THE REVOLUTIONARY GOVERNMENT OF ZANZIBAR

ZANZIBAR PLANNING COMMISSION

PROPOSAL FOR TECHNOLOGY TRANSFER OF CLEAN COOKING ENERGY (BIOETHANOL AND GAS) FOR REDUCTION OF FIREWOOD AND CHARCOAL CONSUMPTION

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EXECUTIVE SUMMARY

This report aims to catalyze the transition transfer from using dirty to clean cooking energy in Zanzibar. Traditional biomass fuels, such as firewood and charcoal are mainly used and contribute to indoor air pollution, deforestation and adverse health effects particularly to the marginalized and vulnerable communities. The objective is to provide strategies and methods to promote the transfer, adoption and utilization of clean cooking fuel (bioethanol and Gas) among the households, communities in Zanzibar aiming at reducing the use of traditional biomass so as to improve household health by reducing indoor air pollution and mitigate environmental degradation. The development of this reports involved reviewing various researches and regulating frameworks related to clean energy followed by data collection to the stove users, community and Managers and operators from Mahonda sugarcane industry. This was done through interview and focused group discussion. The expert opinions were gathered through stakeholders meeting involved the Government and private. The gathered information were processed, analyzed and incorporated in the report. It has found out that, bioethanol has proved to be clean energy and has a potential to protect an environment. It is also cheaper than firewood and charcoal. The Mahonda factory is the only industry current producing Bioethanol fuel. Currently, the industry has a capacity to produce Bioethanol for 15,000 Households how eve it has a potential to produce bioethanol if measures are taken including engagement of outgrowers.

The report illustrates and suggests multi-faceted approaches to achieve the proper usage of bioethanol as a cooking fuel in Zanzibar, including; i. Infrastructure Development such as investment in production facilities , and distribution networks, to ensure reliable access to bioethanol fuel for households and communities in Zanzibar. ii. Stakeholder Engagement such as government agencies, private sector actors, NGOs, and local communities. Iii. Partnerships, collaboration, and knowledge-sharing to promote the adoption of bioethanol clean cooking fuel should be fostered. Iv. Capacity Building: Technical training, skills development, and entrepreneurship support to local communities, farmers, and entrepreneurs involved in bioethanol production, distribution, and utilization in Zanzibar have to be provided. Awareness Campaigns: Public awareness campaigns.

Finally it is recommended that, the Government to create conducive environment for service providers, investors, and business community of clean cooking energy, Review the energy policy and legal frameworks, The Government to provide grants/

subsidy funds to support accessibility of Bioethanol stove and Gas stove of 20 percent of the households using firewood and charcoal. The estimated funds is TZS 3.35 Billions is for subsiding the clean stove by 77 percent for the low income households who uses firewood and charcoal, Increase the capacity of the Mahonda sugar can industry to produce more sugar and bio ethanol, Ministry responsible for industry to mobilize local investors to invest in production processing, bottling and packaging bio ethanol plants and affordable bio ethanol stoves and Ministry responsible for energy, to mobilize Business community to increase distribution of Clean energy especially in urban area.

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CHAPTER ONE

1. Introduction

1.1 Background

Cooking plays a significant role in daily life, serving as an activity that unites families and holds cultural and social importance globally. In many developing nations, households primarily rely on solid fuels such as firewood and charcoal. Similarly, in Zanzibar, both urban and rural households predominantly utilize charcoal and firewood as their main cooking fuels. A cooking fuels consumption survey of 2010 indicated that, 90% of the rural households and 43% of the urban households in Zanzibar depend on firewood for cooking; While the amount of Charcoal consumption was 8% and 52% in the rural and urban households respectively. Very few households, (2.4% in urban and less than 1% in rural) area, used paraffin for cooking. Paraffin were primarily used for lighting. The household firewood and charcoal consumption was gradually decreased from 94.5% in 2014/2015 to 86.5% (52.8% firewood and 34.1% charcoal) in 2019/2020 (HBS2019/2020).

The population and housing Census of 2022 shows that about 46.9% of households use firewood fuel for cooking, 28.9% charcoal, 12.6% gas and 11.4% households use other sources of fuels including electricity. This result conclude that, the Zanzibar, households cooking energy are mainly depend on biomass. The use of biomass (firewood, charcoal) and kerosene results in the emission of high levels of pollutants gases and particulate matter, contributing to both indoor and outdoor air pollution. Gas emissions from biomass fuel usage vary depending on fuel type, combustion efficiency, ventilation, and cooking method. In addition, the use of biomass fuels has many implication to the natural resource associated to forest, whereas Forests and bush lands are major sources of biomass energy in Zanzibar.

