INVESTMENT PROSPECTUS FOR TANZANIA

High-Impact Investment Opportunities for Productive use of Renewable Energy in Tanzania

November, 2025

Acknowledgment

The completion of this important PURE Investment Prospectus is a contribution of joint efforts from a range of individuals and organizations.

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The investment prospectus was prepared by TaTEDO-SESO Staff (Estomih Sawe, Jensen Shuma, Shukuru Meena) with support from WRI Africa (David Njugi and Anderson Ngowa).

Developed by

TaTEDO-SUSTAINABLE ENERGY SERVICES ORGANIZATION
TaTEDO-SESO
Nishati Safi kwa Wote

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Foreword

The initiative on the Productive Use of Renewable Energy (PURE) in Tanzania marks a crucial step in harnessing the nation's vast renewable resources to unlock widespread economic benefits. With abundant solar, hydro, and biomass potential, Tanzania is poised for a clean energy transition that extends beyond mere electrification to foster sustainable development.

For far too long, the energy conversation has focused primarily on access, but as our economy grows, the country must shift its focus toward the productive use of energy. This pivotal transition is essential for lifting communities out of poverty, driving economic growth, and building true climate resilience.

The PURE investment prospectus represents a crucial step in this direction. It provides a comprehensive, ground-level assessment of how clean energy may be harnessed by communities and micro, small, and medium-sized enterprises (MSMEs) for the purpose of improving the livelihoods of people across areas with PURE potential in Tanzania.

The Investment Prospectus is designed to illuminate the potential of PURE in the agriculture, livestock, and fisheries sectors for small businesses and schemes. By providing critical data on renewable energy consumption patterns, market opportunities, and socio-economic impacts, this survey aims to equip policymakers, investors, and development partners with the insights needed to accelerate investment in and the deployment of renewable energy technologies that drive economic activities.

The recommendations illuminate the opportunities that exist for scaling up PURE and expose the persistent barriers that hinder its progress. While Tanzania is blessed with abundant renewable resources, including solar, wind, and hydropower, challenges such as high initial investment costs, gaps in financing, limited technical capacity, and inadequate infrastructure must be overcome to achieve the productive benefits of potential opportunities in various communities. This prospectus document offers a data-driven path forward, identifying the examples of projects, financial models, and collaborative partnerships needed to unlock our full potential.

Ultimately, this Investment Prospectus serves as an impetus for actions, underscoring the potential of PURE to create concerted efforts for boosting income generation, creating dignified employment for youth and women, enhancing energy security, and advancing Tanzania's journey toward becoming a middle-income economy with a low-carbon future. It is our hope that the Investment Prospectus on PURE will inspire collaborative partnerships and innovative financing mechanisms to unlock the full potential of renewable energy for a prosperous and sustainable Tanzania.

The journey ahead requires collaboration and commitment from all stakeholders (government ministries, the private sector, development partners, and local communities). Let this investment prospectus serve as a call to action, reminding us that renewable energy is not merely a commodity but a catalyst for profound socio-economic transformation.

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Eng. Estomih Sawe
CEO, TaTEDO-SESO

Executive Summary

The World Resources Institute (WRI) project on the Productive Use of Renewable Energy (PURE) aims to unlock local private capital from East African Local Financial Institutions (LFIs) to finance the expansion of renewable energy for smallholder agriculture in Sub-Saharan Africa, thereby boosting local economies and ensuring sustainable human societies. The project identifies barriers to LFI lending for PURE and proposes interventions for growth, ultimately aiming to establish momentum for increasing access to renewable energy that will lead to economic prosperity and improved lives.

PURE has been an effective solution for extending energy access and enhancing income generation, particularly among rural and low-income segments of the population who are unable to afford it. In Tanzania, the productive use of renewable energy in agriculture, livestock, and fisheries involves incorporating energy-powered solutions across various value chains to boost income and productivity. The geographical areas proposed for the PURE project in Tanzania are regions of Kilimanjaro, Dar es Salaam, Pwani, and Dodoma.

A major obstacles that rural entrepreneurs face are high costs and low-income levels. LFIs are required to support agricultural sectors, but they are hindered by challenges like limited capacity and funding sources. Therefore, access to finance plays a crucial role in driving and expanding PURE lending to SMEs and end users, who face affordability challenges due to the high upfront costs of PURE appliances and limited financing options. At the same time, PURE provides Local Finance Initiatives (LFIs) with an opportunity to increase their impact by growing green lending portfolios, thus promoting sustainable development.

WRI and TaTEDO-SESO, through their initiative on 'A Data-Driven Approach to Prioritize Productive Use of Renewable Energy Interventions mapped out high-impact, high-potential PURE opportunities within the agriculture, livestock, and fisheries space, being central in affirming the specific subsectors. The value chains identified for the PURE investment were Banana, Horticultural Crops (Tomato), Dairy Milk, Poultry (Chicken), Mango, Livestock (Cattle), Poultry (Chicken), Agricultural Crops (Cassava), and Fish.

The data collection started with developing a wish list of PURE opportunities, secondary information collection, and identification of gaps, and the dynamic engagement of stakeholders by holding a day meeting of representatives of stakeholders from different potential areas at selected venues in Kilimanjaro, Dodoma, Dar es Salaam/Pwani. The wish-list preparation was followed by data collection, which started in the Pwani and Dar es Salaam regions and continued in the Dodoma Region, and was finalized in the Kilimanjaro Region.

Data Analysis was performed by using a set of structured templates for PURE data analysis and Energy Access Explorer (EAE). The qualitative and quantitative analysis was performed to get an assessment of the Gender Equality and Social Inclusion (GESI), and at the end, coefficients for project appraisal were determined to assess the viability of the flagship project, which emanated from proposed value chains in agriculture, fisheries, and livestock sectors.

The information collected also supported the Energy Access Explorer (EAE) through the use of the PURE Prioritization Index, which prioritizes quantitative or qualitative information from project areas. The data collected were uploaded to the Energy Access Explorer Portal, which, in the future, will help to guide decisions, allocate resources, and determine the order of actions. Therefore, the information collected from PURE Value Chains Surveys also became inputs to the EAE portal, and people may access this data for other undertakings in the future.

Project appraisal techniques for assessing the project's feasibility by analyzing its financial, economic, and operational viability using methods like Payback Period and Return on Investment (RoI) were conducted for the project return analysis. The project assessed and renewable energy technologies proposed for supporting those project include PURE intervetions in banana solar drying, solar power for cooling and processing in dairy farming, solar drying for cassava processing, solar lighting and water pumping in fisheries and aquaculture, Solar water pumping for supplying water to livestock (cattle), solar water pumping and drip irrigation for mango farming, solar water pumping and drip irrigation for tomato farming, and solar lighting and warming for supporting poultry (chicken) rearing.

A multi-pronged strategy is needed to address financial, technical, and market barriers for PURE projects. The following are some of the recommendations proposed for developing the PURE project in Tanzania.

- Developing and strengthening the PURE Policy and Regulatory Framework in Tanzania,
- Improving coordination and data gathering, and sharing for PURE initiatives with interested stakeholders,
- Facilitating cooperative and private sector enterprises' investment in PURE small-scale projects, and fostering local capacity building and community engagement for sustainable development
- Fostering Productive Sector Projects for harnessing the existing renewable energy resources
- Encourage private sector investment by creating more attractive and less risky investment environments for small-scale PURE projects.

Investing in Productive Use of Renewable Energy (PURE) in Tanzania offers a significant opportunity for economic growth, climate resilience, and social development by leveraging abundant natural resources. While barriers like financing gaps and data availability persist, the Tanzanian government is supposed to demonstrate strong commitment and implement supportive policies to attract private sector investment, creating an enabling environment for PURE technologies and projects that drive energy access, improve livelihoods, and reduce reliance on fossil fuels. These prospects should attract more improved financing mechanisms for high-risk projects and small businesses, develop innovative business models for PURE services, use geospatial tools to identify opportunities, promote community-driven initiatives, and focus on specific high-impact agri-food value chains and unlock more opportunities.

Abbreviations

AMP	Agricultural Master Plan
ASDP	Agricultural Sector Development Programme
CSP	Concentrated Solar Power
DLWG	Dream Light Women Group
DSFA	Directorate of Socio-Fishers and Aquatic Resources
EAE	Energy Access Explorer
EEZ	Exclusive Economic Zone
ESRF	Eastern and Southern Research Foundation
GDP	Gross National Product
GESI	Gender Equality and Social Inclusion
IP	Investment Prospectus
KWDCS	Kalali Women Dairy Cooperative Society
LFI	Local Financial Institutions
MSME	Micro, Small, and Medium-Sized Enterprise
MTPY	Metric Tonne Per Year
NWDCS	Nronga Women Dairy Cooperative Society
ROI	Return on Investment
SHS	Solar Home System
SIDO	Small Industry Development Organisation
SMEs	Small and Medium Enterprises
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TANESCO	Tanzania Electric Supply Company
TANLITS	Tanzania Livestock Identification, Registration, and Traceability System
TaTEDO-SESO	TaTEDO-Sustainable Energy Services Organization
TDFE	Tam-tam Dairy Farming Enterprise
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAT	Value Added Tax
WRI	World Resources Institute

1.0 Background

1.1 Country Overview

The key aspiration of Tanzania through its Development Vision 2050 has been to have a country that has to developing an educated, skilled, and visionary human capital to propel the nation towards sustainable development. This workforce will be rooted in innovation, entrepreneurship, and social responsibility, empowering a generation of changemakers who will drive economic growth and social transformation. Tanzania is intending to become a nation free from energy poverty, generating sufficient energy to power both productive and social life.

The country has implemented numerous reforms geared towards attracting private investments to the country. These reforms, which cut across sectors, include those in legal and regulatory reforms, institutional reforms, public infrastructure, and technological advancements as enablers of the investment climate.

The majority of people in Tanzania still lack access to sustainable energy services (renewable and energy-efficient services), drastically limiting their economic opportunities. Only more than 55 percent is connected to the grid electricity (TANESCO,2024). Without energy security, the population is more vulnerable to economic and environmental shocks, such as climate change and growing fuel prices, which further widens the gap between those who have resources and those who do not. Without access to sustainable energy and productive use technologies, hundreds of millions of people will lack the tools to lift themselves from poverty. Productive Uses of Renewable Energy (PURE) have the potential to mechanize agriculture, power enterprises, and electrify public infrastructure. PURE technologies contribute to those efforts by increasing productivity and food security for smallholder farmers. These opportunities have the potential to create jobs for youth in rural areas and to pioneer radical new technology innovations that can drive green growth.

Policymakers, decision makers, and citizens often have high expectations that rural energy access investments will transform local economies, but this does not happen automatically. Catalysing Productive Use of Renewable Energy (PURE) often requires extra measures to overcome barriers, such as gaps in local people's skills and financial resources. In Tanzania, there are huge needs and opportunities for ambitious energy access investments to increase rural productivity to support enterprises such as milling, irrigation, poultry, agricultural production, aquaculture, dairy, etc. Some developers of minigrids, and the government in Tanzania, are already testing ways to combine energy with wider rural development processes. A challenge for new entrants, policymakers, and funders is to understand what interventions work and how to support them.

According to WRI (2024), Productive Use of Renewable Energy (PURE) focuses on harnessing energy to enhance economic activities in sectors such as agriculture, livestock, and fisheries. This includes some applications such as water pumping, grain grinding, cooling, and powering tools for fishing and cooling. Facilitating access to renewable energy encourages the profitability and sustainability of micro, small, and medium-sized enterprises (MSMEs), particularly in rural areas.

Tanzania is focusing on Productive Use of Renewable Energy (PURE) to leverage its rich renewable resources and expand economic opportunities, despite a heavy reliance on biomass for households. Government programs and ongoing efforts' objective is to connect more rural communities to electricity and promote clean energy for businesses, cooking, health services, and transport. Key challenges to PURE adoption include limited access to finance for end-users and businesses, a nascent market for PURE solutions, and the need for better budgeting and investment to support PURE initiatives.

2.0 Renewable Energy Potential in Tanzania

Tanzania holds vast and diverse potential in solar, hydropower, wind, and biomass energy, with significant untapped resources that can support the Productive Use of Renewable Energy (PURE). The country aims to increase the share of renewable energy in its power mix to 75% by 2030. Currently, it relies heavily on hydro (hydropower) and natural gas for electricity, which together make up the majority of its power. Despite abundant renewable resources, these have been underutilized, with non-hydro renewable energy contributing less than 5% of the total grid electricity.

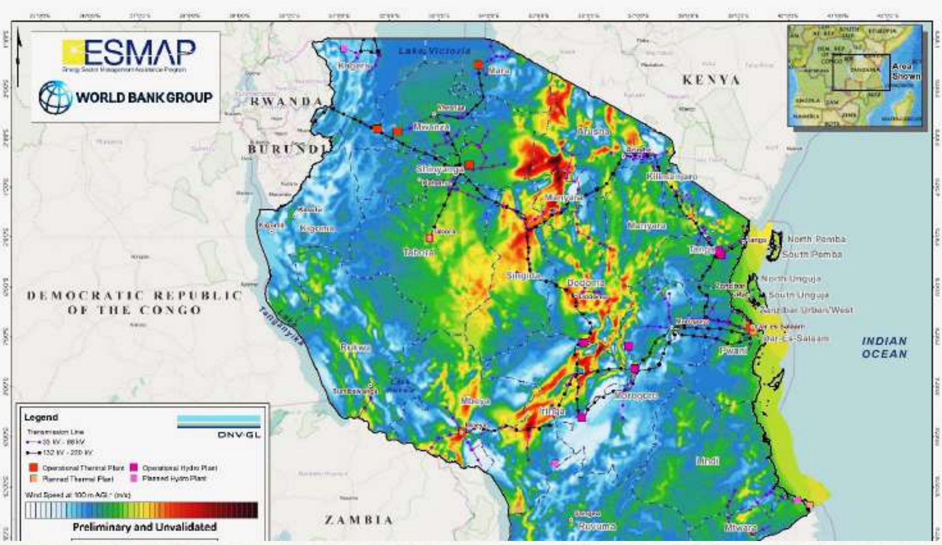


Chart 1: Solar and Wind Potential Map for Tanzania

A large portion of the country's total energy consumption still comes from unsustainable biomass, but the government is working to harness other renewable sources to meet demand and improve access. As of early 2025, Tanzania's total installed hydropower capacity was about 2,879.2 MW, including the 2,115 MW Julius Nyerere Hydropower Project, which became operational in 2024–25, and a pre-existing capacity of around 764.2 MW.

