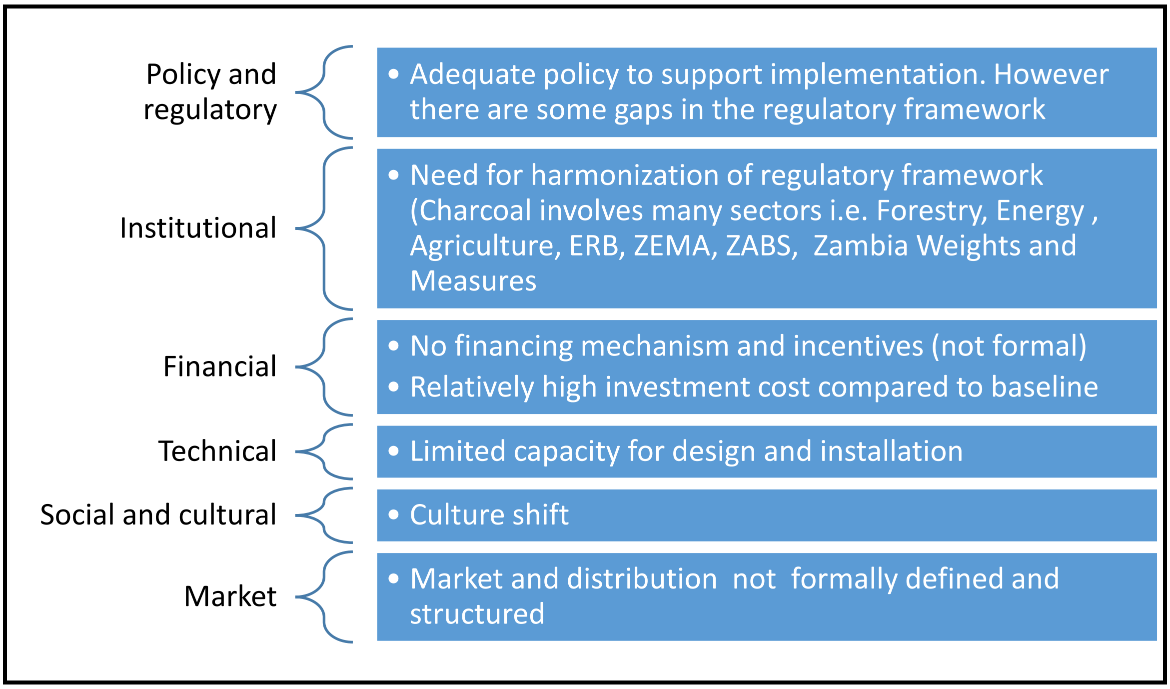


Figure 7: Barrier and barrier removal strategy for implementing the forest enhancement and natural regeneration

2.3.4 Socio-economic impacts assessment using DIA

The project on forest enhancement and natural regeneration will have some positive and negative impacts when implemented. These have been highlighted in Table 23.

Table 23: Socio-economic impacts of implementing the forest enhancement and natural regeneration project

Development objective	Impact
Health	There will be a negative impact on health as charcoal

	producers will still be exposed to emissions during charcoal production
Education	There will be more time for children and young women to go to school and better incomes to support education
Gender equality	Reduced labour intensity leading balanced gender participation: This means women would be encouraged to take up charcoal production as an income generating activity because of reduced labour needs
Climate	a) Reduced GHG emission and precursors b) Rehabilitation of catchment leading to improvement in local climatic condition and improving hydrological cycle c) reduced soil erosion and river siltation in rivers d) availability of forest products e) reduced land use change (deforestation)

2.4 INTER-AGENCY POLICY TASKFORCES

The technical component of the project was performed by the LEDS Modelling Technical Working Group which was a sub-committee of the Technical Committee on Climate Change in the country (See figure 8). The results of the project were then reported to higher level policy makers at Steering Committee and Council of Ministers as provided for in the Zambia National Policy on Climate Change of 2016 (see figure 9).