The biodiversity priority landscapes and ecosystems of the Zanzibar islands include high forests covering 98,329 hectares (ha), coral rag forests covering 6,119 ha and 20,000 ha of mangroves. The Protected Area (PA) system includes the Jozani-Chwaka Bay National Park (5,000 ha), Kiwengwa-Pongwe Forest Reserve (3,325 ha), Ngezi-Vumawimbi Nature Reserve (2,900 ha), Ras Kiuyu Forest Reserve (270 ha), Masingini Forest Reserve (566 ha) and Msitu Mkuu Forest Reserve (180 ha). In addition, 20,000

ha of mangrove forests have been put under conservation management. As a result, the total area under management and protection by the government, under the Department of Forestry and Non-Renewable Natural Resources (DFNRNR), is 35,000 ha, including mangroves. Bush land and thickets cover 11,062 ha, about 45% of the total land area of Zanzibar are the major sources of firewood products. Despite the management efforts, it has been reviled that, the Coral rag forests are being depleted at a rate of 530 ha per year (Kombo, 2010) due to highly exploitation of fuelwood. This leads to the environmental degradation.

It has also been documented by the Sustainable Management of Land and Environment (SMOLE), 2010, that biomass consumption for cooking in Zanzibar amounted to approximately 941,000 cubic meters. Also, the 2013 tree census indicated a notable decline in forest by 1,637,510 cubic meters between 2007 and 2013 (ZWBS, 2013).

The Government and other stakeholders has made various efforts to improve clean cooking by introduction of various projects and programs. Among the many projects include the HIMA project (2010-2014) which provided the gas stoves aimed at reducing the house holds depending on firewood and charcoal. The project increased the adoption of gas energy for cooking which was insignificant before the said project. However, after introduction of the HIMA project the utilization of gas energy for cooking was increased and reached the gas users by 7.7 percent of the cooking energy mix in 2015. The use of gas Continue increasing where in 2019/2022 the house holds using gas increased up to 12.6 %. The adoption of gas, kerosen and electricity remains limited due to various factors, including the substantial upfront costs associated with gas stoves and cylinders, electricity and kerosene and limited suppliers in rural area

Additionally, (UNIDO, 2015,) concluded that, Zanzibar is still experiencing extensive use of traditional fuel (TF) sources like firewood and charcoal, primarily due to limited capacity and awareness on adaptation of clean energy. The reliance TF leads to significant health such as Households Air Pollution (HAP) and the environment impact. Thus continuing to depend TF for cooking will expose the country to a high risk of deforestation and air pollution which negatively impact the health particularly for women and children and economic development.

The bioethanol and gas or Liquefied Petroleum Gas (LPG) energy is proposed as an alternative energy for cooking. Bioethanol was introduced in Zanzibar in in 2015 but it did not got the attention due to high cost of stove and limited suppliers of the fossil

fuel. While LPG has started to gain momentum as users reached 12.6 percent in 2022 from 7.7 percent in 2015.

Therefore, it's crucial to address SDGs 7, universal clean cooking access goal, the Zanzibar Development Vision 2050 which calls for the use of renewable energy and clean cooking fuels and the ZADEP 2021-2026 which call for increasing of households which uses clean energy for cooking through improving the accessibility , sustainable, and affordable clean energy sources like ethanol and gas. This pace will encourage and improve the clean energy users and help mitigate Environmental challenges

1.2 Objective

i. This proposal aims to promote the extensive use of bioethanol and gas as a alternative to firewood and charcoal so as to conserve environment, improve public health and socio-economic development in Zanzibar. It seeks to address the issues by outlining a comprehensive strategy for the technology transfer of bioethanol utilization and promotion of use of LPG for household cooking. This will be achieved through leveraging partnerships, capacity building initiatives, technology subsidy schemes and community engagement.

1.3 Rationale

In 2022, 75.8 percent of households rely on firewood and charcoal for their daily cooking energy needs. This practice raises several environmental concerns, including forest depletion, soil erosion, and loss of biodiversity including increase of Deforestation rates by 1,637,510 m3 between 1997 and 2013 (ZWBS, 2013). In addition, majority of households and communities in Zanzibar still lack value added information that would support production, distribution and marketing of bioethanol as a clean cooking alternative. Thus, implementation of alternative energy solutions is imperative, given their potential to be less harmful to the environment, affordable and accessible.

Among proposed intervention is the adoption of Bioethanol energy and promotion and support the utilization of LPG. This lies on the fact that Zanzibar has good opportunities to expand and increase the production of bioethanol as sugarcane by-products for local, regional and international markets. Currently, the Mahonda Sugar factory produces bioethanol in sugar production processing and will open up the opportunity for the

factory to increase production through engaging farming out growers, adoption of appropriate technologies and farming practices to increase production of raw materials.