The country has made significant progress in expanding electricity access, now reaching over 78% of the population, with household connectivity exceeding 55% in 2024. Tanzania also has a large untapped potential for small-scale hydropower, estimated between 300 and 500 MW, with only about 24 MW developed so far. The country's untapped wind energy potential is roughly 0.65 GW, and progress has already begun with the operation of the Mwenga wind farm, which supplies power to hundreds of homes using small turbines suitable for the local terrain. Tanzania possesses considerable untapped biomass energy potential from agricultural residues, estimated at 135 PJ/year from selected crops alone, with a total potential of 12 million tons of oil equivalent. The opportunities for wave and tidal energy are substantial but remain largely unexplored, especially within its extensive Exclusive Economic Zone (EEZ) and along its approximately 1,424 km coastline.

The large potential of renewable energy in several areas of the country is particularly for solar energy resources. Tanzania has enormous solar energy potential due to its sunny climate and high solar irradiation levels, estimated at between 1800 to 2400 kWh/m^2/year, leading to an annual technical solar power potential of over 31,482 TWh for Concentrated Solar Power (CSP) and 38,804 TWh for PV technology. This potential is currently being leveraged for off-grid solutions, rural electrification, and industrial applications like water pumping, refrigeration, solar drying, and solar water heating, etc., driven by government support including tax exemptions on solar components. Despite this, the country's actual installed solar capacity remains low compared to its potential. Recent figures vary, but a report in 2020 indicated around 26 MW of solar capacity. Another source from 2023 puts the total installed solar capacity at approximately 20 MW. More than half of this capacity is utilized by households in peri-urban and rural areas. Solar thermal energy has been used for drying crops, wood, and salt. Currently, solar dryers are used in the agricultural sector to dry cereals and other farm products, including coffee, pyrethrum, and mangos. The Sokoine University of Agriculture, the University of Dar es Salaam, and TaTEDO-SESO have been at the forefront of promoting solar dryers. These institutions are also promoting solar thermal for cooking in parallel with solar drying and solar heating. Solar water heating systems in Tanzania are used mainly by households and various types of institutions (e.g., hotels, hospitals, health centres, and dispensaries). Despite the potential of solar thermal and the demand for low-temperature water for both domestic and commercial applications, the uptake level is low.

3.0 Overview of the Proposed Regions

The geographical areas proposed for PURE interventions in Tanzania are regions of Kilimanjaro, Dar es Salaam, Pwani, and Dodoma.

3.1. Kilimanjaro

Kilimanjaro is a region of Tanzania located in the north-eastern part of Tanzania. The region borders Kenya in the northeast, the Tanga region in the southeast, the Arusha Region in the west, and the Manyara region to the southwest. According to the 2022 census, the population of Kilimanjaro Region stands at 1,861,934 people. The Region has an area of 13,209 square kilometres. About 2.3 percent of the regional land is covered by water (rivers, lakes, and dams), while the surface area is 98.7 percent. The regional capital is the municipality of Moshi. The region is divided into six district councils, namely, Moshi, Rombo, Mwanga, Same, Hai, and Siha.

Kilimanjaro is one of the top five most developed regions of Tanzania. The Region can be divided into three agroecological zones, namely, the Lowlands (1,500 m and below); the Highlands (1,500-3000 m), and the Forest (above 3000 m). With the exception of land above 3000 m, most of the land can be used for agricultural activities. Agricultural land, on the other hand, can be classified into four main zones: The Coffee zone, which can grow coffee, bananas, maize, beans, and keep dairy cattle. The Wheat zone, where the agricultural activities include wheat, beans, maize, and dairy production. The Lower zone includes areas suitable for maize, cotton, beans, and paddy. The forestry zone accounts for 388,500 ha of forest and a national park.

Agriculture (crops, livestock, and fisheries) is the main economic activity, contributing about 60 percent to the region's GDP and over 75 percent of employment to the rural

population. Irrigation farming is popular in the lowland zone. Rivers are the main source of water for irrigation. About 15.3 percent of the total area of the region is under livestock farming. Despite the scarcity of grazing land, livestock keeping is ranked the second predominant economic activity after crop farming. Households living in the highlands and intermediate zones practice modern dairy farming under zero-grazing systems or stall feeding. The Kilimanjaro Region has favourable geographical and climatic conditions as well as good soil and water conditions, which are crucial for the horticulture sector growth, ensuring a year-round growing season of flowers, cuttings, vegetables, and horticultural seeds.

This geographical concentration provides an option to develop an efficient export cluster of the horticulture industry, infrastructure, related companies, and support services.

3.2 Dodoma

Dodoma Region is a newly unfolding investment and business opportunity. The region Dodoma Region is a newly unfolding investment and business opportunity. The region had a population of 3,085,625 in 2022. The region lies in the heart of Tanzania in the Eastern-Central part of the country, about 300 miles (480 kilometres)

from the Indian Ocean coast. The region covers an area of 41,311 square kilometres. Already, tremendous developments have taken place to support the capital transfer programme by the central government. As a result, regional economic growth has increased over the past two years to match the national average, with an acceleration in per capita income and poverty reduction.

Climatic conditions as well as geological features have been the basis of identifying different agro-ecological zones in the Dodoma Region. The region has three distinctive agro-ecological zones: Maasai Steppe Type Zone (Kondoa, the southern part of Bahi District, and the south-west of Mpwapwa District), Maize Zone (the central and southern part of Kondoa District, the northeastern part of the Bahi area, Chamwino District, the whole of Dodoma Urban and Kongwa Districts, and parts of Mpwapwa), and Rainy Zone (Mpwapwa District's mainly hilly areas and the Bereko highlands in Kondoa District). The rainy zone has the best rainfall regime in the region. Rainfall ranges from 700 to 1000mm per annum. Soils are deep, dark, reddish-brown clay loams with black clay solid in depressions and valleys.

Dodoma Region is famous for the production of fruits such as grapes, mango, papaya, guava, baobab, tamarind, and dates. In addition, grape production is the mainstay for many farmers near Dodoma City and the nearby districts of Chamwino and Bahi. The major staple food crops produced in Dodoma include maize, sorghum, millet, rice, pulses (mainly pigeon peas), cassava, potatoes, bananas, and plantains in some areas. Among staple food crops, maize and sorghum are the major crops produced in the region, mostly in Kongwa, Chemba, Kondoa, Mpwapwa, and Chamwino districts. Several vegetables were found to be commonly grown in Dodoma. These include spinach, amaranths, tomatoes, Chinese cabbage, onions, okra, lettuce, eggplant, bell pepper, and carrots.

Even though Dodoma is largely known as a semi-arid area, which is unsuitable for agriculture, it is yet blessed with shallow water tables with abundant underground water. It is estimated that only 15 to 40 feet are required to be drilled to reach the permanent water table in most parts of the region. Currently, the majority of farmers who are using irrigation in Dodoma rely only on large water bodies, including streams, dams, and rivers, which dry up shortly after the rainy season. The option of extracting groundwater in Dodoma could be the best solution for the agribusiness sector. Livestock keeping is the second major economic activity in the Dodoma Region. Livestock reduces malnutrition, generates income, and determines household economic and social status in many communities. Most of the livestock kept is of the indigenous type (99 percent) that thrives well in the prevailing climatic conditions. Large-scale indigenous chicken production to meet the ever-increasing market in the country, as consumers have gradually shifted preference from commercial poultry products to local chicken products, and the shifting of government offices from Dar es Salaam to Dodoma.

3.3 Pwani

Pwani Region is located in the eastern part of Tanzania's Mainland. Administratively, the region is divided into seven districts, namely: Bagamoyo, Kibaha, Kisarawe, Chalinze, Kibiti, Mkuranga, Rufiji, and Mafia. Pwani Region covers an area of about 3,353,900 total hectares (about 3.8 percent of the country's total area), of which dry land constitutes 3,240,700 hectares and water occupies about 113,200 hectares. The region's population stands at 2,024,947 in 2022, of which 80 percent depends on agriculture as a means of livelihood.

Agriculture contributes about 60 percent of the regional income. Other important sectors of the economy of the Pwani Region include fisheries, industry, mining, and tourism. Pwani Region is located on the coast, in proximity to the Port of Dar es Salaam for imports and exports. The region is well served by a network of roads that link the rural population clusters and also provide easy communication with the surrounding areas. Agriculture is the backbone of the regional economy, on whereby about 80 percent of its population depends on agriculture as its main source of livelihood. It also contributes to 60 percent of the region's Income. The most important cash crops in the region are cashew nuts, coconuts, cotton, sesame, and fruits such as oranges, mangoes, watermelons, passion fruit, and pineapples, as well as cucumber, okra, and tomatoes. Cashew nuts are cultivated in all district councils in the region as part of the promotion of cashew nuts as a commercial crop. Coconut production ranks second after cashew nuts. Its production performs much better in areas such as Mafia, Bagamoyo, Mkuranga, Kisarawe, Kibiti, and Rufiji district councils.

The major staple food crops produced in Pwani Region include maize, cassava, paddy, cowpeas, sorghum, legumes, sesame, sweet potatoes, and green grams. Vegetables produced in the Pwani Region include cabbage, spinach, amaranth, tomatoes, onions, okra, lettuce, eggplant, bell pepper, and carrots. Various types of fruits are produced in the region due to its suitable climatic and weather conditions.

They include oranges, mangoes, cucumbers, watermelons, pawpaws, passion, and pineapples.

Strategic position and availability of water from the three major rivers, i.e., Rufiji, Wami, and Ruvu, give Pwani a relative advantage in irrigated crop farming, mostly paddy, horticulture, and sugarcane. Pwani Region population also relies on the livestock economy, with the major source of income being local zebu cattle. Improved dairy cattle are also reared in all councils, especially in the peri-urban areas. Other domestic animals that support the population's livelihood are goats, sheep, donkeys, pigs, and poultry.

3.4 Dar es Salaam

Dar es Salaam Region lies along the western coast of the Indian Ocean. It is situated between 6 and 7 degrees south of the Equator and between longitudes 33.33 and 39 degrees east of Greenwich. It borders with Pwani Region in the North, West, and South, and the Indian Ocean to the East. The region's population stood at 5,383,728 in 2022. The total surface area of the Dar es Salaam Region is 1,628 square kilometres, which is equivalent to 0.18 percent of the entire Tanzania. The region is divided into five districts, called Ilala, Kinondoni, Temeke, Kigamboni, and Ubungo. The region is divided into three ecological zones, namely the upland zone comprising hilly areas to the west and north; the middle plateau; and the lowlands, which include Msimbazi Valley, Jangwani, Mtoni, Africana, and Ununio areas.

Dar es Salaam has a vibrant and diversified economy, depending mainly on manufacturing, transport and communication, trade, the hospitality industry, fisheries, and urban agriculture. Dar es Salaam has 67,300 hectares of arable land. Agricultural activities are mostly practiced in peri-urban areas. Urban agriculture, including plant and animal husbandry, is an integral part of the local food system in Dar es Salaam, providing fresh vegetables including The characteristics of the region's peri-urban agriculture sector are quite variable, reflecting an engagement of low, middle, and high-income groups. In recent years, high-income groups have become increasingly involved in peri-urban agriculture, mainly in horticulture crops.

Livestock keeping is one of the economic activities undertaken in the Dar es Salaam Region. Animal husbandry contributes to household income and the local food system in the region. Eggs, poultry, milk, and meat are supplied locally. The quality of livestock products like meat, milk, hides and skins, and other related products depends mostly on availability, status, and quality of infrastructure, such as crushes, abattoirs, hide and skin sheds, slaughter slabs, livestock markets or auctions, and accessibility to water.

Dar es Salaam Region has a 112-kilometre coastline extending from Pemba Mnazi in Kigamboni District to Mbweni in Kinondoni District. The coastline is well endowed with mangrove forests and coral reefs, offering ideal ecological habitats for vibrant fish resources., The region had 22 fish landing sites, 7,581 fishermen, and 1,186 fishing vessels. Fish farming is an upcoming activity; there are some fishponds and fish farmers. There are 15 small-scale fish processing plants actively involved in the value addition of fish and fisheries products. One of the notable markets is the Dar es Salaam Ferry Fish Market. Given the increasing demand for fish and fish products, the sub-sector offers a unique investment opportunity in both fisheries and aquaculture value chains.

4.0 Contribution of the Agricultural Value Chains to the Country's Development Agenda

Agricultural value chains are central to Tanzania's development, driving economic growth by increasing farmer income and rural employment, enhancing food and nutrition security, providing raw materials for industrialization, and contributing significantly to the nation's GDP and export earnings. By focusing on improved production, market access, and value addition, the country aims to boost productivity, alleviate poverty, and achieve its long-term development goals.

4.1. Country's Development Agenda

i) Food Security

Tanzania's food security agenda focuses on transforming the agricultural sector to increase productivity, promote climate-resilient practices, and ensure food and nutrition security for all people, as outlined in initiatives like the Tanzania Agriculture and Food Security Investment Plan (TAFSIP). Key priority areas include developing irrigation and sustainable land management, improving strategic grain reserves, strengthening school feeding programs with nutritious local foods, and increasing off-farm income-generating activities to enhance household food access. The initiative involves broad collaboration among government, local communities, international organizations, and the private sector.

ii) Industrialization

Tanzania's industrialization agenda drives the Productive Use of Renewable Energy (PURE) as a fundamental enabler of economic growth, aiming to transform the nation from an agricultural to a semi-industrialized economy. Tanzania's "Vision 2050" focuses on building a reliable, affordable, and clean energy system to power socio-economic transformation. Vision 2050 aims to make Tanzania a competitive industrial hub by 2050, with the industry sector expected to contribute over 40% to the country's GDP. The vision focuses on transforming key sectors to drive this growth, including manufacturing, agriculture, energy, infrastructure, and ICT, and leverages human capital development to build a skilled workforce.

