



**CEEEZ**



Centre for  
Energy, Environment and  
Engineering Zambia Limited

# ZAMBIA

## TECHNOLOGY NEEDS ASSESSMENT AND TECHNOLOGY ACTION PLANS FOR CLIMATE CHANGE MITIGATION

### PART III: TECHNOLOGY ACTION PLANS

**March.2013**



**Supported by:**



## Disclaimer

This document is an output of the Technology Needs Assessment project, funded by the Global Environment Facility (GEF) and implemented by the United Nations Environment Programme (UNEP) and the UNEP Risoe Centre (URC) in collaboration with the Regional Centre (from the corresponding region), for the benefit of the participating countries. The present report is the output of a fully country-led process and the views and information contained herein are a product of the National TNA team, led by the Ministry of Lands, Natural Resources and Environmental Protection.

## Foreword

As a non-Annex I country to the UNFCCC, Zambia is not subject to binding greenhouse gas emission reduction commitments under the Kyoto Protocol. Our contribution to global greenhouse gas emissions is small in the energy sector but relatively high under agriculture and land use and forestry. Although not bound compulsory, as a country, vulnerable country to the impacts of climate change, Zambia takes its responsibilities seriously and it will continue to do its part in the global efforts to address climate change.

Climate variability and change has become major threats to sustainable development in Zambia. Evidence suggests that the country is already experiencing climate –induced hazards such as droughts, floods and extreme temperatures. Without urgent and coordinated action, climate change and related disasters could negate decades of development progress and undermine the efforts to attain MDGs which may eventually result in failure to sustain Zambia’s recently attained low-medium income country status.

Zambia has had some success in mainstreaming climate change in its Sixth National Development Plan and in developing National Programme of Action (NAPA). Zambia has also developed a draft National Climate Change Response Strategy (NCCRS) focusing on capacity development for mainstreaming climate change into policies and programmes. However, most of the projects identified have not been implemented due to scarcity of detailed information and bankable proposals.

The Technology Needs Assessment initiative and its objectives of “(i) identifying and prioritizing through country-driven participatory processes, technologies that can contribute to mitigation and adaptation goals of the participant countries, while meeting their national sustainable development goals and priorities, (ii) identifying barriers hindering the acquisition, deployment, and diffusion of prioritized technologies, (iii) developing technology action plans (TAP) specifying activities and enabling frameworks to overcome the barriers and facilitating the transfer, adoption, and diffusion of selected technologies in the participant countries, and present project ideas”, has resulted in the development of concrete detailed action plans that can help decision makers to identify, create, and expand adaptation technologies and market for identified mitigation technologies.

This Technology Needs Assessment project considered several adaptation technologies related to water and agriculture, some of the most vulnerable sectors in Zambia, and developed concrete action plans to increase the resilience of these sectors in facing the expected adverse effects of climate change. Additionally, the TNA report has developed mitigation option in energy supply, energy efficiency, sustainable charcoal production and sustainable agriculture. The project ideas developed will serve as an input into development of bankable proposal for financing from various climate related funding under the UNFCCC and other bilateral and multilateral arrangement.

**Minister of Lands, Natural Resources and Environmental Protection**

## **ACKNOWLEDGEMENTS**

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We would also like to express our gratitude and appreciation to the contributors of this report, participants of consultation meetings, experts assisting in document reviews, and input guidance from related projects draft Second National Communication, draft National Climate Change Response Strategy, Sixth National Development Plan, in addition to academic institutions, and private companies, whose proactive participation was fundamental to the completion of the Technology Needs Assessment report.

Last but not least, we would like to thank the main authors of these report, Prof F D. Yamba and Dr. D Chiwele for their professionalism, friendship and patience throughout the project process.

The TNA Project Team(Mitigation and Adaptation).