Furthermore, switching to bioethanol as an alternative fuel can contribute significantly to reduce Household Air Pollution (HAP). On the other hand, Gas energy for cooking has more potential to reduce the utilization of Charcoal for urban and Firewood in rural. Promoting the use of LPG as an alternative to firewood and charcoal holds significant potential for mitigating various socio-economic and environmental challenges such as saving cooking time and time to search for firewood and charcoal particularly in rural areas. Hence, it may offers women the opportunity to engage in extra income generating activities, improve market opportunities and increase value addition along the value chains of the product and reduce the household cooking cost. Ultimately, embracing this initiative will significantly benefit the Government, business, industries and communities by bolstering energy security

1.3.1 International and National linkages

The adoption of clean energy is supported by the national and international climate change interventions and the goals for the production of safe, clean, affordable and sustainable renewable energy in Zanzibar and Tanzania at large. This initiative will contribute to the attainment of the Sustainable Development Goals (SDGs) 3, 5, 7, 8, 9 and 13 as described in Table 1below

Table 1: The sustainable development goals and their targets and impacts

SDG goal	Target	Project impact
SDG 3. Good Health and Well-being	Ensure healthy lives and promote well-being for at least 120,000 people in Zanzibar	40,000 households switch to clean fuels for cooking reduces HAP considerably which in turn will reduce respiratory diseases and deaths of women and children
SDG 7. Affordable and Clean Energy	Ensure access to affordable, reliable, sustainable and modern cooking energy for at	At least 40,000 households adopt Tier 4 clean cooking fuels and technologies

SDG goal	Target	Project impact
	least 25,000 households.	
SDG 8. Decent Work and Economic Growth	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	Up to 1,850 jobs can be created by a domestic ethanol market depending on the extent and methods of local production Up to USD 2.6 million can be generated in new income by a domestic ethanol market, with a significant portion going to smallholder farmers and local distilleries
SDG 9. Industry, Innovation, and Infrastructure	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	The investment in ethanol manufacturing and distribution will boost industries and innovation in Zanzibar
SDG 13. Climate action	Take urgent action to combat climate change and its impacts	Up to 68 million kg's of CO_2 equivalent could be saved cumulatively over a ten-year period by switching to ethanol cooking

As for the National goals and programme the initiatives align with number of policies including the Zanzibar Development Vision 2050 which calls for the use of renewable energy and clean cooking fuels, the ZADEP 2021-2026, call for increase of households that uses clean energy for cooking. The Zanzibar climate change strategy (2013) emphasizes on reducing the impacts of climate change through mitigation and adaptation schemes.

The ruling party (Chama Cha Mapinduzi – CCM) election manifesto 2020 -2025, calls for continued effort of innovation and strategize towards reducing the use of firewood and charcoal, through promoting the use of alternative clean energy for environmental conservation

1.4 Policy Landscape

ii. The Promotion of bioethanol and gas cooking energy resource in Zanzibar has been elaborated in various policy instruments, strategies and initiatives aimed at promoting the production, distribution, and utilization purposes. The 2009 Zanzibar energy policy has acknowledged the gradual change of traditional energy sources towards modern and clean energy sources through encouraging import, storage, distribution and sells facilities primarily in urban areas. Also it emphases on providing opportunity for poor and rural households to invest in modern energy technology and establish economic incentives schemes for business and institutions for supporting transition from wood fuel to other clean energy sources. The policy has much emphases in urban population leaving behind the rural households. The reviewed Zanzibar's energy policy should prioritize equally the urban and rural areas.

iii. As per the production process, Bioethanol energy depends on agricultural produce. Thus, the Agricultural Sector Policy of 2002 underscores the necessity for an energy policy that promotes dependable, cost-effective, and environmentally friendly alternative energy sources to diminish reliance on wood for energy. The policy show that the increasing demand for wood fuel is destroying the environment. The reviewed policy has to support the cultivation of crops suitable for bioethanol production, and environmental conservation. This may include incentives for farmers to grow these crops, promoting sustainable farming practices, and ensuring equitable access to land and resources for bioethanol production.

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Zanzibar Environmental Policy of 2013: highlights the growing demand for wood- fuel its impact to the environmental damage include soil erosion, catchments and ground water deterioration as well as ecological degradation. The policy further, elucidates that the government prioritizes the development and efficient utilization of Zanzibar's

alternative energy resources to minimize reliance on imported energy and alleviate strain on natural resources.

iv. **Health Policy (2008):** The policy emphasize the use of clean energy for health population with equitable health care services. Clean cooking energy sources such as bioethanol can improve indoor air quality and reduce respiratory diseases associated with indoor air pollution. Thus , both policy should promote the use of bioethanol as a means to protect public health, reduce greenhouse gas emissions and mitigate climate change.

v. **Regulatory Framework:** the transfer and adoption of clean energy for cooking need other comprehensive regulatory framework that guide the production, distribution and utilization of bioethanol as a cooking energy source in Zanzibar. It should encompass setting the quality standards for bioethanol production, implementing licensing requirements for producers and distributors, and safety regulations for storage and handling.