Productive Uses of Renewable Energy (PURE), directly contribute to the industrialization agenda by increasing incomes and productivity. These initiatives help rural communities and micro, small, and medium-sized enterprises (MSMEs) to provide the energy needed for productive activities, which in turn increases their income and productivity.

iii) Private Investment in Agro-Processing

This sub-sector has the potential to generate employment, raise productivity, food production, transfer skills and technology, increase competitiveness, substitute imports and enhance exports, and contribute to the long-term national economic development. Although increasing, the inflow of foreign direct investment to the agriculture sector remains low, with 2–3% of the total foreign direct investment (USD 31.4 million in 2011). Rapid urbanization and rising incomes have contributed to increased demand for value-added products in the agriculture sector. However, on the supply side, the underdeveloped agroprocessing industry has so far failed to provide significant levels of import substitution for the urban food market. The mismatch between demand and supply for value-added food products resulted in tripling the country's food import bill between 2006 and 2013 (USD 963.9 million). Globally, the pattern of growth of the economy is influenced by the transformation of the agriculture sector through value addition of primary products, thereby influencing investments in industry and service sectors.

iv) Clean Cooking

Tanzania has distinct but complementary agendas of clean cooking. The goal is to ensure 80% of Tanzanians have access to affordable, sustainable, safe, and easy-to-use clean cooking solutions by 2034. The agenda for clean cooking intends to improve health and the environment, and a broader National Energy Compact focusing on increasing electricity connectivity to 75% by 2030 and implementing Productive Use of Renewable Energy (PURE) to boost economic growth and overall energy access. While clean cooking addresses specific household health issues and deforestation, PURE initiatives aim for systemic economic benefits by leveraging electricity for income-generating activities and wider societal development, complementing the goals of a modernized energy sector. Access to electricity for PURE can reduce reliance on traditional fuels for other uses, while clean cooking can free up household time and resources that can be channeled into productive activities.

v) Grid Extension for Rural Electrification

Tanzania aims for universal energy access by 2030, using a two-pronged approach: grid extension to reach more populated areas and Productive Use of Renewable Energy (PURE) through mini-grids and off-grid solutions to service remote areas and boost economic growth. While grid extension provides widespread connections, PURE inspires to use connected stakeholders to use grid electricity productively and also focuses on integrating renewable energy for income-generating activities, increasing rural productivity, employment, and incomes, and contributing to climate goals by diversifying the energy mix. The agenda intends to improve the livelihoods of rural populations by providing electricity for homes, public services, and productive uses, leveraging partnerships with international bodies and private sector investors..

4.2. PURE as an Enabler to Unlocking Agricultural Value Chains

Productive Use of Renewable Energy (PURE) will unlock agricultural value chains in Tanzania by powering tools and processes like irrigation, milling, drying, and cold storage, which increase crop yields, enable value-added processing, and expand market access for farmers, ultimately boosting incomes and supporting sustainable growth. Renewable energy sources such as solar, hydro, and biomass will be key enablers, providing an affordable, eco-friendly alternative to expensive fuel, allowing for year-round farming and the transformation of raw produce into higher-value products. The Agricultural Value Chains will be unlocked by investing in the following areas.

i) Enhanced Productivity

Renewable energy powers irrigation systems, ensuring a consistent water supply and allowing for multiple cropping seasons, leading to higher yields.

ii) Value Addition

By powering mills, dryers, and other processing equipment, PURE enables farmers to transform crops into higher-value products like flour, oils, or dried fruits, capturing more profit.

iii) Improved Market Linkages

Renewable energy supports infrastructure like cold chains for preserving perishable goods and helps create local markets by powering night markets and selling points for products.

iv) Income Generation and Economic Development

Increased productivity, value addition, and improved market access directly translate to higher farmer incomes and create new job opportunities within the agricultural sector.

To realize PURE's full potential, Tanzania must address challenges such as access to finance, developing supportive market ecosystems, and providing technical capacity building for rural entrepreneurs.

4.3 Unlocking Agricultural Value Chains through the Productive Use of Renewable Energy and Financial Access.

The unlocking of agricultural value chains involves integrating renewable energy technologies into agricultural activities to enhance productivity, increase incomes, and improve livelihoods. This is achieved by providing access to crucial financial resources and appropriate PURE technologies, such as solar-powered irrigation or mills, to smallholder farmers and rural businesses. The process creates persistent benefits when renewable energy access supports agricultural processing, local industries, and market connectivity, leading to greater economic value creation and more resilient rural economies. Financial access involves making loans, grants, and other forms of capital available to PURE enterprises and smallholder farmers, enabling them to acquire and deploy PURE technologies.

i) Productive Use of Renewable Energy (PURE)

PURE focuses on using clean, renewable energy to power income-generating activities in rural communities, creating a positive feedback loop that boosts economic growth, increases incomes, and spurs demand for renewable energy. PURE is an effective solution for extending energy access and enhancing income generation, particularly among rural and lower-income populations that lack electricity access or are unable to afford it. In Tanzania, the productive use of renewable energy in agriculture, livestock, and fisheries involves incorporating energy-powered solutions across various value chains to boost income and productivity.

Initiatives to build electricity demand in remote communities must also develop reliable and affordable energy delivery systems. Getting local businesses to productively use renewable energy is a key part of building this demand and enhancing livelihoods to benefit community economic development.

Use of renewable energy in the Aquaculture Scheme

ii) Access to Finance

Access to finance plays a crucial role in driving and expanding PURE lending to SMEs and end users, who face affordability challenges due to the high upfront costs of PURE appliances and limited financing options. At the same time, PURE provides Local Finance Initiatives (LFIs) with an opportunity to increase their impact by growing green lending portfolios, thus promoting sustainable development. A major obstacles that rural entrepreneurs face are high costs and low-income levels. LFIs are required to support agricultural sectors, but they are hindered by challenges like limited capacity and funding sources. To leverage this interest, overcome these barriers, and fully unlock the transformative potential of PURE, LFIs must institutionalize PURE lending, forge stronger partnerships with last-mile distributors and development cooperatives or enterprises, diversify their funding sources, and advocate for supportive policies while aggregating demand. In doing so, LFIs can position themselves as key drivers of energy access and economic empowerment, propelling forward the regional sustainable development agenda.

4.4 Country's PURE Investment Readiness

Tanzania has high potential for Productive Use of Renewable Energy (PURE) in the agriculture, livestock, and fisheries sectors. Investment readiness involves assessing the legal/regulatory environment, developing bankable projects with clear returns, demonstrating the link between energy and increased productivity/income, and securing patient capital from public and private investors.

Tanzania has high potential to scale up the use of renewable energy, including improvements in policy and regulatory frameworks, private sector involvement, and human capacity. The assessment, which includes the Renewable Readiness Assessment (RRA) by IRENA, highlights Tanzania's abundant renewable resources such as solar, wind, and hydropower. Key action areas involve detailed resource assessments, policy refinement to create a favorable environment for investment, and building the human capital needed to deploy and manage renewable energy technologies.

Tanzania has several agricultural readiness initiatives, notably the Agricultural Master Plan (AMP) (aiming for food systems transformation by 2050), the Second Agricultural Sector Development Programme (ASDP II), which focuses on increasing productivity, food security, rural incomes, and resilience to climate change, Tanzania Livestock Identification, Registration, and Traceability System (TANLITS) (for operational efficiency and system effectiveness in controlling disease, ensuring food safety, and regulating movement), and Institutional Strengthening (to improve the capacity of national institutions such as the Directorate of Socio-Fishers and Aquatic Resources (DSFA)). These initiatives are essential for effective management of investments in agriculture, livestock, and fisheries.

The country is also addressing risks such as climate variations, pests, and market volatility through programs that enhance access to agricultural technologies, inputs, and financial services, with support from various stakeholders, including the government, private sector, and development partners.

However, investment readiness faces challenges due to a developing market, limited access to finance, and a lack of understanding of capacity and profitability among rural entrepreneurs and financiers. Major challenges include high initial costs for solutions, risk aversion from investors, limited market access for PURE-powered products and services, and communities lacking the ability to operate commercial enterprises. To enhance readiness, stakeholders must identify opportunities, unlock funding, empower local communities, and adopt a comprehensive, ecosystem-based approach to foster sustainable, scalable solutions and attract capital for growth.

5.0 Objectives of the Investment Prospectus

PURE Investment Prospectus provides an approach to operationalizing the value chains proposed in agriculture, livestock, and fisheries by identifying and developing a set of implementable flagship projects, including their investment requirements, that can be presented for support to potential investors, financial institutions, government, including development partners.

6.0 Methodology for the Development of the Investment Prospectus

The value chain survey started with the identification of priority regions and value chains. The development of the Investment Prospectus (IP) drew on a broad range of information sources, including published and grey literature, key informant interviews, focus group discussions, secondary quantitative data, and primary data collection.

6.1 Selection of Priority Regions

The geographical areas selected for PURE interventions were regions with potential for proposed agriculture, livestock, and fishery activities. These are regions with various improved and new income-generating activities, often in agriculture, livestock, and fisheries, which could support communities in rural and urban areas. These are activities that will be supported by renewable energy to lower their costs and increase productivity. The districts selected from project regions are Hai, Mwanga, and Moshi Districts (Kilimanjaro), Chamwino, Bahi, Dodoma Urban, and Kondoa (Dodoma), and Ubungo, Ilala, Kinondoni, Bagamoyo, Nkuranga, and Rufiji (Dar es Salaam/Pwani).

6.2 Selection of Priority Value Chains

The preliminary desk review assessment was conducted to identify Value Chains
The preliminary desk review assessment was conducted to identify Value Chains
of High-Impact Opportunities for Productive Use of Renewable Energy in proposed regions. High Impact, high potential opportunities according to WRI 2024 are the value chains that exhibit the most prospects of demonstrating long-term effects on livelihoods and the environment as a result of the intended implementation of development initiatives aimed at achieving positive benefits at scale. These are productive opportunities that are not only economically viable, scalable, and replicable but also

with social impacts on food security, livelihood improvement, and gender equality, and can reduce greenhouse gases and practice eco-friendly waste management.

WRI and TaTEDO-SESO, through their initiative on 'A Data-Driven Approach to Prioritize Productive Use of Renewable Energy Interventions mapped out high-impact, high-potential PURE opportunities within the agriculture, livestock, and fisheries space, being central in affirming the specific subsectors. The value chains proposed for the PURE research surveys are shown in the table hereunder

Table 1: Identified Projects by Value Chain

Region	Sector	Value Chain	Potential Projects	Energy Investment Needs
Kilimanjaro	Agriculture	**Banana**	Solar Drying of Banana	Commercial Solar Dryers Storage Facilities for Dried Products Packaging Materials Grinding of Dried Banana
		Horticultural Crops (Tomato)	Solar Water Pumping for Horticultural Crops in Lowlands	Solar Water Pumping System Water Storage Facilities Sprinkler or Drip Irrigation facilities
			Solar Drying of Horticultural Crops	Commercial Solar Dryers Storage Facilities for Dried Products
	Livestock	**Dairy Milk**	Cooling and Processing Dairy Milk in Rural Areas	Solar PV System Milk Coolers Dairy Milk Product Processing Facilities (for cheese, yogurt, and butter)
		Poultry (Chicken)	Solar Lighting in Poultry Production	Solar PV for lighting to substitute expensive grid electricity in chicken pens

Region	Sector	Value Chain	Potential Projects	Energy Investment Needs
Dodoma	Agriculture	**Mango**	Drip Irrigation for Mango Crop Production Solar Drying of Mango Fruits	Solar PV System Solar Pumps Drip Irrigation Commercial Solar Dryers Storage Facilities for Dried Products
	Livestock	**Livestock (Cattle)**	Water Supply for Livestock in Arid Areas	Solar PV System Solar Pumps
		Poultry (Chicken)	Solar Lighting in Poultry Production	Solar PV for lighting to substitute expensive grid electricity in chicken pens
Dar es Salaam / Pwani	Agriculture	**Agricultural Crops (Cassava)**	Agricultural Crops Drying in Dar es Salaam and Pwani Regions	Commercial Solar Dryers Storage Facilities for Dried Products Packaging Materials
	Livestock	**Poultry (Chicken)**	Solar Lighting in Poultry Production	Solar PV for lighting to substitute expensive grid electricity in chicken pens
	Fisheries	**Fish**	Support Fishing in Dar es Salaam and Pwani Regions	Solar Lanterns for Lighting and Fishing Solar PV for Powering Fish Cooling Facilities

Source: Regional Investment Profiles (UNDP/ESRF) 2018-2022

6.3 Data Collection (Survey & Field Visits)

The data collection started with developing a wish list of PURE opportunities, secondary information collection, and identification of gaps, and the dynamic engagement of stakeholders by holding a day meeting of representatives of stakeholders from different potential areas at selected venues in Kilimanjaro, Dodoma, Dar es Salaam and Pwani. The secondary data collection was also conducted from regional and district agricultural, livestock, and fisheries offices and relevant organizations related to selected value chains.

The wishlist defined research questions, identification of the target population, a plan for data collection and analysis, ethical considerations, and a strategy for managing and presenting the data. Additionally, developing a “wishlist” of potential questions helped in prioritizing the most important areas required for the PURE survey.

The wishlist was improved by WRI and TaTEDO-SESO, and the proposed questions were used to develop space and a questionnaire for each value chain that supported data collection through the data collection software named ArcGIS Survey123.