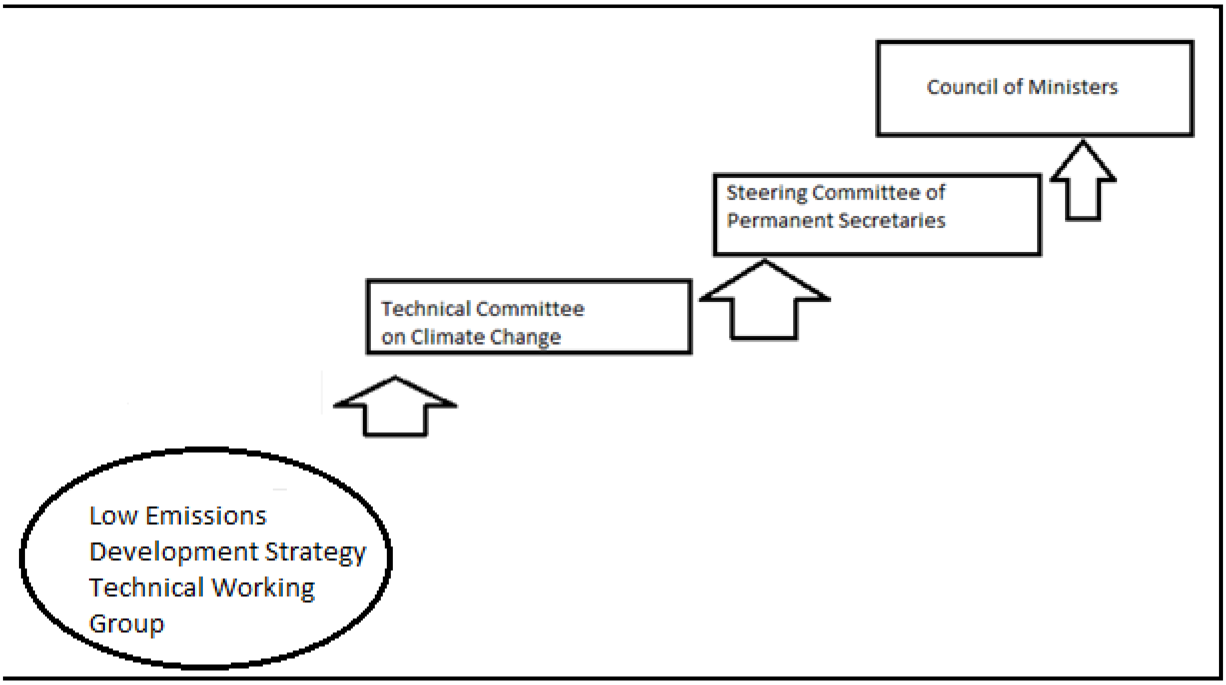


Figure 8: LEDS modeling structure at project level

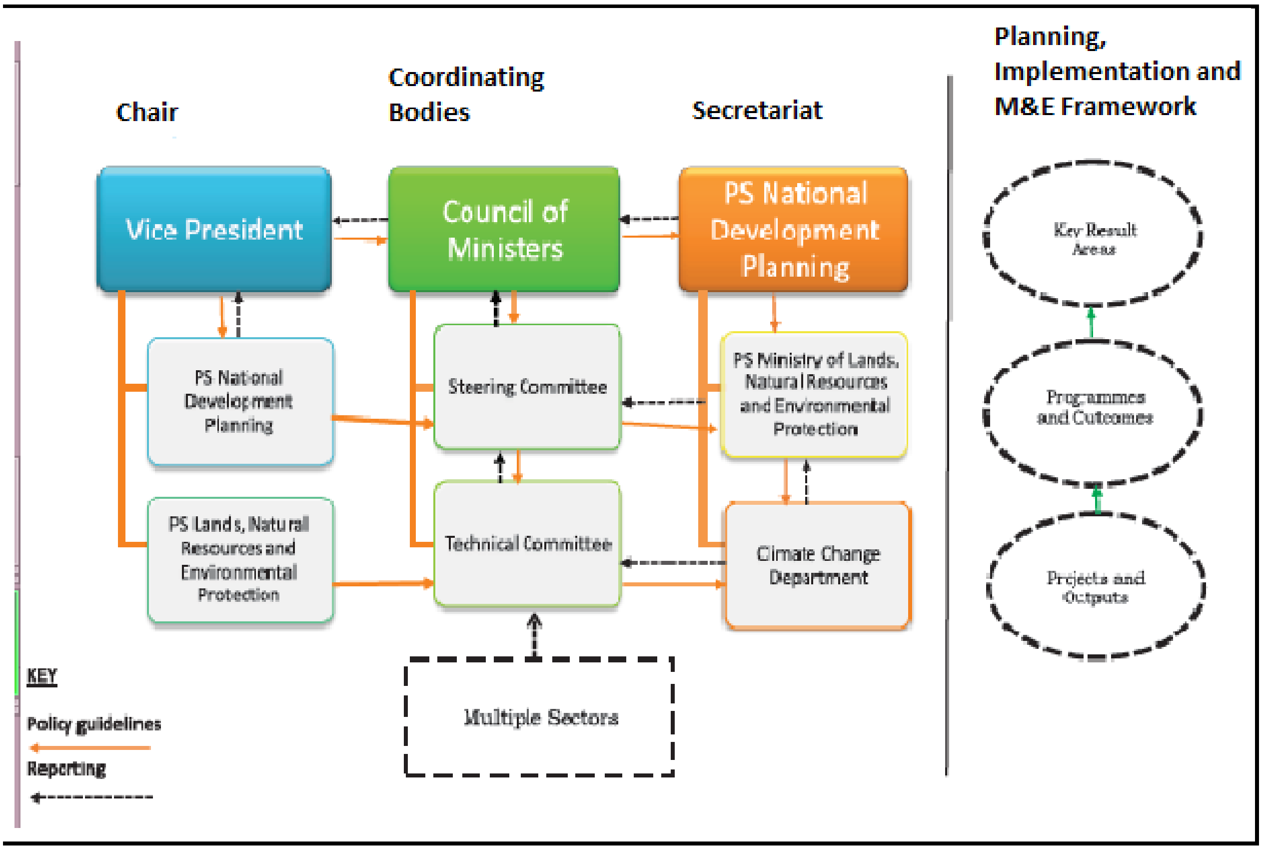


Figure 9: Institutional arrangement for the coordination of climate change action in Zambia

2.4.1 Council of Ministers (CoM)

The Council of Ministers is the supreme decision-making body for overseeing Climate Change interventions in the country. It is composed of Ministers from various sectors tackling issues of climate change including the Minister responsible for National Development Planning and is chaired by the Vice President. However, any other Minister may be co-opted to the Council when need arises. Among various responsibilities of the CoM is the provision of policy guidance to facilitate the mainstreaming and integration of climate change activities in National Development Plans, Sector Policies and Plans including private sector and non-state actors' strategic plans.

2.4.2 Steering Committee of Permanent Secretaries

The Steering Committee is the main advisory body to the Council of Ministers on policy and programme coordination and implementation. The Steering Committee of Permanent Secretaries is chaired by the Permanent Secretary in the Ministry responsible for National Development Planning. The Permanent Secretary from the Ministry responsible for Natural

Resources is the secretariat to the Steering Committee. Among various responsibilities of the Steering Committee is overseeing the development and review of appropriate policies, and legislation to facilitate the implementation of the National Policy on Climate Change as guided by the Council of Ministers in consultation with other stakeholders. The composition of the steering Committee includes Permanent Secretaries from the ministries responsible for:

i. National Development Planning
ii. Local Government
iii. Health
iv. Energy
v. Agriculture
vi. Environment
vii. Natural Resources
viii. Communications
ix. Minerals Development
x. Information and Broadcasting
xi. Works and Supply
xii. Home Affairs
xiii. Disaster Management and Mitigation
xiv. Gender
xv. Transport and Communication

2.4.3 Technical Committee on Climate Change

The Technical Committee comprises representatives from relevant Ministries and other key stakeholders including private sector and civil society organizations. The Technical Committee is chaired by the Permanent Secretary from the Ministry responsible for Natural Resources. Its main responsibility is the development and reviewing, in consultation with other stakeholders, appropriate policies, and legislation to facilitate the implementation of the National Policy on Climate Change

2.4.4 LEDS Modelling Technical Working Group (TWG)

The technical team from various sectors relevant to the LEDS modelling project was constituted to provide technical know-how in the execution of the project objectives (see plate 2). The TWG was officially appointed by the Ministry of Lands and Natural Resources to be working on this project and became a sub-committee of the Technical Committee on Climate Change for the purpose of the LEDS project.

Plate 2: LEDS TWG-Zambia

3. CONCLUSION AND WAY FORWARD

The choice of tools and models used in the analyses and reporting was based on the data available, performance of the tools and models, and expertise of the TWG.