In conclusion, by appropriate incorporating clean energy for cooking (bioethanol and gas) into Zanzibar's policy, and framework, the government can safeguard the environment, foster sustainable agriculture, and bolster public health and well-being for all citizens.

1.6 The Process

The development of this reports encompassed reviewing various studies and regulatory frameworks related to clean energy. Mini survey to the household users of stove and study visit to Mahonda sugarcane industry and stakeholders meeting which involved the Government and private institutions. The data collection included interview and focused group discussion. The expert opinions were gathered during the stakeholders meeting. The gathered information were processed, analyzed and incorporated in the report.

CHAPTER TWO

2.0 BIOETHANOL AND GAS ENERGY TECHNOLOGY AND ITS MERIT IN REDUCTION OF ENVIRONMENT AND POLICY LANDSACAPE

This chapter provides a comprehensive background and significance of bioethanol and gas energy in mitigating environmental issues.

2.1 Global bioethanol production and use

Bioethanol is already a widely produced commodity, with well-established industries in Brazil, Canada, China, the European Union, India, Thailand, and the USA. Global production climbed up significantly between the year 2000 and 2015 and is still growing, driven by an increasing demand for ethanol as a blending component in the transport sector. While the current market for ethanol as a transport fuel is much larger than the market for ethanol for cooking purposes, the market share of ethanol as a cooking fuel is also growing and has high potential for the future, in Asia and Sub-Saharan Africa in particular.

Global production of ethanol amounted to 98.4 billion liters in 2018. More than half of this amount was produced in the USA in its approximately 200 ethanol production plants. The second biggest player was Brazil, producing about one quarter of global ethanol in close to 400 ethanol production plants (primarily sugarcane). Jointly, Brazil and the USA account for 85% of global ethanol production. About 5% of ethanol was produced in the EU.

2.2 Africa bioethanol production and use

Production and consumption of ethanol in Africa is still at a low level, but it is growing. In Kenya bioethanol has been taken to be a viable alternative cooking fuel option for the lower-income urban population. Thus the government has signed an agreement with the State Oil Corporation to build a new ethanol plant to meet biofuel blending mandates. In Zambia, Sunbird Bioenergy Africa 2 has launched a program to develop a sustainable cassava supply chain for ethanol production in order to provide 20% (100 million liters) of the country's gasoline requirements (REN21, 2020).. In Ethiopia, the usage of bioethanol leads to the displacement of kerosene in 100% of urban households, and charcoal in up to 50% of rural households, with considerable savings in fuel expenditure. This is also the same for. Additionally, Malawi is attempted to

achieve a 20% fuel blending target. Whereby bio-ethanol is widely used for cooking with high cooking efficiency and low carbon monoxide and particulate matter from burning ethanol (Nyambane et al., 2020).

2.3 Bioethanol in Tanzania

An overview of the status of biofuels in Tanzania Biofuels can directly contribute to access to modern energy, enhance energy security and promote sustainable development in any country if produced responsibly (Dellomonaco et al., 2010). In fact, biofuels has become a major business and a new commercial venture (UNEP, 2009). Tanzania, like many other countries of the world, has experienced a dramatic increase in biofuel investment in recent years in particular bioethanol and biodiesel (Sulle & Nelson, 2009).

Tanzania has the potential of producing about 4010 million liters of ethanol per year . The local annual demand for ethanol are estimated at 568 million liters. This means, the country has annual export potential to the world market of ethanol of about 3442 million liters per year, (Philip, 2007). There is also an anticipation of production of 103 million liters of biodiesel/year from oil obtained from Croton megalocarpus an indigenous trees species (E-INFO-WILMA, 2006). Over 40 organizations engaged in differing ways in bioenergy development in Tanzania.

2.4 Bioethanol in Zanzibar

Bioethanol fuel and stoves have a significant positive impact on the local and global environments. Currently, in Zanzibar, the Mahonda sugarcane factory produces 700,000 Metric Tons of IS 96 bioethanol annually. This type of ethanol is commonly used for cooking and 20 % is utilized in Zanzibar and the remaining 80% is sold to Tanzania mainland. Most bioethanol cooking energy end users are situated at Mahonda ward and few are scattered in Urban area.