The wish-list preparation was followed by data collection, which started in the Pwani and Dar es Salaam regions and continued in the Dodoma Region, and was finalized in the Kilimanjaro Region. The survey activities for Pwani and Dar es Salaam were undertaken in Kisarawe, Mkuranga, Bagamoyo, and Ubungo Districts from 4 – 8 March 2025. The survey was performed in the districts of Kongwa, Chamwino, Bahi, Dodoma MC, and Kindoa (Dodoma Region). The survey was completed by survey activities in Hai, Moshi Rural, and Mwanga Districts, Kilimanjaro(i) Visit social and economic groups and enterprises which are farming and process cassava and rear chickens in Kisarawe District. Social and Economic groups visited were Kisarawe Joint Poultry Farm, TASHIMWA Poultry Women Group, Jipe Moyo Women Groups, Upendo development Groups, and Five Poultry Rearing Groups in Kisarawe. Enterprises visited were Upendo Cassava Processing Enterprise and TASAF Cassava Processing Women Group, Mtomola Poultry Project, Sarah Ernes Poultry farm (4-5 March 2025)

6.4 Data Analysis

Data Analysis was performed by using a set of structured templates for PURE data analysis and Energy Access Explorer (EAE). The qualitative and quantitative analysis was performed to get an assessment of the Gender Equality and Social Inclusion

(GESI), and at the end, coefficients for project appraisal were determined to assess the viability of the flagship project, which emanated from proposed value chains in agriculture, fisheries, and livestock sectors.

6.4.1 EAE (PURE Prioritization Index)

The Energy Access Explorer (EAE) was also supported by using the PURE Prioritization Index that prioritizes quantitative or qualitative information from data collected from project areas for uploading to the Energy Access Explorer Portal, which, in the future, will help to guide decisions, allocate resources, and determine the order of actions.

The Energy Access Explorer (EAE) is an open-source, interactive online geospatial platform that helps users identify high-priority areas for expanding energy access by analyzing and visualizing energy supply and demand data. It was developed by the World Resources Institute (WRI) and partners, and it uses spatial analysis tools like multi-criteria analysis and overlays to link energy infrastructure and resources with demographic data and indicators for social and productive uses.

Therefore, the information collected from PURE Value Chains Surveys will also become inputs to the EAE portal, and people may access this data for other undertakings in the future.

6.4.2 Gender Equality and Social Inclusion

The data collected from the field visits were also used to analyze Gender Equality and Social Inclusion (GESI) in the research survey project areas. The GESI needs assessment was conducted by collecting disaggregated data (e.g., by sex, age, disability, gender identity) using qualitative and quantitative methods like surveys and focus groups. The GESI analysis explored how different social identities intersect to create disparities and then developed methods for tracking progress and ensuring PURE projects avoid marginalizing any group.

6.4.3 Project Appraisal Techniques (Payback Period, RoI)

Project appraisal techniques for assessing the project's feasibility by analyzing its financial, economic, and operational viability using methods like Payback Period and Return on Investment (RoI). These coefficients were used to analyse the flagship projects which originated from PURE Value Chain Surveys in Agriculture, Livestock, and Fisheries Sectors. Beyond financial metrics, appraisals also involve market analysis, technical appraisal, etc.

7.0 Investment Projects Across Priority Value Chains

7.1 Production Status (plus estimated demand/consumption) of Each Value Chain by Regions

i) Banana

Bananas are a central part of the diet and economy of Tanzania and are grown in many regions of the country. They are versatile fruits that can be used in many ways, including boiled, roasted, eaten ripe, dried chips for eating, pounded into flour, or brewed into beer. Tanzania is one of the leading producers of bananas in Africa, with significant cultivation in regions such as Kilimanjaro.

According to the Tranquil Kilimanjaro report (2024), the Kilimanjaro Region grows around 20 varieties of bananas, including the Kitarasa, Nduya, Red, Giant Cavendish, Kisukari, Mshare, Matoke, Gros Michel, Bluggoe, Mzuzu, etc, which are marketed locally or exported to external markets.

Kilimanjaro Region produces an average of 700,000 to 1 million tonnes of bananas annually. This significant production makes it one of the leading areas for banana cultivation in Tanzania. During the surplus production of bananas, smallholder farmers face difficulty in marketing them, and post-harvesting facilities are inadequate and may not increase their shelf life.

ii) Horticultural Crops (Tomato)

Tanzania's market consumes 322 tons of the annual tomato production in the country. According to the Kilimanjaro Region Investment Guide (2018), Horticulture farming in the Kilimanjaro Region includes a variety of crops, farming practices, and business opportunities. A large part of the region is suitable for horticultural crop farming. The Kilimanjaro Region is an area that has so far been exporting horticultural products. The climate and soils around Mt Kilimanjaro are favourable for the year-round cultivation of sub-tropical and temperate vegetables. The horticultural crop selected for the value chain is tomato. Kilimanjaro Region is a significant tomato-producing region in Tanzania, with a substantial acreage dedicated to the crop. Tomatoes are a major crop in Kilimanjaro, particularly in areas like Hai, Moshi, Mwanga, and Rombo, and the production is largely for urban markets. Tomato yields in the Kilimanjaro Region vary, showing a yield of 7.8 tons/ha. A niche market exists for innovative technology that will improve production efficiency and reduce production costs.

iii) Dairy Milk

The Kilimanjaro region has a high potential for dairy milk farming. The region is endowed with more than 38,000 zero-grazing dairy cattle, which are kept on the southern slopes of Mount Kilimanjaro, where dairy farming is practiced. It is estimated that over 40 million litres are produced annually, most of which is consumed locally and sold to urban areas as raw or cultured milk (UNDP/ESRF 2018). In the Kilimanjaro Region, dairy milk is cooled in electric-powered cooling tanks after it is collected in the morning and evening. Milk is then processed or sold unpasteurized to consumers or wholesalers in the urban areas of Kilimanjaro. The constraints that smallholders are experiencing are ineffective milk collection, processing, and marketing. The result has been the vending of milk by middlemen and the establishment of dairy cooperatives in rural areas.

iv) Poultry (Chicken)

Poultry continues to strengthen its dominant position within meat production, accounting for nearly half of all the meat demand that needs to be produced over the next decade. The population of chickens in Tanzania currently stands at 83,280,000, comprising 38,770,000 indigenous chickens and 44,510,000 exotic chickens. Annual egg production stood at 4.05 billion and about 80,601.3 metric tons of poultry meat. The Government seeks to enhance poultry production and productivity by 2030 to be able to produce 553 million chickens (80% exotic) and 27.35 billion eggs per annum by 2050 (Edmond J Ringo and Faustin P. Lekule, 2020). The poultry value chains dominate in all four regions selected for the PURE project. In all four regions, both indigenous and exotic breeds of chickens are reared by smallholders for consumption and commercial purposes. The poultry subsector is a youth- and women-friendly

enterprise. Poultry industry creates opportunities throughout the value chain, not only in poultry production, processing, and marketing but also in grain production (the largest opportunity for small-scale farmers) and provision of critical inputs, especially feed.

v) Mango

Tanzania is a significant mango producer, generating around 700,000 metric tons annually, positioning it as the 12th largest global producer and a major player in the African market. The mango industry faces challenges, including limited infrastructure, high post-harvest losses due to perishability, pest control issues, and a lack of value addition, though opportunities exist to improve production, increase exports, and develop processing for pulp, juice, and dried products. High losses occur due to the fruit's perishability and improper handling.

Mango farming is a potential crop in the Dodoma Region, which is known for its fruit production. Mango production in the Dodoma region of Tanzania is dominated by smallholder farmers, leveraging the region's arid climate to grow mangoes, a versatile and adaptable crop. The general yield in Tanzania is high enough to make it a significant global producer, and the semi-arid conditions of Dodoma may even enhance the sweetness and yield of specific varieties.

vi) Livestock (cattle)

More recent data shows Tanzania having a total of 33.9 million cattle in 2019/20, with central Tanzania, where Dodoma is located, being a major area for cattle concentration. According to Ceven Shemsanga (2024), in Dodoma, Tanzania, the main sources of water for livestock and domestic use are wells and dams. However, water availability is limited and unreliable due to the dryland environment and unpredictable rainfall. Most groundwater in Dodoma is suitable for watering livestock such as herds of cattle, goats, and sheep. However, the availability of freshwater has been reduced by population growth and climate change. Some previous stakeholders drilled boreholes and installed diesel generators and pumps. As time goes on, the water demand is increasing due to the increase in the number of livestock and population for domestic water. However, these systems were installed in a few areas and powered by diesel water pumps.

vii) Agricultural Crops (Cassava)

Tanzania is a major cassava producer in Africa, cultivating it across various regions, including the Pwani Region, where it serves as a staple food and famine reserve crop. Tanzania produces around 6 million tons of cassava annually, placing it among Africa's top producers, with recent production figures from 2020-2025 suggesting an average of about 6.3 to 8.2 million tons. Production is supported by drought tolerance, diverse agro-ecological conditions, and initiatives to improve seed systems, develop high-yielding and disease-resistant varieties, and enhance commercialization. The crop is used for human food, animal feed, starch production, and export, with efforts underway to strengthen the entire value chain to boost farmer income and support national development goals. Preservation of cassava is one of the central problems faced by small-scale farmers in peri-urban areas of Dar es Salaam and Pwani Region. Poor infrastructure also increases the time to get crops to markets and often results in crops being damaged. At the end of the growing season, the supply of produce diminishes until the next harvest.

viii) Fish

Tanzania harvests tons of fish annually, with figures varying by source and year, but most recently reported at around 472,579 tonnes in 2024, primarily from natural waters. Freshwater sources, especially inland lakes, contribute the majority of this catch, alongside marine fisheries. The sector includes small-scale artisanal fisheries and a growing but still underdeveloped aquaculture industry. Fishing includes both large-scale and small-scale fishing in the Dar es Salaam and Pwani regions. According to the USAID et al. (2019), the annual demand for fish is 350,000 metric tons.

Demand for fish is rising steadily due to population growth and rising incomes. According to the AGRA (2023), the fish production-consumption gap by 2030 is estimated to be 914,329.47 metric tons based on annual per capita consumption of 10.5 kg and an additional 10% for export.

7.2 Proposed and Surveyed Investment Projects

7.2.1 Banana

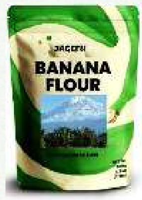
i) Project Name	Chajenda Kitarasa Banana Processing Project
GPS Coordinates	Longitude: 37.34777 Latitude: -3.339536667
Project Description	The Chajenda Kitarasa Banana Processing Project is a micro-business project that processes banana flour from the Kitarasa variety. The project is implemented by the Chajenda Women's Group. The group was established on February 20, 2021. Kitarasa Banana Flour is a gluten-free, nutrient-rich alternative to traditional flours, made from 100% green bananas. This versatile flour is high in resistant starch, which supports digestive health and helps regulate blood sugar levels. The objective of this project is to process and market Kitarasa Banana Flour to the local and national markets. The market for this flour is growing due to its gluten-free and nutritious qualities. Bananas are collected from fifteen villages in Moshi Rural District in the Kilimanjaro Region. The banana project is a cooperative business run by six (6) shareholders who support the drying, processing, and marketing of bananas from the processing centre of this cooperative. Kitarasa Banana Project contributes about 60% of the group's income compared to other business enterprises. Members are collecting and buying bananas from farmers, and processing is done at the centre. Bunches of bananas are collected from farmers, brought to the centre, peeled, dried, milled, packed, and sent to the market. Ripe bananas are used for solar-dried chips, and green bananas are used for processing banana flour. A solar dryer can dry up to 40 kg of dried banana at an interval of five (5) days. The initial investment costs for establishing this enterprise were TZS 4,250,000 (approximately USD 1,635), which were contributed by members. The overall recurrent monthly cost for electricity. And fuel is TZS 960,000 (USD 370). The average cost of buying a bunch of bananas is TZS 20,000. The profit margin for each bunch of bananas is TZS 5,000. The annual revenue from the processing of bananas is over TZS 8,320,000 (USD 3200). The annual net profit is TZS 2,080,000 (USD 800). The source of water for processing is tap water from the water supply system of the Moshi Rural District Council. The energy used for drying bananas is traditional sun drying. The cooperative is seeking a technology that utilizes renewable energy to mitigate the challenge of frequent power outages.

Photos	   
Project Risks	• Fluctuation of prices due to ripe banana market saturation, which lowers the profit of bananas in the market but advantage to the women's group. • The attack of the banana by rodents. • Difficulty of drying bananas all the time of year-round
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Expanding banana farming by increasing production and using electricity or renewable energy to power banana solar drying
Investment Needs	For drying bananas, a conceptual design is needed for a **solar dryer** in the Kilimanjaro Region capable of handling at least **200 kg of green bananas per batch. Currently, the** Chajenda Kitarasa Banana Processing Project **dries 40kg of green banana at an interval of 5 days. In designing the solar dryer, we will need to upgrade it to handle at least 200kg per batch, 5 times the current capacity.** A typical banana[1] pulp contains 70 – 80% water content, which needs a lot of energy to dry. The removal of moisture is around 60 to 70%. (200kg x 70% = 140 kg of water/day) ***Drying energy requirement*** Energy required to evaporate 1kg of water = 2,260kJ/kg Total energy = 140 kg water x 2,260kJ/kg = 316,400 kJ/day. Conversion of kJ/day into kWh 316,400 ÷3596=87.98 kWh/day A solar collector produces 1kW of useful energy per m^2 per day. The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh. • Required area for a solar collector=Total energy/useful energy per square meter. • Required area = 87.98kWh/day ÷ 3 kwh/day = 29.32m^2 • If the drying efficiency is adjusted to 80%, the final solar collector area will be. 29.32 ÷ 0.8 = 36.65m^2

[1] Cheok, C.Y et el, (2018) Pasting and physical properties of green banana flours and pastas

Proposed Investment Ticket Size	**Solar dryer** • Total system size = 36.65 m^2. Cost per m^2 = \$350 - Solar dryer cost = 36.65 m^2 x \$350/m^2 =\$12,828 - Milling machine (1000kg per hour) = \$3,000 - Total investment ticket = **\$15,828** To establish a retrofit for a solar PV system, the existing energy situation at the enterprise's premises is required, which will be determined during the development phase.
Proposed Investment Structure	**Models**: Lease-to-Own, High upfront costs of solar dryers encourage the cooperative to use a lease-to-model whereby the cooperative will rent a solar dryer with the option to purchase it at a later date. **Instruments:** Blended (Grant (80%) and Loan (20%)) are financial instruments required for the proposed investment in the solar dryer. The leader is avoiding putting cooperation into the liabilities.
Potential Impact	• Procurement of an efficient solar dryer, which will enable drying for all seasons throughout the year. • Some jobs and income will be created through solar drying for peeling and processing flour. • Increased incomes for smallholder farmers through Kitarasa Banana Flour and Solar-dried products

ii) Project Name	**Jagefu Women Group Banana Processing Project**
GPS Coordinates	Longitude: 37.38147766 Latitude: -3.342056292
Project Description	Jagefu Women Banana Processing Project is a cooperative micro business project for processing banana flour for the Kitarasa Banana variety. The project is implemented by the Jagefu Women's Group. The group was established on May 20, 2018. The group currently has fifteen female members.