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## ABBREVIATIONS

BAZ	Biofuels Association of Zambia
CBA	Cost Benefit Analysis
CDM	Clean Development Mechanism
CEEEZ	Centre for Energy, Environment and Engineering Zambia Ltd
CFL	Compact Fluorescent Lights
CH <sub>4</sub>	Methane
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CSP	Concentrated Solar Power
DOE	Department of Energy
EE	Energy Efficiency
ERB	Energy Regulation Board
FD	Forest Department
FNDP	Fifth National Development Plan
GART	Golden Valley Research Institute
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse gas
HFCs	Hydrofluorocarbons
IRR	Internal Rate of Return
LFA	Logical Framework Analysis
MDG	Millenium Development Goals
MCA	Multi-Criteria Analysis
MFI	Micro Financial Institution
MLNREP	Ministry of Lands, Natural Resource and Environmental Protection
NAMA	Nationally Mitigation Actions
N <sub>2</sub> O	Nitrous Oxide
NGO	Non Governmental Organisation
NMVOG	Non Methane Volatile Organic Compounds
NO	Nitrogen Oxide
NPV	Net Present Value
PV	Photo voltaic
R&D	Research and Development
RTSA	Road Transport and Safety Agency
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SNC	Second National Communication
SNDP	Sixth National Development Plan
SO <sub>2</sub>	Sulphur Dioxide
TAP	Technology Action Plan
TFS	Technology Factsheet
TNA	Technology Needs Assessment
UNCED	UN Conference on Environment and Development
UNEP DTIE	UNEP Division of Technology, Industry and Economics
UNFCCC	United Nations Framework Convention on Climate Change
URC	UNEP Risoe Centre
UNZA	University of Zambia

WCED	World Commission on Environment and Development
ZARI	Zambia Agriculture Research Institute
ZACCI	Zambia Chamber of Commerce and Industry
ZEMA	Zambia Environmental Management Agency
ZENGO	Zambia Environment and Energy Organization (ZENGO)
ZNFU	Zambia National Farmers Union

## Executive Summary

Part II of this report identified policy, institutional, technical, financial and other barriers inhibiting the acquisition, deployment, and diffusion of prioritized technologies namely: (i) geothermal for electricity generation, (ii) biomass gasifier for off-grid electricity generation, (iii) energy efficiency and management systems, (iv) sustainable charcoal value chain, (v) biofuels development - biodiesel, (vi) sustainable agriculture. Part II also specified measures and activities, and enabling framework to overcome barriers identified. Part III follows up these activities and develops Technology Action Plans (TAPs).

The technology actions prioritized are in line with the SNDP vision, goal and strategic focus on renewable energy, natural resources and agriculture. Actions (i), (ii), (iii) are energy based and the strategic focus stipulates Government commitment to continue putting in place appropriate measures to promote the role of renewable resources in the energy mix. Action (v) is also energy based and falls on the strategic focus of biofuels development. Action (iv) on sustainable charcoal value chain falls under the SNDP strategic focus of promoting sustainable forest and land management practices under natural resources. Action (vi) falls under promotion of soils management for sustainable agriculture.

## 1.0 Background

Part II of this report identified policy, institutional, technical, financial and other barriers inhibiting the acquisition, deployment, and diffusion of prioritized technologies namely: (i) geothermal for electricity generation, (ii) biomass gasifier for off-grid electricity generation, (iii) energy efficiency and management systems, (iv) sustainable charcoal value chain, (v) biofuels development - biodiesel, (vi) sustainable agriculture. Part II also specified measures and activities, and enabling framework to overcome barriers identified. Part III follows up these activities and develops Technology Action Plans (TAPs)

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## 2.0 Methodology

The TAPs were developed based on the logical framework analysis. Logical Framework Analysis (LFA) is used in the design, monitoring and evaluation of development projects. LFA describes different types of events that take place as a project is being formulated and implemented, strategic objectives and strategies, project activities and outputs, means of verification, responsible actors, timeframe and estimated budget.