Recently, the factory has improved its production capacity and planned to produces 21,000 tons of sugarcane yearly compared to the current capacity of 8500 tones. However, this target could be reached through engagement of other stakeholders as the current available land of 3500 ha compared with the required 7000 ha; Challenge such as frequently of fire outbreak in sugarcane farms, encroachment of residential areas near sugarcane production zones and natural disasters may exacerbate the situation

2.5 The Experience from researches and pilot study of 2015

In 2015, a pilot study was conducted distributing approximately 350 bioethanol stoves to residents of Zanzibar, including those in Stonetown, Kisakakasaka, North A, and North B. Alongside stove distribution, training sessions were provided to ensure proper usage of the bioethanol stoves for cooking purposes. In 2023, the ZPC conducted survey revealed that although there are still some households using the bioethanol stoves, many have reverted to their previous cooking fuels due to challenges in accessing bioethanol fuel and the stoves. Despite this setback, users expressed a preference for bioethanol over traditional fuels like firewood, charcoal, or kerosene.

During the pilot study, the bio-ethanol stoves were sold at subsidized rate of Tsh. 15000/= and people eliciting a a positive response from the community towards the adoption of bioethanol as a cooking fuel over other alternatives. Figure 1 shows the traditional cooking method and figure 2 shows clean cooking method and stove.

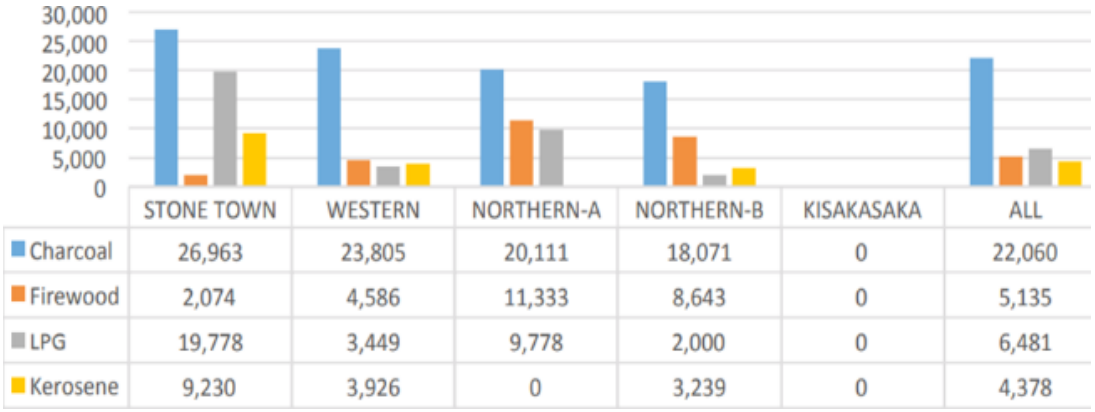
Figure 1: Women and children can be exposed to health risks due to household air pollution

Source: Zanzibar Pilot Study, 2015

A switch to bio-ethanol cooking was confirmed as completely acceptable to Zanzibar households, improving the lifestyle of women and children, and achieving significant economic, health and environmental benefits (Zanzibar Pilot Study 2015). It can control black carbon which is produced by burning biomass fuels.

Figure 2: Women and children are safe from household air pollution

Source: Zanzibar Pilot Study, 2015



	STONE TOWN	WESTERN	NORTHERN-A	NORTHERN-B	KISAKASAKA	ALL
Charcoal	26,963	23,805	20,111	18,071	0	22,060
Firewood	2,074	4,586	11,333	8,643	0	5,135
LPG	19,778	3,449	9,778	2,000	0	6,481
Kerosene	9,230	3,926	0	3,239	0	4,378

Figure 3: Households' average monthly expenditure for cooking fuel (TZS/Month)

Source: Zanzibar Pilot Study, 2015

In pilot studies, the comparison on the CLEANCOOK stove can burn on high power for four hours and burn on low power for up to nine hours with a full canister (1.2 litres of bio-ethanol) and costs of fuel was analyzed and the results are shown in figure 3.

2.6 LPG importation and usage in Zanzibar

The Population and Housing Census report of 2022 shows that, about 12.6% of the Zanzibar population are using gas for cooking, with more usage in urban compared to rural areas. ZURA statistic data for 4 year period (2019-2022) reveal that, the average gas importation per year was 6,890,919 kg while average consumption was 6,320,094 kg. This indicate that, the consumption is growing at rate of 77,769 kg per year, while

importation is growing at a rate of 83,144 kg per year. Also the data revealed that, the national demand of LPG per year is about 6,000,000-7,000,000 kg. As for the period of last three (3) month (January – March 2024) the report shows an importation of 2,940,916 kg and consumption were 2,880,892 kg with the average cost of LPG is 3,763 Tsh per kg. The increase in consumption and importation was associated with a number of measure taken by government and private institution toward promoting clean cooking energy. The awareness on the use of gas energy sources has been gradually increased.