	Kitarasa banana flour is a growing business opportunity, particularly in the Kilimanjaro Region, where the Kitarasa banana is cultivated and consumed. Bananas are purchased from the nearby markets of Moshi and Arusha Regions and brought to the centre for processing banana flour. Processing of bananas is in the form of drying ripe and unripe bananas. After drying, they are milled and sold as dried chips and banana flour. The dryer at the centre can dry up to 15 Kgs for three days. The initial investment costs of this enterprise were TZS 6,200,000, which were accrued from members' contributions. The overall recurrent monthly cost for electricity. and fuel is TZS 670,000 (USD 258). The annual revenue from the processing of bananas is over TZS 5,640,000 (USD 2,170). The annual net profit is TZS 1,500,000 (USD 577). The source of water for washing bananas during processing is fetched from a tap. The available solar dryer has a capacity of 15 kg. The drying is performed at an interval of 72 days. The energy used for processing is natural solar energy depends on weather conditions.
Photos	   
Project Risks	• Difficulty of getting profitable markets with high profit margin, • Inadequate solar dryer, which can dry 15 Kg in three days • High taxes on banana flour in the market
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Expanding banana farming by increasing production and using renewable energy for drying during rainy seasons
Investment Needs	The situation at the Jagefu Banana Processing project has an environment similar to Chajenda. Assumptions might be similar too. For drying bananas, we need to design a solar dryer in the Kilimanjaro region capable of handling at least 50 kg of green bananas per batch (three-day drying period). Currently, the Jagefu Women's Group Banana Processing Project dries 10kg of green bananas for 3 days. In designing the solar dryer, we will need to upgrade it to handle at least 50kg per batch, 5 times the current capacity.

	A typical banana pulp contains 70 – 80% water content, which needs a lot of energy to dry. The moisture to be removed is around 60 – 70%. 50kg x 70% = 35 kg of water/day Drying energy requirement Energy required to evaporate 1kg of water = 2,260kJ/kg Total energy = 35 kg water x 2,260kJ/kg = 79,100 kJ/day. Conversion of kJ/day into kWh 79,100÷3596=21.99~22 kWh/day A solar collector produces 1kw of useful energy per m². The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh. • Required area for a solar collector=Total energy/useful energy per square meter. • Required area = 48.99 kWh/day ÷ 2.1kwh/day = 23.33 m^2 • If we adjust for drying efficiency of 80%, the final solar collector area will be 23.33 ÷ 0.8 = 29.16 m^2
Proposed Investment Ticket Size	**Solar dryer** • Total system size = 29.16 m^2. Cost per m^2 = $350 • Total cost = 29.16 m^2 x $350/$m^2$ **=$10,206**
Proposed Investment Structure	**Models: Lease-to-Own**, High upfront costs of solar dryers encourage the cooperative to use a lease-to own-model whereby the cooperative will rent solar dryer with the option to purchase it at a later date. **Instruments:** Grant (70%) and equity (30%) are instruments required for the proposed investment in solar drying.
Potential Impact	• Kitarasa banana flour, made from the Kitarasa banana variety, has a positive impact on Tanzania's food security, nutrition, and livelihoods. • The flour also promotes biodiversity since people have increased cultivation of this variety after realizing its value to their health and income. • Create employment for the people in the community through cultivation, processing, and marketing. • Banana Flour from Kitarasa has been one of the means of increasing incomes for smallholder farmers and group members

7.2.2 Cassava

i) Project Name	Upendo Cassava Processing Project
GPS Coordinates	Longitude: 39.06786167 Latitude: -6.918048333
Project Description	The Upendo Cassava Processing Project is a family-owned business enterprise located in Kisarawe Peri-Urban, Kisarawe District, Pwani Region. The business enterprise activities are coordinated by Lydia Jacob Majollo, working with five (5) members, but acquiring cassava from an average of 150 smallholder farmers. The enterprise aims to convert cassava and other food products from smallholder farmers into processed products for distribution to customers in both urban and rural areas. The central function is to market cassava flour and cassava chips, which are processed at the enterprise centre. The products of Upendo Food Processing of Cassava Flour and Cassava Dried Chips. Other products include spices and solar-dried fruits and vegetables. Cassava contributes 30% of all business enterprises in the centre with a potential annual revenue of TZS 35 million (USD 13,677) Cassava is collected from farmers, peeled, washed, chopped, and sun-dried, then processed into cassava flour, cakes, and cassava starch, which is used in biscuits and tomato sauce. Some cassava is used to make cassava chips. About 150 smallholder farmers are cassava out-growers supplying cassava to the enterprise. The enterprise can process up to 1,200 Kg per day (approximately 438,000 Kg per year). The source of water is tapping water from the Kisarawe Town Council Water piping system. The water is stored in the tank. A total of 2000 litres is required per week for post-harvesting handling of the cassava. Upendo has storage facilities that can store 1,200 Kg of dried cassava. The enterprise uses traditional methods of storing fresh cassava, of putting it in shade (considering ventilation and temperature), sometimes digging pits, and watering fresh unpeeled cassava in the pits for four (4) days. The enterprise has a processing facility that operates five times per week, with a capacity of processing 4800 Kg per week. The facility is used for chipping, filtering, and grinding cassava. The facility includes a motorized chipping machine costing TZS 2,400,000, powered by grid electricity. The power rating for cassava processing equipment is 3.75 kW, consuming about 256 kWh per month. These facilities have monthly high maintenance and repair costs of an average of TZS 120,000, performed by a hired technician. Cassava waste is used as organic manure on the farm.

The initial investment cost for the enterprise was twenty million (which came from a loan and family contribution). The Cassava enterprise has a monthly revenue of 2,400,000 (net profit of TZS 600,000).

The members of staff are trained by SIDO and Plan International in food processing, and all of them have certificates in marketing, business, and food processing. Further skills and knowledge are required in record keeping, financial management, technical assistance to monitor various parameters in food processing, like humidity, temperature, food quality, marketing, and exposure to export processes.

Renewable Energy required in the centres includes solar PV for powering lights and processing machines. The modern commercial-size solar dryer is also required for drying cassava, and modern processing facilities for pressing and grinding cassava flour.

Photos




Project Risks

- High market competition for cassava products in the market. The number of cassava processors has increased competition in the market.
- Power blackouts for grid electricity are unfavorable to processing cassava products at the Centre.
- The high perishability of cassava requires fast processing machines, which are not available at the centre.
- Inability of the process on a large scale due to the inadequacy of processing facilities
- Monthly electricity costs: TZS 179,200 (USD 68.92)
- The centre has old solar drying facilities which can dry up to 1200 Kgs of cassava, competing with other products processed in the centre
- The enterprise does not have infrastructures that support adequate processing of starch, peeling, and grinding machines. The solar dryer is of old model and is not in good shape. They do not have cold storage, and the source of water is tap water from the town council water piping system, which is not reliable, and available water storage can not suffice the requirements of enterprise activities

Project Enablers	• Enabling environment in terms of policies, a favorable agricultural and business environment that does not favor cassava processing. • Extension services and credits, which may expand the cultivation and processing of cassava for small-scale processors and farmers. • Inability of the central and local governments to ensure access to quality planting materials appropriate for processing cassava flour and chips. • Inadequate opportunities to access finance for buying processing facilities and markets for products
Investment Needs	**Sizing the solar dryer** Typically, cassava in coastal areas of Tanzania contains 60 to 70% water content, which needs a substantial amount of energy to dry, ready for grinding into flour. Upendo Cassava Processing Project processes around 40 kg of raw cassava per day. We have to design a semi-industrial solar dryer that can dry at least 100kg per batch. The moisture to be removed is around 70%. 100kg x 70% = 70 kg of water/day Drying energy requirement Given that the energy required to evaporate 1kg of water = 2,260kJ/kg Total energy = 70 kg water x 2,260kJ/kg = 158,200 kJ/day. Conversion of kJ/day into kWh, we therefore get 158,200÷3596 = 44 kWh/day A typical solar collector produces 1kW of useful energy per m^2 per day. The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh. • Required area for a solar collector = Total energy/useful energy per square meter. • Required area = 44 kWh/day ÷ 6 kwh/day = 7.33 m^2 • If the required area is adjusted for drying efficiency of 80%, the final solar collector area will be 7.33 ÷ 0.8 = 9.16 m^2 • Total system size = 9.16 m^2. Cost per m^2 = $350 • Solar dryer cost will be: 9.16 m^2 x $350 = **$3,206**

Sizing the solar PV system

Average daily consumption: 8.53 kWh. Primary usage: Electricity is used for grinding, while cassava is dried by an old semi-industrial solar dryer. Secondary loads: lighting and office machines. The enterprise also has electrically powered machines with 1.5 kW, which all require at least 6 kWh during weekly processing and 256 kWh per month for grinding and pressing. The new technologies are required for chipping, packing, milling, peeling machines, and a solar dryer with a capacity of more than 5000 kg at a time.

The Solar PV System and solar dryer will be required with technical specifications of system capacity: 2 kW for the solar PV system for powering processing machines during power cuts and lighting. The expected solar contribution is to generate roughly 14 kilowatt-hours (kWh) of electricity per day. The system efficiency includes the ability to receive an average of 5.5 to 6 peak sun hours per day. This translates to an approximate daily solar energy generation of 11 to 14 kWh, assuming standard solar panel efficiency. The solar PV system will be a separate system that will operate to save costs of grid electricity, or energy during power cuts.

- Daily energy needs = 8.53 kWh/day
- Assuming the plant operates for 12 hours a day
- Total energy demand = 8.53 x 12 hours = 102.36 Kwh

Solar capacity required (with 6 peak sun hours)

Solar system size = 102.36 Kwh ÷ 6 = 17.06 Kw

Total cost = 17.06 kW x 1000 x 2.75USD/kW = **$46,915**

Proposed Investment Ticket Size

Total system cost (both solar PV and Dryer): USD 12,692.3. The annual energy savings are $599. The renewable energy systems are expected to have a simple payback period: 3-4 years.

· Solar dryer cost = **$3,206**

· Solar PV system = **$46,915**

Total investment cost = **$50,121**

Proposed Investment Structure	**Models** **Out-grower Enterprise Model** - for receiving cassava from smallholder farmers and improving the efficiency of the cassava value chain, **Lease-to-Own** - High upfront costs of solar PV systems encourage the cooperative to use a lease-to-Own model, whereby the cooperative will rent solar PV systems with the option to purchase them at a later date. **Energy-as-a-Service -** someone can invest in a solar PV system and supply electricity for lights and processing during blackouts. **Instruments:** Grants (60%) and loans (40%) are the instruments required for the proposed investment in solar PV systems and solar drying facilities.
Potential Impact	• Solar PV system will provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Some jobs and income will be created through solar PV installation. • Solar drying facilities will provide an opportunity to increase the conversion of perishable products of cassava into dried cassava products (ready market for cassava growers)

ii) Project Name	**Inuka Cassava Processing Project**
GPS Coordinates	Longitude: 39.3301319, Latitude: -7.032994787
Project Description	The Inuka Cassava Processing Project is managed and implemented by Inuka Women Group, with eight members, located in Mkuranga District, Pwani Region. The business enterprise was established in 2019. The project has managed to create 14 job opportunities for the people in the community. The main function of this project (around 75%) is the processing of cassava. Other products processed by Inuka include Mlenda, Kisamvu, Sweet Potatoes, etc.

The market for cassava products is the urban areas of Mkuranga Town and the city of Dar es Salaam (retailers, wholesalers, individuals, and supermarkets). The processed products are sold on the market through various channels. Some customers come to the centre; others order and buy products from the centre and then transport those products to local and distant markets. The group is also using online means of ordering through mobile contacts and sending cassava products to the customers.

The processing functions offered by the cooperative group for processing cassava include cleaning, washing, peeling, chipping, drying, grinding, and packaging. The capacity of the cooperative for cassava processing is 5.5 Kg. The motorized chipping equipment is used, which costs TZS 240,000

The water consumption for cassava processing is 15000 liters per day. The centre has a storage tank of 5,000 litres. The cooperative fetches water from the borehole.

The repair and maintenance are undertaken by a hired technician. The costs of repair and maintenance for the processing facilities are TZS 40,000 twice per month.

Cassava flour is packed in polyethylene bags of 25 kg. The cooperative group has a plan to expand cassava-related services by expanding the cassava farming and buying from out-growers to increase the volume of products sold to the market. This will influence them to have more machines for processing and more employed people, especially empowering youth and women.