## 3.0 TECHNOLOGY ACTION PLANS FOR PRIORITIZED TECHNOLOGY

### 3.1 Geothermal for Electricity Generation

Geothermal energy is thermal energy generated and stored in the earth. This energy can be used to generate electricity using technologies such as dry steam power plants, flash steam power plants and binary cycle power plants.

Geothermal uses no fuel, and is therefore immune to fuel cost fluctuations. Geothermal electricity production has been successfully developed in regions with hydrothermal manifestations (e.g., geysers and hot springs). For example the rift valley where Kenya is currently producing electricity around 250 MW. Zambia lies in the rift valley and has similar manifestations like Kenya and therefore has good potential which warrants serious investigations. Geothermal power is a stable source of energy as it is independent of weather circumstances. It is therefore a reliable source of energy and commonly has a high capacity factor of between 70 and 90% of installed capacity, which makes it applicable for both base and peak load. Geothermal power production has the environmental benefit of being a relatively clean. The contribution to greenhouse gas emission reduction from geothermal

The SNDP recognizes that dependence on hydro electricity alone, currently standing at 99.0%, is risky since hydro power is vulnerable to climate change and associated hazard, and hence the need to formulate mitigation measures through diversification of the energy mix such as geothermal energy. The target for diffusion of geothermal technology aims at developing a framework to support exploration and development of geothermal, and development of 20MW geothermal plant for electricity generation. Installation for such a plant will contribute to avoidance of 140, 000 tonnes of GHG emissions per annum using the SAPP interconnected system as a baseline.

Strategic Objective	Deployment of geothermal for electricity generation				
Strategies	Output		Responsibility	Timeframe	Budget(Estimated Budget)US\$
	Objective verifiable activity	Means of verification	Key actors		
Development of framework for	Devise framework and mechanism for provision of financing to support	Financing to support exploration phase identified	DOE, REA, ZDA, private sector, Bilateral and	24 months	50,000

provision of financing for geothermal exploration	completion of exploration works to include: Identification, hydrochemistry, geophysics, interpretation and exploration.		Multilateral organizations		
	Provide the same as above to support pre-production drilling at identified promising sites.	Pre-production drilling of identified site completed.			
Capacity development on specialized skills on geothermal exploration and development.	Develop capacity in identification, hydrochemistry, geophysics, remote sensing and interpretation of results for geothermal exploration and development for future works	Capacity developed in exploration techniques for participation in future works	DoE, Geological department, NISIR, UNZA, private sector	36 months	200,000
	Develop capacity in exploration, pre-production and production wells drilling specific for geothermal development	Capacity developed in drilling for exploration, pre-production and production wells development.			
Formulation of support policies through provision of fiscal incentives and public finance.	Undertake a study to develop a portfolio of support policies (grants, rebates, tax credit, equity investment and feed in tariff) to leverage relatively higher tariffs from geothermal electricity production	A range of support policies to leverage relatively higher tariffs from geothermal electricity production developed	Ministry of Mines, Energy and Water Development, Ministry of Finance, ZDA, consultants and stakeholders	12 months	50,000
	Consultations with stakeholders aimed at selecting appropriate and suitable support policies for geothermal exploration and development.	Appropriate and suitable support policies selected for implementation			
Establishment of appropriate legal and regulatory framework for geothermal exploration and development.	Undertake a study for establishing Institutional framework for supervision and financing of geothermal exploratory activities.	Institutional framework for supervision and financing of geothermal exploratory activities recommended	Ministry of Mines, Energy and Water Development, Geological department, UNZA, private sector	12 months	50,000
	Consultations with stakeholders for establishing a suitable institutional arrangement for supervision and financing of geothermal exploratory activities.	Institutional framework for supervision and financing of geothermal exploratory activities agreed upon for implementation			

Various actors will have different roles in relation to the strategic objectives and related activities requiring attention

### 3.2 Biomass Gasifier

Biomass gasification for off grid applications involves production of gaseous fuel called producer gas used in a gas engines and modified gasoline and diesel internal combustion engines for electricity generation. Producer gas can also be used to produce steam which is then expanded on a steam reciprocating internal engines to produce electricity. Besides providing electricity to isolated areas in rural areas, it has the additional benefit of creating employment for the feedstock providers who are mostly small and medium scale farmers and foresters.