Table 1: Cost Clean Cooking energy (Bio-ethanol, and Gas) and Traditional Fuel

Cooking source	Measure	Cost in TZS	Cooking time
CLEAN COOKING ENERGY			
Bio-ethanol	1.2 litre	2,500	9 hours
LPG gas	1kg	3763	3 hours
TRADIONAL COOKING SOURCES			
Charcoal	1 local measure	1,000 (6,000)	1.5 hour (9 hours)
Fire wood	1 local bunch	1,000 (4,500)	2 hours (9 hours)

Source : UNIDO 2015

The data from the pilot study shows that traditional fuels are more expensive than the proposed fuel. Likewise, LPG stoves and Electricity cookers are more expensive than ethanol stoves. Thus, bio-ethanol could be reliable cooking fuel in the context of Zanzibar.

Currently, there is a global concern for developing countries to use clean cooking energy such as bioethanol and LPG as a clean cooking fuel due to its economic and environmental advantages as compared to firewood, charcoal and kerosene. The usage of clean cooking energy will lead to an increase in energy security and fight against the increasing price of cooking energy as well as overcome the shortage of energy access in the country.

2.7 The Benefit of Using clean cooking energy (Bio Ethanol and LPG)as a Cooking Fuel in Zanzibar

Zanzibar biomass energy has been overwhelmed by population pressure which severely deplete the vegetation by cutting trees suitable for charcoal making and firewood harvesting. Hence adaptation of clean cooking energy bioethanol and LPG fuel have a significant economic, social and environmental benefits for Zanzibar include saving of s foreign exchange through the reduction of supplementation of imported kerosene, the conservation of forest and biodiversity will attract number of tourists, possibility of earning of foreign exchange from the sale of Certified Emission Reductions (CERs). Other benefit are:

i. The establishment of policies, standards and guidelines that will direct production levels, bioethanol consumption, costs;
ii. The usage of bio-ethanol and LPG as a cooking fuel increase employment for young people in the processing and distribution and stoves business which in turn increase socio-economic benefits;
iii. The production of Mahonda sugarcane factory will be increased leading to the demand of raw materials (sugar cane) from various production institutions including SMZ Forces and the private sector. This will increase the income generation of the sugarcane growers and famers;
iv. The investment on LPG processing increase number of economic growth for both employee, owners and community (users);
v. Strengthening the health of citizens due to the reduction of indoor air pollution as a result of the application of firewood and charcoal.
vi. Attract investor of carbon credit project to invest thus the government will earn more money due to the decreasing of deforestation

CHAPTER THREE

3.0 Findings and Discussion

This chapter investigate the utilization of clean cooking energy (bioethanol and LPG) for cooking purposes and environmental conservation. By examining the results, challenges and opportunities associated with technology transfer in clean cooking energy. The context will pave the ways and develop strategies to initiate and promote the usage of this energy and save the environmental ecosystem.

3.1 Production and Factory Capacity on Clean cooking Energy (Bio-ethanol and LPG) in Zanzibar

In Zanzibar, bio-ethanol suitable as a cooking fuel; bio-ethanol (IS – 96) is produced by the Mahonda sugar can factory. Annually the factory has a capacity to produce about 700,000 metric tones (MT) in which 20% of it is used in Zanzibar and 80% is used in Tanzania mainland. It has been reported that the factory could produce more than the current production if large farming area and new technologies are available.

The current practice of the usage of bioethanol as a cooking fuel in Zanzibar is very small as that 20% of bio-ethanol used in Zanzibar is largely used in hospitals and academic institutions while very few is used as a cooking fuel particularly to those who have bio-ethanol stoves. It has been reviled that, the usage of bio-ethanol for cooking energy in Zanzibar is very limited due to several factors including low-level awareness, shortage of bioethanol stoves and the complexity of procedures for buying bioethanol from the factory. There are three types of bioethanol produced in many sugarcane factories include IS bioethanol 96%, RS bioethanol 98% and ENA bioethanol 99.9%. In Zanzibar, there is no the value chain system Bioethanol fuel processing, denaturing, packaging in various volume and distribution.

Additionally, it was observed that at the Mahonda factory, bioethanol is not directly sold to individual users. Instead, users are required to adhere to certain procedures, which include obtaining a letter from a recognized organization or government. This process posed challenges for individuals not affiliated with any of recognized organization.