The profit is distributed equally among members at the end of the season. The profit goes to only those who actively participate jointly in the group-assigned work. The initial investment cost for establishing the cassava enterprise is TZS 4,000,000. The monthly revenue from the cassava business is TZS 1,350,000, with a profit margin of TZS 1,270,000 (USD 5,862 per year).

The cooperative has received training from TaTEDO-SESO on solar drying. The cooperative management is always seeking new knowledge through training from the community, the district development officers on processing and packaging. More knowledge and skills are required in areas of business and entrepreneurship development, credit facility education, cassava preparation, and drying.

The opportunities for improving services in the cassava value chain for ensuring local communities will receive well-prepared cassava products for breakfast staff (porridge, and bites) and exploiting distant markets for cassava flour products.

The renewable energy services required by this enterprise are the Solar PV system for lighting and powering the processing facility, and additional solar drying and processing facilities. The processing machine and ovens for baking cassava cakes are other technologies required by the cooperative for cassava processing.

The cassava industry (farming and processing) is expanding to meet high demand in the market. The group intends to build a separate processing and packaging place for cassava. This will go concurrently with expanding storage facilities and ordering packaging materials from outside the country. An additional modern commercial-size solar dryer is also required for drying cassava, and modern processing facilities for pressing and grinding cassava flour.

Photos

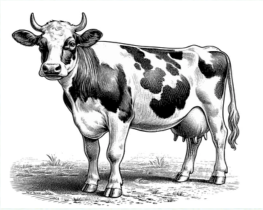


Project Risks

- High market competition for cassava products in the market. The number of cassava processors has increased competition in the market.
- The high perishability of cassava requires fast processing machines, which are not available at the centre.
- The milling place is mixed with other products, hence reducing the quality of the cassava flour.
- The packaging materials are too expensive and less available.
- Working capital and equipment,
- The production drops during the cloudy and rainy season due to reliance on solar energy

Project Enablers	• Enabling environment in terms of policies, a favorable agricultural and business environment that favors cassava processing, • Inability of the central and local governments to ensure access to quality planting materials appropriate for processing cassava flour and chips. • The TBS and TMDA certifications are required to access the market without restrictions. • District government support to gain knowledge and exposure from different exhibitions, • There are opportunities to get a loan for cooperative activities (cassava inclusive) from the Mkuranga District Council (MDC)
Investment Needs	Inuka Cassava Processing Project looks bigger in scale. Cassava in coastal areas of Tanzania contains 60 to 70% water content, which needs a substantial amount of energy to dry, ready for grinding into flour. It is estimated that the project harvests 10,000kg of cassava per season. A solar dryer that can dry 1200kg per batch should be designed for this project (3 to 5 days, depending on weather conditions). ***Sizing the solar dryer*** The moisture to be removed is around 70%. 1200kg x 70% = 720 kg of water/day Drying energy requirement Given that the energy required to evaporate 1kg of water = 2,260kJ/kg Total energy = 720 kg water x 2,260kJ/kg = 1,627,200 kJ/day. Conversion of kJ/day into kWh: results are: 1,627,200÷3596=452.5 kWh/day A typical solar collector produces 1kW of useful energy per m^2 per day. The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh. • Required area for a solar collector = total energy/useful energy per square meter. • Required area = 452.5 kWh/day ÷ 3 kwh/day = 150.83 m^2 • If the required area for drying efficiency is adjusted to 80%, the final solar collector area will be 150.83 ÷ 0.8 = 187.5 m^2

	Sizing the solar PV system for Water Pumping and peripherals The solar PV system is expected to power a 5.5 HP (3.73 kW) cassava chipping machine, a 3HP (2.24 kW) submersible water pump, 8 (15-watt) LED lights and 3 pcs of 90-watt fans. Total energy demand is 6.6kW. Estimated daily energy demand (6 peak sun hours per day) • It is assumed that the plant operates for 10 hours a day. • Total energy demand = 6.6kW x 10hrs =66 kWh/day • During power outages, solar will provide 100% energy to the project. During ordinary days, solar may contribute about 60% of power to the project with an efficiency of 80%. • Solar energy contribution = (66 ÷ 0.8) x 60% = 49.5kWh/day • Solar capacity required: 49.5 kWh ÷ 6 = 8.25kW • Total cost = 8.25kW x 1000 x$2.75/W = $22,687
Proposed Investment Ticket Size	**Solar dryer** • Total system size = 150.83 m^2. Cost per m^2 = $350 **Total cost = 150.83 m^2 x $350/$m^2$ = $52,790.5** • Solar PV system • Total cost = 6.6kW x 1000 x$2.75/W = **$18,150** **Total project cost =** $52,790.5 **+** $18,150 = **$70,940.5**
Proposed Investment Structure	**Models:** Lease-to-Own - High upfront costs of solar dryer and solar PV system encourage the enterprise to use a lease-to-own model, whereby the cooperative will rent the solar PV system and solar dryer with the option to purchase them at a later date. **Instruments:** Blended finance from grant (50%), technical assistance (10%), and loan (40%) are the instruments required for the proposed investment in solar drying facilities.
Potential Impact	• Some jobs and income will be created through the solar dryer installation and use. • Solar drying facilities will offer an opportunity to improve the conversion of perishable cassava products into dried cassava products. • The project will solve the problem of the perishability of cassava and gent flour to reduce food insecurity in the community. • The byproducts of cassava are disposed of on erosive land areas and help reduce soil erosion by dumping cassava waste in eroded areas.



7.2.3 Dairy Farming

i) Project Name	**Nronga Women Dairy Cooperative Society (NWDCS)**
GPS Coordinates	Longitude: 37.210975, Latitude: -3.197373333
Project Description	The Nronga Women Dairy Cooperative Society Limited was formed on 01 September 1988 and registered with the number KLR 476 as an organization of female dairy farmers in Hai District, Kilimanjaro Region, Tanzania. The cooperative is aimed at improving the well-being of the Nronga village community through promoting small-scale dairy farming and its flow-on benefits. Currently, the cooperative has a membership of 105 smallholder dairy cow keepers with the potential of supplying more than 547,500 litres of milk per year. Milk is collected through milk collection points and flows out of the village, and revenue from dairy products flows into the village for investment, ensuring a sustainable financial circulation necessary for poverty reduction, rural development, and a better life for the rural community. The cooperative's services provided to the Nronga community and members include: • Buying milk from all the dairy farmers in the village. • Promoting milk consumption through school milk nutrition programs. • Offering savings and credit facilities to the community (by way of a village community bank), • Providing artificial insemination of dairy cows, also for neighbouring villages, Evening and morning milk is collected and cooled in the electric-powered cooler before transporting it to the processing plant or selling fresh to wholesalers or consumers in urban areas of Kilimanjaro and Arusha Regions. The processing plant at Boma was initiated by their financial resources and support from development partners (Australian Aid), which contributed resources for building a dairy factory in the district capital town (Boma - Hai) to enable NWDCS to make more milk packets and process more dairy products.

The three Australian donors requested Global Development Group (GDG), an Australian charity organization to carry out a project to relieve poverty, provide a governance role and assist in the areas of planning, monitoring and evaluation, as well as compliance, risk management and auditing, to ensure that this project is carried out to Australian aid requirements.

The products processed are yoghurt, butter, pasteurized milk, and ghee. Fresh milk is also supplied to the consumers for drinking, tea, and other uses. Currently, Cooperative buys a litre of milk at TZS 1,100 and sells it at the retail price of TZS 1,500. The profit margin for the cooperative is 400, which is also used to meet the costs of transport, electricity, labour, and other operations. This cooperative profit may amount to more than TZS 200 million per year.

The cooperative has a milk cooler which is powered by grid electricity. During power blackouts, the cooperative uses the generator or a small solar PV system, which is not enough to power all our processing machines. The solar PV system was undersized; therefore, it has been difficult to maintain milk cooling during long power blackouts.

The source of water for the cooperative is tap water that is supplied to the cooperative through a network of pipes installed by the government in the village. Cooperative requires the supply of 150 litres of water per day.

Photos




Project Risks

High market competition for dairy products in the market. The number of dairy groups and processors has increased competition in the market. This sometimes leads to lowering the price of milk and dairy products, or slowly disposing of products to the customers

Power blackouts for grid electricity are unfavorable to the dairy product processing and milk cooling at the Dairy Cooperative Centre.

Project Enablers

- Expanding the processing plant at Boma to process more dairy products
- Focus on market penetration and expansion to the regional and export markets.
- Installation of a solar PV system with high capacity for power backup during power blackouts
- Vehicle with cooling facilities for transporting milk to the processing plant and distant markets

Investment Needs	• Investment needs are directed towards increasing milk production at dairy farming levels and processing in the milk plant. • Dairy Farming: extension services for better feedstock for dairy cows and appropriate dairy keeping husbandry. Other requirements are artificial insemination facilities. All these services and facilities may cost about TZS 150,000,000 (for dairy keeping husbandry) and TZS 14,500,000 (artificial insemination). ***System sizing of PURE equipment needs.*** **Sizing and Installation of Solar PV System:** • A solar PV system is required for the milk cooler at the Milk Collection Centre in Nronga Village, and another large solar PV System at Boma ya Ng'ombe for powering the dairy processing plant during power blackouts. • Solar PV system for Milk Cooler: A solar PV system is a viable solution for powering a milk cooler at Nronga Dairy Society.
	• A 600-liter milk cooler typically requires a power supply of 220-240V, 50Hz. The cooling power is 6219 W (2.5 HP), with a maximum power of 3186 W. • A 2-3kW Solar PV system will be needed for a 600L solar-powered milk cooler at Nronga to generate enough electricity to power the cooler and charge the batteries. • Solar PV system for Dairy Processing Plant • Solarized Refrigerated Vehicle for Transporting Milk to the processing plant and distant markets. • A basic refrigerated truck could range from \$31,000 to \$46,000 (TZS 76 to 105 million), including all taxes, potentially higher for larger, more specialized trucks.
Proposed Investment Ticket Size	• Solar PV System for 600L solar-powered milk chiller will require TZS 16,900,000 (\$6,500) • Solar PV system for Dairy Processing Plant will require the cost of TZS 65,000,000(\$25,000) • Refrigerated Vehicle for Transporting Milk to the processing plant costs \$ 40,000 Ex Japan (***this item is not included in the total investment ticket***) **Estimated total Investment.** Solar PV System for milk chillers = \$6,500 Solar PV system for a milk processing plant = \$25,000 Refrigerated truck = \$31,000 **Total investment = 6,500+25,000 +31,000 = \$62,500**

Proposed Investment Structure	• Models: There is a need for a joint venture between companies with an interest in investing in dairy farming and the Nronga Dairy Women Society to further develop Dairy Farming and Marketing for smallholders in Nronga Village, thereby improving profits and sharing the risks associated with dairy farming development. • **Instruments:** The total investment costs of the dairy business enterprise are TZS 65,000,000 (approximately USD 25,000). The kind of funding preferred is a grant and equity (80% grant and 20% loan)
Potential Impact	• Good dairy keeping husbandry will help to increase the yield of milk for dairy cow keepers, and therefore, more volume of milk will be sent to the cooperative, and more income to the dairy farmers. • Solar PV system will offset the high costs of diesel used in the generators for the milk cooler and the dairy processing plant. • Solar PV system will also provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs will be created for artificial insemination and extension services for the farmers

ii) Project Name	**Kalali Women Dairy Cooperative Society (KWDCS)**
GPS Coordinates	Longitude: 37.21838333, Latitude: -3.218476667
Project Description	Kalali Women Dairy Cooperative Society started in 1988 with the goal of which has been empowering women farmers and improving the lives of their households for over 20 years. The society began with 160 members and has since surpassed 250. It is a women-owned dairy cooperative located in Machame Ward, Hai District, the Kilimanjaro region. About 300 women members bring milk to the cooperative milk collection centre. The cooperative has a milk processing plant with a capacity of up to 1000 litres per day; however, the plant may process about 3000 litres per day.

The KWDCS performed different functions to support women members in the dairy value chain. The central function was the marketing of milk and dairy products produced by members and processed at the centre. Other services are to offer saving and credit facilities to their members, including Village Community Banks (VICOBA) and Savings and Credit Cooperative Societies (SACCOS), and provide artificial insemination of dairy cows in the two villages, as well as in neighbouring villages. The cooperative can collect up to 750 litres per day (approximately 270,000 litres per year).

The financial support from various development organizations and members' contributions for Kalali Women Dairy Cooperatives managed to establish micro dairy product processing plants to process milk and to produce other products. Thus, collected milk is supplied and processed into various products, including fresh whole milk, skimmed cultured milk, whole cultured milk in packets, pasteurized butter, and yogurt, which are mostly sold to the community and shops in Moshi and Arusha towns. The cooperatives have secured milk markets from the farmers in Kalali and neighbouring villages.

The products processed are Pasteurized milk, Raw fresh milk, Yoghurt, Cheese, and Butter. Currently, Cooperative buys a litre of milk at TZS 1,300 and sells it at the retail price of TZS 1,500. The profit margin for the cooperative is 200, which is also used for meeting transport, electricity, labour, and other costs. This cooperative profit may amount to more than TZS 54 million per year.

The cooperative has a milk cooler which is powered by grid electricity. The cooperative has a diesel generator for power backup during power cuts. The costs of running the generators are high, especially during the long power blackouts.

The source of water for the cooperative is tap water that is supplied to the cooperative through a network of pipes installed by the government in the Wari Sinde village. Cooperative requires the supply of about 400 litres of water per day.