The vision for REA is “Electricity for all Rural Areas by the year 2030.” To achieve this target the SNDP stipulates that the Rural Electrification Master Plan (REMP) will continue to be implemented and will utilize other technologies including renewable energies for isolated min grids . The target for diffusion of biomass gasifier technology involves dissemination of the technology of at least 20 sites with an estimated capacity ranging from 100 to 1000 kW per site. Implementation of such a program will lead to avoidance of 70,000CO<sub>2</sub>equiv. Other benefits will include creation of employment for the rural folk in the provision of the biomass feedstock to the gasifier plants.

Strategic Objective	Deployment of biomass gasifier for off grid electricity generation				
Strategies	Output	Responsibility	Timeframe	Budget(Estimated Budget)US\$	
	Objective verifiable activity	Means of verification			
Create awareness and information program for small scale project developers and entrepreneurs for biomass gasifier	Provide information on markets, technology and feedstock characteristics	Information on markets, technology and feedstock characteristics prepared	DOE, REA, ZDA, Consultants	12 months	20,000
	Create awareness on off-grid business opportunities for small scale project developers and entrepreneurs and financial institutions	Information on off grid business opportunities for small scale project developers and entrepreneurs and financial institutions prepared and disseminated.			
Techno-economic assessment of off-grid systems.	Undertake techno-economic assessment aimed at ascertaining viability of biomass gasifier for off grid applications	Techno-economic assessment undertaken	DOE, REA, ZDA, Consultants, Project developers	12 months	30,000
	Ascertain cost effectiveness and comparison with cost of on-grid extension.	Cost effectiveness and comparison with cost of on-grid extension ascertained.			

Resource assessment and logistics.	Undertake a study on resource assessment and logistics at promising sites to include their suitability for use in biomass gasifiers for electricity generation.	Resource assessment and logistics undertaken	DOE, REA, ZDA, Consultants, Private sector	12 months	20,000
	Select feedstock suitable for biomass gasifier operations and identify suitable locations influenced by demand.	Feedstock suitable for biomass gasifier selected and suitable locations identified to feed into implementation plan			
Implementation program and support policies for biomass gasifier.	Develop implementation program for biomass gasifier dissemination identified locations	Implementation program developed	DOE, REA, ZDA, Consultants, Private sector, Financial institutions	12 months	50,000
	Provides support policies in terms of incentives and public finance for off-grid systems to leverage tariff	Support policies in terms of incentives and public finance provided.			
	Recommend business model for implementation of biomass gasifier for electricity generation dissemination.	Business model recommended			
	Develop the project for biomass gasifier to meet the criteria of eligibility, baseline setting and MRV to benefit from carbon financing through CDM/PoA/NAMA/SE4ALL/LEDS	Project for biomass gasifier developed to benefit from CDM/PoA/NAMA/SE4ALL/LEDS			

Various actors will have different roles in relation to the strategic objectives and related activities requiring attention

### 3.3 Energy Management – Energy Efficiency

This measure involves introduction of energy efficiency and management tools aimed at improving energy use in industrial, commercial/services and household. Under industry, technologies include on site electricity generation, energy system optimisation and energy management standards. This measure is relatively low cost and contributes to reduced cost and hence enhanced competitiveness of affected industrial concerns in addition to reduction of GHG emissions. Under commercial/ services, the technologies include air conditioning efficiency, load control measures, and ripple control technologies. Under household use, the measures include use of Compact Fluorescent Lights (CFL) or Light Emitting Diodes lights (LEDs) and solar water heater (for domestic and commercial entities). All these measures contribute to reduction in electrical energy demand and avoids premature investments in energy supply in addition to reducing GHG emissions and air pollution