The study revealed that the current bioethanol produced by the Zanzibar Sugar factory has the capacity to serve up to 15,000 households per month. However, the company has the potential to produce 1.9 million litres annually which is capable of meeting the

demand of urban dwellers and reducing dependency on dirty if the raw materials (sugar cane) are available at the required amount. According to Household survey of 2019/2020, Zanzibar has a total of 286,440 households that still use charcoal and firewood. Hence there is a need for special strategy and plan to make sure the number of household using firewood and charcoal are reduced. This report propose the intervention to start with 20 percent of the households (10 percent for gas and 10 percent for bioethanol)

3.2 The production Sugarcane as a row materials for bioethanol production

Mahonda sugarcane factory is planned to produce 21,000 tones of sugarcane yearly, the current production is less due to among others ate limited available land. However, the factory has the legal contract without growers of sugarcane in order to increase production capacity, the growers are of two different farms:

1. Zanzibar special force such as JKU and Mafunzo
2. Community out growers

Currently production of sugarcane from out growers is lower compared to other country In India, one hectares of sugarcane farm produce minimum 50 tone/hectares and can reach up 80-100 tones, whereas in Zanzibar only 20 tones/hectares. Lower production from Zanzibar growers caused by Poor agronomical production practices, Insufficient production inputs, Limited knowledge and Insufficient capital.

3.3 Cook stove test

The results shows that, The Clean cook stove is sold TZS 85,000. Its utilization reduced particulate matters of emissions by 94% and reduction in carbon monoxide emissions by 79% from traditional firewood stoves. Indoor air pollution was decreased from 575.4 µg/m^3 to 109 µg/m^3. The CLEANCOOK stove also grants significant timesaving over traditional and improved wood, charcoal stoves. The results show that, 2.2 hours saved every day from cooking by clean cooking stove. The CLEANCOOK performs similarly to LPG. In addition, Also, the energy consumption costs decreased for about Tsh 51, 000 per month.

3.4 The production and distribution of LPG in Zanzibar

The Population and Housing Census report of 2022 shows that, about 12.6% of the Zanzibar population are using gas for cooking, with more usage in urban compared to

rural areas. The Zanzibar Utilities Regulatory Authority (ZURA) continues to regulate importation and supply of the LPG in Zanzibar**.** The statistic for 4 year period (2019-2022) reveal that, the average gas importation per year was 6,890,919 kg while average consumption was 6,320,094 kg. This indicate that, the consumption is growing at rate of 77,769 kg per year, while importation is growing at a rate of 83,144 kg per year. The national demand of LPG per year is about 6,000,000-7,000,000 kg. As for the period of last three (3) month (January – March 2024) the report shows an importation of 2,940,916 kg and consumption were 2,880,892 kg with the average cost of LPG is 3,763 Tsh per kg. Currently there are fives companies which licensed to deal on LPG which ORYX gas Tanzania Limited, Lake Gas Limited, National Gas Tanzania Limited, Al-Nabahani Gas Supply(O-gas) and M-Gas. This increase in consumption and importation was associated with a number of measure taken by government, and private institution toward promoting clean cooking energy.

3.5 Accessibility of clean cooking energy challenges and opportunities.

The survey also showed that there are number of the people who received bioethanol stoves but abandoned due to the accessibility challenge of bioethanol regardless of its comparative advantages with other cooking fuels like kerosine, firewood, and charcoal where by 80% of these consumers facing a challenge of accessing bioethanol energy. The end users, pointed out that on average, households spent less money per day on using bio-ethanol as a cooking fuel as compared to charcoal, firewood.

Challenges

i. Limited awareness and training on utilization of bioethanol to end users and large population across Zanzibar;
ii. Limited supplies of bioethanol cooking stoves across Zanzibar;
iii. High cost of Cooking stove or gas cylinder, dwindle the wide spread adoption of the Safe energy;
iv. Limited processed companies and Insufficient infrastructures for production, packaging and distribution of bioethanol;
v. Insufficient supplier of the gas stove particularly in rural area;
vi. Limited funds for research and publications on the issue of bioethanol as cooking fuel;
vii. Scarcity of land for production of sugar cane and its by products such as bioethanol.

CHAPTER FOUR

4.0 Recommendations

In the realm of sustainable energy solutions, bioethanol and gas stands out as a promising alternative for clean cooking energy, offering significant environmental benefits and economic opportunities. This chapter provide actionable recommendations to facilitate the adoption and implementation of clean cooking energy source. Through effective technology transfer mechanisms, we can accelerate the transition towards cleaner and more sustainable cooking practices, thereby contributing to the overarching goal of mitigating climate change improve of socio-economic wellbeing, health, safety and enhancing energy access and security. The following are recommended:

4.1 Recommendations

vii. The Government to create conducive environment for service providers, investors, and business community of clean cooking energy project through price regulation and development of guidelines and standards.

viii. Review the energy policy and legal frameworks provision of regulation and standards to allow the distribution of bioethanol in wholesale or retailers, as another option for cooking fuel in Zanzibar.

ix. The Government may allocate and provide grants/ subsidy funds to support accessibility of Bioethanol stove and Gas stove of 20 percent of the households using firewood and charcoal. The estimated funds is TZS 3.35 Billions is for subsiding the clean stove by 77 percent for the low income households who uses firewood and charcoal. 10% of the household to be supported to access Bioethanol and another 10% of the household for support the access and use the LPG gas energy.