Photos

Project Risks	• High market competition for dairy products in the market. The number of dairy groups and processors has increased competition in the market. This sometimes leads to lowering the price of milk and dairy products, or slowly disposing of products to the customers • Power blackouts for grid electricity are unfavorable to the dairy product processing and milk cooling at the Dairy Cooperative Centre. • Inability to process other forms of dairy products due to the unavailability of processing facilities and small capital.
Project Enablers	• Expanding the processing plant at Kalali for more dairy products • Focus on market penetration and expansion to the regional and export markets. • Installation of a solar PV system with high capacity for power backup during power blackouts
Investment Needs	• Investment needs are directed towards increasing milk production at dairy farming levels and processing in the milk plant • Average daily consumption: 56.1 kWh • Primary usage: milk processing, cooling, and cream separation • Secondary loads: lighting, and cooperative office machines • System sizing of PURE equipment needs • Sizing and Installation of Solar PV System • A solar PV system is required for the milk cooler and Processing Plant at the Milk Collection Centre at Kalali Dairy Cooperative Society. • Solar PV system for Milk Cooler and Processing Plant • A system capacity of 6kW solar PV system will be required to support processing, cooling, and other office energy requirements • Solar energy requirements of 30 kilowatt-hours (kWh) of electricity per day (32% of energy needs) • System efficiency: 85% with 5 peak sun hours daily • The solar PV system will be a separate system that will operate to save the costs of grid electricity or during power cuts

Proposed Investment Ticket Size	• Total cost of Solar PV System will be around TZS 21,125,000 **($8,125)** • Refrigerated truck **($31,000)** • Total investment ticket = **($39,125)** • The annual energy savings by introducing a solar PV system will be TZS 3,296,800 (equivalent to $1,268) • Simple payback period: 3.88 years
Proposed Investment Structure	• **Models:** Lease-to-Own, and Energy-as-a-Service High upfront costs of solar PV systems encourage the cooperative to use a lease-to model, whereby the cooperative will rent solar PV systems with the option to purchase them at a later date. Otherwise, someone can invest in a solar PV system and supply electricity during blackouts (energy as a service) • **Instruments:** Grant (75%) and Loan (25%) are financial instruments required for the proposed investment in solar PV systems. The leader is avoiding putting cooperation into the liabilities.
Potential Impact	• Solar PV system will offset the high costs of diesel used in the generators for the milk cooler and the dairy processing plant. • Solar PV system will also provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs and income will be created through solar PV installation

iii) Project Name	**Dream Light Women Group (DLWG)**
GPS Coordinates	Longitude: 37.51667, Latitude:-3.28333
Project Description	Dream Light Women Group started on April 23, 2015, intending to empower female smallholder farmers by enabling them to acquire heifers and receive training on dairy keeping husbandry for their improved livelihoods in rural areas of Moshi District. The cooperative has five (5) leaders and another 60 dairy farmers who supply milk from the community.

The DLWG is located at Ashira, Marangu Ward, in the Rural Moshi District of the Kilimanjaro region, with a building for accommodating milk processing facilities and keeping dairy cows. The cooperative has a milk processing plant with a processing capacity of up to 850 litres per day; however, the plant is now processing about 600 litres per day.

The DLWG performed different functions to support women members in the dairy value chain. The central function is to market milk and dairy products produced by members and processed at the centre. Other services were to offer dairy keeping extension services and provide artificial insemination of dairy cows of their members and suppliers of milk to the centre. The cooperative can collect up to 219,000 litres per year.

The financial support for developing a dairy keeping and processing plant was contributed from the family-own-funds which established a micro dairy processing plant to process milk and to produce other products. Thus, collected milk is supplied and processed into various products, including fresh whole milk, skimmed cultured milk, whole cultured milk supplied through buckets, butter, ghee, and yogurt, which are mostly sold to the community and shops in Moshi towns. The cooperatives have in the past secured dairy product markets around the urban centres near the border in Kenya.

Currently, Cooperative buys a litre of milk at TZS 800 and sells it at the retail price of TZS 1,500. The profit margin for the cooperative is 700, which is also used for meeting transport, electricity, labour, and other costs. This cooperative profit may amount to more than TZS 153 million per year.

The cooperative has a milk cooler which is powered by grid electricity. The cooperative has a diesel generator for power backup during power cuts. The costs for running the generators is high, especially during the long power blackouts.

The source of water for the cooperative is tap water that is supplied to the cooperative through a network of pipes installed by the government in the Marangu Ward. Cooperative requires the supply of about 100 litres of water per day.

Photos




Project Risks	• High market competition for dairy products in the market. The number of dairy groups and processors has increased competition in the market. This sometimes leads to lowering the price of milk and dairy products, or slowly disposing of products to the customers • Power blackouts for grid electricity are unfavorable to the dairy product processing and milk cooling at the Dairy Cooperative Centre. • Mistake in processing and managing milk, which sometimes results in the milk curdling
Project Enablers	· Expanding the processing facilities at Ashira to process more products by using modern dairy processing facilities, · Focus on market expansion to the national and export markets. Installation of a solar PV system with high capacity for power backup during power blackouts
Investment Needs	Investment needs are directed towards increasing the processing of more dairy products and the installation of a solar PV system to offset the challenges of electric blackouts. *System sizing of PURE equipment needs.* To properly size the solar PV system, we need to know the existing loads and their capacity. • A ***1,000L milk chiller*** (approx. 2.5 kW input), • A ***milk processing plant*** (Daily Energy = ***2.5 kW × 4 h = 10 kWh***), and • ***10 lighting points*** (roughly 120 W total). So, ***Total continuous load:*** ~3.62 kW (chiller 2.5 kW + processing 2.5 kW + lights 0.12 kW). For buffer and battery charging, a ***5.12 kW PV system*** is appropriate. Total system size = 5.12 kW, cost per watt=$2.75 Solar PV cost = **5.12 kW x 1000 x 2.75 = $ 14,080** A 1000-litre milk chiller costs around **$10,000** A 10,000-litre milk processing plant (pasteurization and packaging) = $150,000
Proposed Investment Ticket Size	Solar PV cost = **4 kW x 1000 x 2.75 = $ 14,080** A 1000-litre milk chiller costs around **$10,000** Milk processing plant = $150,000 Total investment ticket = **$174,080**

Proposed Investment Structure	• **Models:** Lease-to-Own, and Energy-as-a-Service High upfront costs of solar PV systems encourage the cooperative to use a lease-to own-model whereby the cooperative will rent solar PV systems with the option to purchase them at a later date. Otherwise, someone can invest in a solar PV system and supply electricity during blackouts (energy as a service) • **Instruments:** Blend of Loan, Grant, Equity, and technical assistance: Blended financial instruments (20% loan, 40% grant, 10 %equity, 30% technical assistance) are financial options required for the proposed investment in solar PV systems.
Potential Impact	• Solar PV system will offset the high costs of diesel used in the generators for the milk cooler and the dairy processing plant. • Solar PV system will also provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs and income will be created through solar PV installation

iv) Project Name	**Tam-tam Dairy Farming Enterprise (TDFE)**
GPS Coordinates	Longitude: 37.57436488, Latitude: -3.261261261
Project Description	Tam-tam Dairy Farming Enterprise is owned by Pastor Ebenezer Festo Mrema and is located in Mwika, Moshi Rural District of Kilimanjaro Region. TDFE started its operations on May 21, 2015, intending to collect fresh milk from smallholder farmers and send it to the market in the nearby urban centres of Moshi and Himo. The enterprise has nine (9) leaders and five (5) staff working in the enterprise for dairy cattle keeping, milk collection, processing, and marketing. The TDFE is accommodated in the family compound with milk cooling facilities, herd of dairy cows, piggery, and poultry. The milk cooling facilities have a capacity of up to 1,000 litres per day. The plant is now processing about 650 litres per day.

The TDFE collects milk from other dairy cow keepers in Mwika. The central function of TDFE is to market milk and dairy products collected in the enterprise. Other services were to offer dairy keeping advisory services to other dairy cow keepers in the Mwika Community. The enterprise can collect up to 1,000 litres of milk per year.

The financial support for developing dairy farming and processing facilities was provided by the family (TZS 500,000). Thus, milk is collected, cooled, and some is used for processing dairy products. Others are packed and transported to the local and urban markets. The dairy products available in the enterprise include fresh milk, yoghurt, skimmed milk, and butter.

Currently, TDFE buys a litre of milk at TZS 800 and sells it at the retail price of TZS 1,500. The profit margin for the cooperative is TZS 700, which is also used for meeting transport, electricity, labour, and other costs. This cooperative profit may amount to more than TZS 255.5 million per year.

The enterprise has a local milk boiler made from metal tanks. After boiling, milk is cooled to increase its shelf life and sent to the market. The wood fuels are the energy used by the enterprise to boil milk. The milk cooling facilities are used for cooling boiled milk. During power fluctuations and blackouts, they take advantage of the cold weather in Kilimanjaro, which helps to maintain milk for a long time without curdling. The cooling facilities are powered by grid electricity. The enterprise does not have a generator or solar PV system for powering cooling facilities during power cuts.

The source of water for the cooperative is tapping water that is supplied to the enterprise through a network of pipes installed by the government in the Mwika Ward. Enterprise requires a supply of about 2400 litres of water per week.

Photos




Project Risks	• High market competition for dairy products. The number of dairy groups and processors has increased competition in the market. This sometimes leads to lowering the price of dairy products, or slowly disposing of those products to the customers • Power blackouts for grid electricity are unfavorable to the dairy product processing and milk cooling at the Dairy Cooperative Centre.
Project Enablers	• Expanding the processing facilities at Mwika to process more dairy products • Focus on market expansion to the national and export markets. • Installation of a solar PV system with high capacity for power backup during power blackouts.
Investment Needs	Investment needs are directed towards increasing milk production at dairy farming levels and processing in the milk plant. One of the strategies to increase production is to have chillers which will help avoid milk curdling. **System sizing of PURE equipment needs** • A solar PV system is required for the milk cooler and to power the dairy processing plant during a power blackout at the Milk Collection Centre of the Tam-tam Dairy Farming Enterprise. *Sizing the Solar PV System* • **Milk chiller (1000 L)** – A typical industrial milk chiller may draw ~2–3 kW (estimating average daily usage 24kWh), assuming TDFE will use modern stainless steel chillers for milk cooling instead of ordinary freezers. • **Milk-processing equipment** – Varies widely; a small plant (pasteurizer, pumps, etc.) may need ~5 kW, ~30 kWh/day. The pasteurizer will help with producing pasteurized milk for the international market. • **8 lights** – Assuming 15 W LED each, running 10 hours/day = 8 × 15 W × 10 h = **1.2 kWh/day** (~0.1 kW). • **Total estimate**: ~8 kW load capacity, ~55 kWh energy per day. To allow for autonomy during blackouts and to compensate for system inefficiencies, we must size the PV system at **10 kW** with battery storage for **2 days of autonomy** (≈110 kWh usable). • It is assumed that the factory operates 10 hours a day • Energy demand = 10kWx10 hours=100kWh/day • With the assumption that solar contributes 50% of the daily energy needs, the demand would therefore be 100kWhx50%=50Kwh/day.

- With the assumption that the system operates at an efficiency of 80%, the energy produced will be 100kWhx0.8=80kWh

For the firewood milk boiler, the enterprise needs to replace it with two (2) energy-efficient institutional stoves that run on uncarbonized briquettes. The stoves are coupled with a 500-liter pot each, so they will have a combined capacity of 1000 litres. Due to the low price of briquettes (TZS 800 per kg), the enterprise will get rid of firewood, hence save the environment.

Proposed Investment Ticket Size

- Total system size=10 kW cost per watt = $2.75
- Total cost=10kW x 1000 x $2.75/W= $27,500

Equipment needs for a solar PV system

Table 2: Approximate equipment costs in Dar es Salaam

Item	**Spec & Quantity**	**Est. Cost (USD)**	**Est. Cost (TZS; ~/USD×2,500)**
PV panels	10 kW total (e.g., 20 × 500 W)	$6,500	TZS 16,250,000
Inverter (Hybrid/ off-grid)	10 kW capacity	$2,000	TZS 5,000,000
Batteries	~120 kWh Li-ion (usable)	$12,000	TZS 30,000,000
Mounting & BOS (wiring, charge controller, etc.)	Assorted items	$4,000	TZS 5,000,000
Installation/ Commissioning	Labor, permits	$3,000	TZS 5,000,000
Total Estimate		**$27,500**	**68,750,000**

Equipment needs for the institutional stove (to replace wood-fired milk boilers)

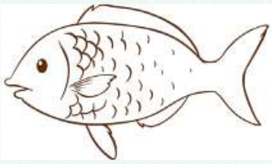
- Two (2) institutional cook stoves with 500L pots = 2x5,000,000 = 10,000,000
- With the current exchange US$ to TZS, 10,000,000/2500 = $4,000

Total investment costs for the project:

- Solar PV = $27,500
- Improved institutional Stoves = $4,000
- 1000-litre milk chiller = $10,000

Total investment = $41,500

Proposed Investment Structure	• **Models**: Lease-to-Own, and Energy-as-a-Service High upfront costs of solar PV systems encourage the cooperative to use a lease-to model, whereby the cooperative will rent solar PV systems with the option to purchase them at a later date. Otherwise, someone can invest in a solar PV system and supply electricity during blackouts (energy as a service) • **Instruments**: Grants, Loans Blended financial instruments (90% Grants,10% Loans) are financial options required for the proposed investment in solar PV systems.
Potential Impact	• Solar PV system will offset the high costs of diesel used in the generators for the milk cooler and the dairy processing plant. • Solar PV system will also provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs and income will be created through solar PV installation



7.2.4 Fisheries/Aquaculture

i) Project Name	Fahari Fish Aquaculture Business Project
GPS Coordinates	Longitude: 39.34788167, Latitude: -7.315366667
Project Description	The Fahari Fish Aquaculture Business Project in Mkuranga is a fish farming venture that focuses on sustainable aquaculture practices. The business enterprise is managed by Yahaya Kwangu and was established on December 22, 2023. The objective is to bridge the gap between the increasing demand for fish and the limited supply from capture fisheries, particularly in some areas of Pwani and Dar es Salaam Regions, where fish is a vital source of protein. The project will improve livelihoods, reduce fishing pressure, and enhance the local supply of protein. The business project will offer training, workshops, consultancies, and research on freshwater aquaculture and mariculture, promoting fish farming and attracting investment. The project has five (5) acres covered with fish ponds located in Mkuranga District, Pwani Region. The value proposition of this aquaculture business project lies in its ability to provide a sustainable and reliable source of seafood, thereby contributing to food security, economic growth, and environmental responsibility. It offers a solution to the challenges of overfishing and declining wild fish stocks, while also providing opportunities for income generation and improved livelihoods. The species of fish reared in ponds are Mkuyule, Tilapia, and Midomo Mirefu. The sources of fish feeds and seeds, Mkuranga and Dar es Salaam. The average production per cycle for harvesting fish is 120 days, and three (3) production cycles are performed per year. Water for filling in fish ponds is sourced from the nearby Indian Ocean, which is at a distance of 16 Km from the fish farming area. Supply of water is ensured by continuously lifting water to the ponds by a water pump and supplying it through a piping system. The total production of the enterprise per month is 120 fish. The vehicles and motorcycles are used to transport fish to the collection centre located 33 kilometres. The cooperative collection capacity per day is 50 fish per day. Water for fish handling and washing fish is obtained from a borehole.