The SNDP strategic goal and focus on Energy Efficiency and Management stipulates development and implementation of Energy Efficiency Strategy with the main objectives of ensuring major industrial sectors public institutions and households bring their energy intensities in line internationally acceptable standards and best practice. The target of diffusion of Energy Efficiency measures and technologies is to contribute to the implementation of the strategy through reduction of energy use in the electricity sector equivalent 200 MW in the year 2020, and leading to avoidance of 1,400,000Co<sub>2</sub> equiv and saving of US\$85million by the industrial, commercial and household sectors

Strategic Objective	Deployment of energy efficiency and management				
Strategies	Output		Responsibility	Timeframe	Budget(Estimated Budget)
	Objective verifiable activity	Means of verification	Key actors		
Creating awareness and information program for industrial and commercial entities and municipalities	Develop awareness and information program on EF opportunities and benefits, technology costs, standards for industry, commercial/service entities and municipalities	Awareness and information program on EF opportunities developed.	DOE, Ministry of Commerce, Trade and Industries, ZACCI and ZAM, Bureau of Standards, Zesco, Financial institutions	36 months	100,000
	Disseminate awareness and information program on EF opportunities and benefits, technology costs, standards for industry, commercial/services entities and municipalities	Financing mechanisms for industrial and commercial entities and municipalities disseminated			
Introduction of energy management program to industrial and commercial entities and municipalities	Develop baseline settings on energy consumption and associated GHG emissions for base year 2010 and projections up to for industry, commercial/services entities and municipalities	Baseline energy consumption determined for industry, commercial/services entities and municipalities	DOE, Ministry of Commerce, Trade and Industries, ZACCI and ZAM, Bureau of Standards, Zesco, Financial institutions	36 months	300 000
	Identify EF opportunities, services and market for industry, commercial/services entities and municipalities	Opportunities, services and market for industry, commercial/services entities and municipalities identified			
	Identify and select EF measures and portfolio of technologies for reducing energy consumptions and	EF measures and portfolio of technologies for reducing energy consumptions and GHG emissions for industry, commercial/services			

	GHG emissions for industry, commercial/services entities and municipalities	entities and municipalities identified			
	Determine investment costs and operations and maintenance costs for measures and technologies identified for implementation for baseline and projected up to 2020	Investment costs and operations and maintenance costs for measures and technologies identified for implementation for baseline and projected up to 2020 determined			
	Undertake financial analysis of selected measures and technologies to ascertain viability	Viability of measures and technologies verified			
	Assess/review financing including carbon financing and investment requirements for implementation of selected measures and technologies	Financing including carbon financing and investment requirements assessed and determined			
	Develop the projects for EF to meet the criteria of eligibility, baseline setting and MRV to benefit from carbon financing through CDM/PoA/NAMA/SE4ALL/LEDS	Projects for EF developed to benefit from CDM/PoA/ NAMA/SE4ALL/LEDS			
Provision of financial mechanisms and incentives	Provide financial mechanisms and incentives for implementation of selected measures and technologies	Financial mechanisms and incentives implementation of selected measures and technologies introduced and provided	DOE, Ministry of Commerce, Trade and Industries, ZACCI and ZAM, Bureau of Standards, Zesco, Financial institutions	12 months	50 000
	Provide private equity/venture capital, self financing, debt financing, public funds from international financial institutions, innovative financing (carbon finance)	Private equity/venture capital, self financing, debt financing, public funds from international financial institutions, innovative financing provided.			
Formulation of a national energy efficiency and management policy, strategy,	Develop policy, strategy and action plan to include: fiscal incentives and regulatory tools, vision and mission for EF strategy.	Policy, strategy and action plan to include: fiscal incentives and regulatory tools, vision and mission for EF developed.	DOE, Ministry of Commerce, Trade and Industries, ZACCI and ZAM, Bureau of Standards, Zesco,	6 months	20 000

and action plan	Develop strategic intervention measures, target objectives and activities, action plan, all for implementation of EF program	Strategic intervention measures, target objectives and activities, action plan, all for implementation of EF program developed.	Financial institutions		
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Various actors will have different roles in relation to the strategic objectives and related activities requiring attention