Implementation of the energy (off-grid) projects will have a number of impacts on the communities where the projects will be situated and also the surrounding areas. The impacts that have been identified in the modelling activities include the creation of jobs, contribution to the earnings, GDP and output for the communities. From the construction of the mini-hydros, 1, 368 jobs will be created and ZMW 44.4m in GDP will be realized. During the O&M phase of the three mini hydro operations, 151.1 jobs and ZWM4m in GDP will be realized.

The implementation of the solar mini grids will result in creation of 257 and 8.6 jobs in the construction and O&M phases, respectively. A total of US$341, 012 and US$7, 239 in GDP will be realized during the construction and O&M phases, respectively. Other impacts will be from the switching of cooking devices. There will be a negligible number of jobs created during the single year of implementation of cook-stoves, but 78 jobs will be created once the project is established (on-going activities). In terms of GDP, a negative impact will be observed during the implementation due to the demand on electricity and efficient firewood stoves, in the amount of US$ (-641). A positive impact will result in the on-going activities with a GDP of US$11, 756,586. The potential socio-economic benefits of switching from firewood use to efficient and electric cook-stoves benefits on health, education, gender equality, climate, food security and increased economic activities. The proposed intervention under the energy (off-grid) will result in a net GHG emission reduction of -85 thousand MT by 2020 and -241 thousand MT by 2030.

Implementation of the sustainable agriculture projects will result in creation of 6,824 jobs; earnings of US$8,272,418; GDP of US$15,863,018; and output of US$22,205,582 in the three districts. The socio-economic impacts assessment for implementing the project identified negative and positive impacts. Land tenure was a negative impact due to the lack of security on tenure, and improved households revenue/income was identified as a positive impact. The assessment of GHG reduction for the project indicates that by 2020 a reduction of 1.11Gg will be realized and about 0.91Gg by 2030.

The forest enhancement and natural regeneration project will result in the creation of 84 jobs in a single year. However the number of jobs in the on-going activities will be negligible. The results of assessing on-going expenditures in this project revealed negative values for the earnings, GDP and output. This is attributed to the fact that there is more creation of jobs in the support sectors which result in negative figures for the sector that the project is targeting. This is however a positive impact in that activities that directly affect the forests will be reduced, e.g. uncontrolled cutting down of trees.

Although Serenje District has been a net sink from 1995 to 2015, the sink is drastically reducing and would require mitigation measures to reduce emissions from firewood, charcoal, biomass burning, land use change from to settlements, land use change from forest to crop land and rice cultivation.

Annex I

List of modelling team (LEDS TWG)

No.	NAME	ORGANIZATION	E-mail	Phone
1	Ephraim M. Shitima	MLNR-CCNRMD	Emshitima40@gmail.com	+260977893961
2	Carol Mwape Zulu	MLNR-CCNRMD	cmwapezulu@gmail.com	+260977603672
3	Beausic M. Chongo	MLNR-CCNRMD	beausique@gmail.com	+260966839552
4	Sylvester Siame	MLNR-CCNRMD	slysiame@yahoo.co.uk	+260978074991
5	Abel M. Siampale	MLNR-FORESTRY DEPARTMENT	a.m.siampale@gmail.com abelsiampale2015@gmail.com	+260976311415
6	Keddy Mbindo	MLNR - FORESTRY DEPARTMENT	kdfolks@yahoo.co.uk	+260977225119
7	Hartley Walimwipi	MLNR - NDC	hartleykabunda@yahoo.co.uk	+260977797906
8	Prof. Francis Yamba	CEEEZ	ceeez2015@gmail.com	+260977856167
9	Francis Mwila	CEEEZ	francismwila85@gmail.com	+260968400232
10	Nancy Serenje Ngo’ma	CEEEZ	nserenje13@gmail.com	+260979434983
11	Dr. Bernard Tembo	ZIPAR	btembo@zipar.org.zm	+260953425397
13	Tamara Bilima	ZIPAR	tbillima@zipar.org.zm tbillima@gmail.com	+260977175793
14	Dr. Kalaluka Munyinda	UNZA	kalalukamunyinda@yahoo.com	+260978270898
15	Elijah Chibwe	MOE	chibwelijah@gmail.com	+260975887443
16	Musadabwe Chulu	MOA	Musadabwe.chulu@agriculture.gov.zm	
17	Annel Phiri	ZEMA	aphiri@zema.org.zm	
18	Michael Phiri	NRSC		
19	Richard Lungu	EMD	mfumurichard@yahoo.co.uk	
20	Oliver Mudenda	ZMD	olivermudenda1@gmail.com	+260972254641