x. Increase the capacity of the Mahonda sugar can industry to produce more sugar and bio ethanol. These could be done through increase collaborations without growers such as JKU and MAFUNZO and establishment of contract farming together with collaboration with research and development institutions

xi. Ministry responsible for industry to mobilize local investors to invest in production processing, bottling and packaging bio ethanol plants and affordable bio ethanol stoves

xii. Ministries related to Clean cooking have to work together to increase education, awareness on adaptation , utilization and conservation of the environment

xiii. To finance more studies based on the production of bio ethanol using agricultural yields including rice, cassava among others.

xiv. Ministry responsible for energy, to mobilize Business community to increase distribution of Clean energy especially in urban area.

4.2 Implementation Procedures (Strategies)

i. Rolling out the use of clean energy requires a systematic approach that involves collaboration among stakeholders, targeted interventions and sustained efforts to overcome barriers and promote adoption. The following are the step-by-step guide on how to roll out the use of bioethanol clean cooking fuel in Zanzibar:

ii. **Stakeholder Engagement and Partnerships:** A multi-stakeholder platform or task force should be formulated so as to coordinate efforts, share responsibilities, and mobilize resources for the roll-out process. These stakeholders include government agencies, private sector actors, NGOs, community leaders, and international development partners, in the bioethanol clean cooking fuel initiative.

iii. 2. **Policy Advocacy and Institutional Support:** Supportive policies, regulations, and incentives to facilitate the adoption and utilization of bioethanol clean cooking fuel in Zanzibar should be advocated. Policymakers, legislators, and relevant government agencies should be responsible to develop and implement policies that promote bioethanol fuel production, distribution, and utilization. Also, lobby for tax incentives, subsidies, and regulatory reforms to create an enabling environment for bioethanol production and usage.

iv. 3 **Awareness Campaigns:** Public awareness campaigns, and educational programs should be launched on the benefits of bioethanol clean cooking fuel and promote its adoption among households in Zanzibar. Variety of communication channels, including mass media, community events, and interpersonal communication, should be used to disseminate information and

address misconceptions to build trust in bioethanol fuel as a safe, reliable, and sustainable cooking energy option.

v. 5. **Pilot Projects and Demonstration Initiatives for all regions of Zanzibar**: Recommended initiatives from pilot study of 2015 and other initiatives from UNIDO should be used to showcase the benefits and feasibility of bioethanol clean cooking fuel in real-world settings. Monitoring and evaluation on the performance, acceptability, and user satisfaction of bioethanol fuel technologies should be gathered and feedback will be communicated for further scale-up efforts.

vi. 6. **Capacity Building and Training Programs:** Capacity-building, technical training, and development programs for the production, distribution, and utilization of bioethanol for cooking, stove maintenance, safety protocols, and entrepreneurship skills on bioethanol fuel in Zanzibar should be offered.

vii. **Market Development and Supply Chain Strengthening:** the value chain of bio-ethanol should be strengthened by investing in infrastructure development, storage facilities, and transportation networks to ensure reliable access and affordability of bioethanol fuel for households in Zanzibar. Partnership with other bioethanol producers, distributors, retailers in and outside the county should be fostered to expand market chain, for improving quality, and lowering the costs.

viii. **Monitoring and Evaluation Mechanisms:** Robust monitoring and evaluation mechanisms will be established to track progress, measure impact, and assess outcomes of the bioethanol as a cooking fuel in Zanzibar.

The outlined strategies can effectively promote the adoption and utilization of bioethanol clean cooking fuel, improve household health, reduce indoor air pollution, and advance sustainable energy access for its population. Collaboration, innovation, and stakeholder engagement are essential for the successful roll-out of bioethanol clean cooking fuel initiatives in Zanzibar.

4.3 Partnerships

The implementation of the proposed initiative will involve several actors, which will be charged with different but complementary roles and responsibilities necessary for the attaining of the intended objectives. In order to ensure that the initiative run smoothly all key partners will be required understand the initiative overview and descriptions and

to agree to the principles of good partnership practices. All key partners will be made to have a clear understanding of their roles and responsibilities in the initiative implementation.

The Consumer Choice Company is the key partner in this initiative. The stakeholder can collaborate in a number of ways in the implementation of the initiative. This private sector will continue to engage in the supply and distribution of required amount ethanol to consumers. Likewise, UNIDO can as well provide subsidy to Consumer Choice for easy facilitation and performance. Consumer Choice can also participate in the investment of ethanol denaturing and packaging plant. Wholesalers and retailers can also purchase products and resale them to consumers, thus providing the marketing avenue for the products.

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