### 3.4 Sustainable Charcoal Utilization and Production

Sustainable charcoal involves both sustainable forest management, and use of efficient improved kilns and stoves. The basic components of sustainable charcoal systems include supply and demand side interventions. Supply side interventions are aimed at managing forest resources for charcoal production to include: (i) agro forestry, (ii) woodlot management, (iii) controlled exploitation of forestry resources, (iv) improved carbonization skills and technologies. Demand side interventions include: promote use of improved cookstoves and briquetting, (ii) create awareness on energy conservation, and encourage use of eco-charcoal concept of certification.

In view of the strong relationship between charcoal utilization through use of cooking stoves and charcoal production and their combined effects on deforestation and forest degradation and associated GHG emissions, the actions on improved charcoal production and improved cooking stoves have been merged and considered in a holistic manner considering the entire sustainable charcoal value chain. The value chain involves the following processes to include; (i) forest resources and production, (ii) harvest conversion, (iii) packaging and harvesting , (iv) transport, (v) marketing , (vi) consumption, (vii)financing

The SNDP strategic objective under natural resources is the promotion of sustainable forest and land management in particular focusing on expanding options for effective forest management. The target of diffusion for sustainable value chains technology is aimed at contributing to the attainment of the strategy above. Once implemented, the measure will go along way to the contribution of reduction of the current deforestation rate estimated between 250,000 to 300,000 hectares per year.

Strategic Objective	Development of a sustainable charcoal value chain framework and implementation				
Strategies	Output		Responsibility	Timeframe	Budget(Estimated Budget)
	Objective verifiable activity	Means of verification	Key actors		
Strengthen forest resources and	Strengthen the Forest Act to include specifically charcoal production	Forest Act strengthened with introduction of specific charcoal production regulation.	FD, Local Government,	12 months	20,000

production legal framework for charcoal production	regulations aimed at specifying forest management plans , wood production systems		Charcoal producers Association, DOE, ZEMA, District Councils, Traditional leadership, civil society		
	Establish a harvesting committees at the local level with the roles to manage charcoal production in accordance with the set rules at that level including monitoring , reporting and verification	Institutional arrangement created at the local level for governance of charcoal production			
Harvest and conversion	Introduce and specify improved charcoal production technologies for use	Improved charcoal production techniques introduced and disseminated.	FD, Local Government, Charcoal producers Association, DOE, ZEMA, District councils, Traditional leadership, civil society	36 months	100,000
	Develop capacity and skills for the operators on construction, operation and maintenance of improved charcoal making production technologies	Capacity and skills developed among charcoal production operators on construction, operation and maintenance of improved charcoal making production technologies			
	Creating awareness and information of benefits of improved charcoal production technologies to various stakeholders(operators )	Awareness and information created for up scaling of use of charcoal production technologies			
Transport	Specify appropriate modes of transport with restrictions and regulations	Specification of modes of transport provided with corresponding restrictions and regulations	Ministry of transport, Transport associations, Charcoal traders, Zambia Police, RTSA	36 months	50,000
	Monitor transport costs in relation to average distances covered and quantities carried.	Transportation costs continuously monitored and serve as input in the end charcoal price			
Marketing	Specify mode of marketing through designation of charcoal marketing sites	Modes of marketing specified	Local authorities and charcoal traders association	12 months	20,000
	Specify proper storage/depot and standards	Storage and standards specified			
Consumption	Introduce and standardize improved cookstoves	Standards on improved stoves formulated and actual stoves disseminated	Bureau of Standards, artisans, R&D community, civil	36 months	500,000



	Create awareness and information of benefits of improved cookstoves.	Awareness s and information among end users created aimed at up scaling dissemination of improved cookstoves	society		
Financing	Develop an innovative financing mechanism through provision of dedicated fund and involvement of micro financial institutions to provide risk capital and development of business model for charcoal producers, transporter and traders	Innovative financing mechanism created for charcoal producers, transporters and traders	Financial institutions, MFIs, philanthropic finances , donor funding and dedicated fund	36 months	500,000
	Develop innovative financing mechanism and Involvement of micro financial institution to provide micro credit. To improved cooking stoves end users	Innovative financing mechanism created for provision for micro credit for end users			

Various actors will have different roles in relation to the strategic objectives and related activities requiring attention

### 3.5 Biodiesel - Biofuels Development

Biodiesel fuel can be produced from oilseed plants such as sunflower, soy beans, and jatropha. Bio Diesel can be used alone or mixed in any ratio with mineral oil diesel fuel. Biofuels production chain is characterized by the cultivation, production, gathering and transport of feedstock, and its conversion to yield biofuels as an energy carrier, distribution and end-use. To arrive at sustainable biofuel production requires (i) assessing what bioenergy technology and feedstock options are available, (ii) identifying suitable areas for production, (iii) assessing impacts to include environmental and natural resources impacts, socio-economic effects, and food security impacts, (iv) develop risk mitigation measures

The SNDP strategic objective for biofuels under energy is to increase the use of biofuels as a substitute to mineral fuels at 10% and 5% for bioethanol and biodiesel, respectively, and to develop a rationale and implementable approach to improve sustainability of biomass supply. The target for diffusion of this technology is formulation of a conducive environment for contributing to biofuels development in Zambia.

Strategic Objective	Formulation of a conducive environment for biofuels development in Zambia				
Strategies	Output		Responsibility	Timeframe	Budget(Estimated Budget)
	Objective verifiable activity	Means of verification	Key actors		
Benchmark pricing, awareness program to financial institutions and specific investment framework	Government through DOE and ERB continue consultations aimed at arriving benchmark pricing for biofuels including biodiesel for ex-factory and pump price	Biofuels bench prices at ex-factory and pump agreed upon	DOE, ERB, BAZ, financial institutions and private sector, ZNFU	12 months	20,000
	Create awareness programme to financial institutions on the benefits to invest in biofuels business	Financial institutions begin to consider and invest in biofuels business			
Study on cost effectiveness of feedstocks for biofuel-biodiesel productions and associated logistics for supply chain	Undertake study on cost effectiveness of biofuels feedstock to include: jatropha, soybeans, sunflower seeds, cotton seeds, palm oils	Cost effectiveness of biodiesel feedstocks determined	DOE, ERB, BAZ, private sector, ZNFU	12 months	20,000
	Make recommendations on viable feedstocks for biodiesel production	Recommendations on viable feedstocks for biodiesel production made.			
Comprehensive legal and regulatory framework	Formulate comprehensive, legal and regulatory framework Development of comprehensive framework taking account of marketing arrangements modalities, dedicated fund to support feedstock and biofuel production, land availability and suitability assessments and sustainable criteria development, and R&D of feedstock optimization	Comprehensive legal and regulatory formulated and implemented	DOE, ERB, BAZ, private sector, ZNFU	12 months	50,000

### 3.6 Sustainable Agriculture

Sustainable agriculture is a widely recognized technology which enhances crop adaptation to climate variability and reduces GHG emissions. Sustainable agriculture has an advantage of increasing the yield without the use of fertilizer and a relatively lower cost. Sustainable agriculture involves 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

One of the SNDP strategic objectives under agriculture is promotion of soil management for sustainable agriculture production through; (i) mainstreaming climate change adaptation and developing mitigation action plan and measures including variability assessment and risk management, (ii) promoting appropriate sustainable conservation measures, (iii) the target for diffusion of the technology is a 5 to 10 year plan aimed at involving small scale farmers switch to sustainable agriculture starting with 1000 hectares in the first year, 3000 hectares in the second year and stabilizing at 5000 hectares. Implementation of such an action will lead to sequestration and reduction of GHG emissions. Other benefits include less use of mineral fertilizers, less runoff, and sustainable use of land.

Strategic Objective	Development of sustainable agriculture				
Strategies	Output		Responsibility	Timeframe	Budget(Estimated Budget)
	Objective verifiable activity	Means of verification	Key actors		
Development resources	Provide development resources for enhanced integrated crop research and conservation technologies training and outreach programs, extension services and working capital for herbicides and insecticides	Resources provided and research results emerge to feed into sustainable agriculture dissemination	Ministry of Agriculture, ZARI, UNZA, ZNFU, GART, bilateral and multilateral institutions , financial institutions	36 months	1,000,000
Appropriate machinery	Provision of appropriate machinery to identified small scale farmers for ease of conservation agriculture application.	Innovative financing mechanism formulated and start supporting small scale farmers identified aimed at scaling up sustainable			

Awareness and information program.	Awareness and information program to highlight the benefits and technologies for sustainable agriculture to	Awareness program formulated and more small scale farmers participate in sustainable agriculture activities			
Projected developed as mitigation option	Develop project as a mitigation option to meet the criteria REDD+, NAMAs	Project developed to meet the criteria of REDD+ and NAMAs to enable small scale farmers under the program benefit from carbon financing			

Various actors will have different roles in relation to the strategic objectives and related activities requiring attention

## LIST OF REFERENCES

NPE, 2007: National Policy on Environment, published by Ministry of Tourism, Environment and Natural Resources

*CEEEZ, 2005: Sustainable development goals and indicators from clean development mechanism (CDM) perspectives*

SNDP, 2010: Sixth National Development Plan for Zambia published by Government Republic of Zambia(2011-2015)

FNDP, 2006: Fifth National Development Plan for Zambia published by Government Republic of Zambia (2006-2010)

Vision, 2006: The Vision 2030 –“A Prosperous Middle-Income Nation by 2030”. Published by Government Republic of Zambia

SNC, 2010: Second National Communication for Zambia

NCCRS, 2010; National Climate Change Response Strategy for Zambia; Government Republic of Zambia

ICE CAP 2010: Laboratory cook stove measurements,

SREEN 2011: IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation

ILUA, 2005: Integrated Land Use Assessment Report

RESAP, 2011: Renewable Energy Strategy and Action Plan

SAPP, 2010: SAPP annual report

Annex I. List of stakeholders involved and their contacts

Group	Technology	Personnel	Institution	E-mail
1	Geothermal Electricity	Ms B Muyunda	Zesco	<a href="mailto:bmuyunda@zesco.co.zm">bmuyunda@zesco.co.zm</a>
	Off- grid	DoE	DoE	
	Energy Management	Dr Kwenda kwema	Lloyds	
		Mr G Kayawe	Ash Field	<a href="mailto:georgekayawe@yahoo.co.uk">georgekayawe@yahoo.co.uk</a> +260976317107
2	Improved cook stoves	Mr Luwaya	UNZA	
	Brick klins	Mr Siakachoma	UNZA	<a href="mailto:csiakachoma@yahoo.com">csiakachoma@yahoo.com</a>
		Mr A Makano	MPMC- Metro	<a href="mailto:abraham.makano@gmail.com">abraham.makano@gmail.com</a>
		DoE	DoE	
3	Sustainable Agriculture	Dr K Muyinda	UNZA	<a href="mailto:kmunyinda@unza.zm">kmunyinda@unza.zm</a> Cell:+260 978270898
	Bio-diesel	Ms Mwangala	Ministry of Agriculture	
		Dr D Chibamba	UNZA	<a href="mailto:doutypaula@yahoo.co.uk">doutypaula@yahoo.co.uk</a>
		DoE	DoE	