The processing of fish is performed by frying fish before sending them to the market. The type of storage facilities available in the enterprise is Cooler Boxes. A total of 50 fish are fried and sent to the market. The equipment used for fish processing is Pots and stoves. Charcoal and firewood are used as fuels for fish processing.

The packaging is done manually by filling boxes before sending them to the market. The packaging materials have a capacity of 40 Kgs, costing TZS 1000 per kg. The average distance from the cooperative to the market is 33 Km. Two distribution channels are used by the business project to supply fish to the customers. These channels are starting from the Enterprise Centre via retailers to the local customers, and another channel is starting from the centre via wholesalers, retailers, to urban markets. Around 80% of fish is sold to national urban markets while only 20% is bought by customers in local nearby markets. The retail price per kg of fish is TZS 3,000. Petrol Motorbikes and Non-Refrigerated Vehicles are used to transport fish products to the market. Twenty (20) litres of fuel, costing TZS 60,000, are filled into the rented vehicles each week for centre activities.

The quantity of water required for all processes by the cooperative is 2,000 litres per day. Water is pumped twice per day from the borehole to the tank by a 2.5kW petrol water pump. These water pumping facilities are procured from the city of Dar es Salaam. The additional cost of labour and others is TZS 10,000.

The daily cost incurred by the project is TZS 25,000. The average net income/profit at the cooperative level per month is TZS 360,000, which is funded by the owner. The investment priorities required by this enterprise are to expand the project by developing more fish-ponds, which can produce and supply fish to meet demand in the local, regional, and national markets

The renewable energy solutions which is required for fish operations are solar PV systems in each pond, coupled with the provision of pond facilities and improvement of fish marketing facilities

Photos

Project Risks

- Inefficient equipment for processing fish and fish products
- Seepage losses of water from fishponds due to cracks in the pond bands
- Difficulties and high competition in the fish market at Dar es Salaam and Pwani regions
- High perishability of fish and spoilage, which was reported to be 15 % of the yield from fish ponds

Project Enablers

- Enabling environment in terms of national fisheries policies, a favorable fisheries and aquaculture sectors that favor fisheries industries
- Power company electricity supply is available, but need for a reliable supply to the customers.
- Technical support to the fishers and owners of aquaculture enterprises from LGAs

Investment Needs

Table 3:Load Estimation

Appliance	Quantity	Power (W)	Daily Use (Hours)	Daily Energy (Wh)
Chest Freezer (500 L)	2	~120 W (average)	48	5,760 Wh
LED Lights (e.g.10W)	5	10 W each = 50 W	6	300 Wh
Submersible Pump	1	~1,000 W (est.)	1 intermittent use	1,000 Wh
Total	—	—	—	**7,060 Wh (7.06 kWh)**

System sizing

- We assume that the plant operates for 10 hours a day and
- Total energy demand = 7.06kW x 10hrs =70.6 kWh/day
- During power outages, solar will provide 100% energy to the project. During ordinary days, solar may contribute about 60% of power to the project with 6 peak sun hours.
- Assuming solar (with efficiency of 80%) provides 60 of daily energy needs.
- Solar energy contribution = (70.6÷0.8) x 60%= 52.95 kWh/day
- Solar capacity required: 52.95 kWh ÷ 6 = 8.83kW
- Total cost = 8.83kW x 1000 x $2.75/W = $24,282.5

Proposed Investment Ticket Size	The investment amount needed for solarizing this aquaculture project is **$24,282.5**
Proposed Investment Structure	**Models**: • **Direct Purchase**: The enterprise requires fish-frying efficient cookstoves, which will be constructed at the fish collection centre for frying fish • **Lease-to-Own** – High upfront costs of solar PV systems for supporting lighting, processing, and cooling facilities encourage the cooperative to use a lease-to-own model, whereby the cooperative will rent solar PV systems with the option to purchase them at a later date • **Energy-as-a-Service** – someone can invest in a solar PV system and supply electricity during blackouts **Instruments**: • The blended financing (Grants (33%), Loan(15%), and Technical Assistance (52%)) is required as financial instruments for investing in the proposed four (4) solar PV systems. The additional funds will be used to expand the project by installing the renewable energy systems and aquaculture facilities
Potential Impact	• The enterprise likely emphasizes environmentally friendly and economically viable fish farming methods. • By providing training and resources, the enterprise could help local communities develop skills and income opportunities through fish farming. • Sustainable aquaculture can help alleviate pressure on fish stocks by providing an alternative source of fish for consumption. • The enterprise may focus on transferring knowledge and best practices in aquaculture to farmers. • With the increasing demand for fish and the potential for aquaculture to contribute to food security and play a significant role in the local economy. • The aquaculture enterprise will enable the creation of more employment from the existing six (6) to thirteen (13) job opportunities

7.2.5 Livestock

i) Project Name	Chipukizi Hakika Kyando Cattle Watering Project
GPS Coordinates	Longitude: 36.30810134, Latitude: -6.074568265
Project Description	Chipukizi Hakika Kyando Cattle Watering Project is a family business enterprise established on March 18, 2023, located in Kongwa District along the main road from Dodoma to Dar es Salaam. The aim is to provide water for drinking to the community people and livestock which are reared in the miombo woodlands of rural areas of Kongwa District and other areas from the Kongwa District Livestock Auction. The source of water is a borehole. Water is pumped from the borehole by the Grundig Water Pump 3 HP to the 2,000-litre tank and three (3) surface galvanized water troughs (each with a capacity of 200 litres) that are used for livestock water drinking. The size of the water pump in terms of water discharge is 5,000 litres per hour (operated for 4 hours in seven days per week). The borehole can accommodate 20 livestock at a time. A total of 300 cattle receive water for drinking per day. The primary source of energy for water pumping is electricity. A value proposition for this business enterprise is focusing on improving access to clean water for livestock, boosting productivity, and enhancing livelihoods for pastoral communities and animals, which are brought from the auction. This is achieved through innovative water management solutions, potentially involving local expertise, leading to increased better livestock health, and reduced time spent fetching water. Another value proposition is the availability of water for local uses to households and people in the nearby community. The Initial investment of the project was TZS 39,230,000 (USD 15,088.5). The average daily revenue for watering livestock is TZS 30,000. The total annual revenue is TZS 10,950,000. The profit margin for this enterprise is 55 percent. Energy used for water pumping is grid electricity. They have a desire to have a solar PV system for backup during power blackouts to continuously supply water to the livestock and people in the community.

Photos



Project Risks

Power blackouts for grid electricity are which cause an inability to supply water to livestock during the power cuts.

Project Enablers

- Enabling environment in terms of policies, agricultural and business environment,
- Extension services and credits, which may expand the water supply for livestock for pastoralists

Investment Needs

Improving and expanding facilities for watering cattle and an alternative energy supply (solar PV system). According to the information from the project, there is an existing 3HP water pump that pumps water from the borehole for the needs of both people and livestock. Given that the existing equipment does not meet the demand, we need to augment the whole water system to meet current demands and potential future growth.

System sizing based on energy demands.

- 1 electrical horsepower (hp) ≈ **746 W**; therefore, a 3 hp pump = **3 × 746 W** ≈ **2,238 W.** For three pumps: 2,238 W × 3 ≈ **6,714** W (~6.7 kW total pump load)
- Estimate Lighting Load: Assuming each light bulb is **15 W** (common residential LED): total lighting load = 15 W × 8 = **120 W**. The light is needed, given that during a blackout, pumping operations at night should go on from the backup power. Assuming 5 hours/day 0.12 kW × 5 h = 0.6 kWh/day. Therefore, the total daily demand ≈ is **27.456 kWh** With 25% system losses **~34.3 kWh/day**
- Three (3) 3HP surface water water pump = $219x3 = 657
- Eight (8) light bulbs @$4 = $32
- Three (3) 15,000-litre storage polyethylene water tanks @ $996.36 = $2,989.08
- Assorted pipes and fittings for supplying water to the community for extra income generation = $3000

(The above components are not to be counted in the total investment ticket)

Total demand = 27.456 kWh

Solar capacity required (6 peak sun hours) = 27.456kWh ÷ 6 = **4.576**

Total system size = 4.58 kW. Cost per watt = 2.75

Total cost = 4.48 Kw x 1000x $2.75 = $ 12,320

Energy generation per annum from this system will be: -

Annual Energy Production (kWh) x Electricity cost per kWh =

4.48 kW x 6 hours/day x 365 x 0.8 x 0.139 = $ 1,091

Therefore, the simple payback period is expected to be:-

Initial investment/Annual savings (energy revenue)

$12,320/$1,091 = 10.06

Payback period = **10.29 years.**

Table 4: Material Cost Estimation in Dar es Salaam

Component	Specification / Capacity	Est. Cost (TZS)
Solar Panels (~450 W) ×18	~8 kW total	14,400,000
Batteries ($LiFePO_4$, ~76 kWh)	~1,590 Ah @ 48 V	19,250,000
Inverter Hybrid)	(8 kW, 48 V	2,400,000
MPPT Charge Controller	Suitable for ~8 kW array	1,000,000
Assorted items (mounts, cabling, protection, installation)		3,000,000
Total Estimate		**40,050,000 TZS**
1 USD (2,500 TZS)		**~16,020 USD**

Proposed Investment Ticket Size

- Total Investment Amount for the above **Energy Needs**
- Costing of energy needs – Both for PURE equipment and retrofitting needs (with assumptions in the Annex)
- Standalone solar PV system = $12,320
- **Total investment** = $12,320

Proposed Investment Structure	• Total Investment Amount for the above **Energy Needs** • Costing of energy needs – Both for PURE equipment and retrofitting needs (with assumptions in the Annex) • Standalone solar PV system = $12,320 • **Total investment =** $12,320
Proposed Investment Structure	• **Models: Public-Private Partnerships; Lease-to-Own** High upfront costs of solar PV systems encourage the enterprise to use a Public-Private Partnership or a lease-to-own model. Through the lease-to model, the enterprise will rent a solar PV system and pay by installments with the option to purchase it at a later date. Otherwise, arrangements can be facilitated by the government or LGAs to practice PPP for supporting pastoralists to water their livestock. • **Instruments**: Grant (85%) and Loan (15%) are financial instruments required for the proposed investment in the solar PV system.
Potential Impact	• Solar PV system will also provide energy freedom and reduce the risk of electricity cuts during power blackouts. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Some jobs and income are and will be created through solar PV installation, and watering the livestock in the miombo woodlands

ii) Project Name	**Naiman Kileo Livestock Watering Project**
GPS Coordinates	Longitude: 35.37323954, Latitude: -5.997068266
Project Description	Naiman Kileo Livestock Watering Project is a family business enterprise located in the Bahi District. The enterprise has five (5) shareholders. The aim is to provide water for drinking to the community and livestock that are reared in the rural miombo woodlands of the Bahi District. The source of water is a borehole of 180 metres in depth. Water is pumped from the borehole by the Water Pump to the tank and flows to the concrete water trough (with a capacity of 5,000 litres), which is where livestock drink water.

The size of the water pump in terms of water discharge is 3,000 litres per hour (operated for 5 hours in six days per week). The borehole can accommodate 60 livestock at a time. A total of 600 cattle receive water for drinking per day. The primary source of energy for water pumping is a solar PV system (with 4.16 kW) and a malfunctioned diesel generator (20 litres per day). The water pumping cannot meet the demand of water to livestock, so instead diesel generator is used as an alternative.

A Naiman Kileo livestock watering facility offers a compelling value proposition for both domestic and livestock needs, particularly due to the region's limited surface water sources and reliance on groundwater. Boreholes provide access to clean, reliable, and potentially affordable water, improving sanitation, health, and livestock productivity, boosting livelihoods and resilience in a water-stressed area.

The initial investment of the project was TZS 39,500,000 (USD 15,192.3). The average daily revenue for watering livestock is TZS 60,000. The total annual revenue is TZS 21,900,000. The profit margin for this enterprise is TZS 13,140,000 for a year.

Energy used for water pumping is a small solar PV system and a diesel generator. They have a desire to have a bigger solar PV system to increase water pumping and supply water to the livestock and people in the community.

Additional Information

- The project has a 4.16 kW solar PV system (4 panels x 400 watts = 1600), and another one with 8 panels x 320 watts = 2, 560
- Borehole is 160 metres deep.
- The scheme has a 3 HP submersible water pump,
- An old diesel generator set is KVA 5.5 (4.4 kW). Is not working.
- The solar PV system has no backup; it is used directly during the daytime.
- The water tank is 5000 liters. The water is used instantly without storage.
- There is a need for a new borehole, just an additional water pump, and an additional PV system.

They need backup power (battery bank)

Photos	  
Project Risks	Inadequate facilities for water pumping, which cannot meet the requirements of watering livestock in the rural areas of the Bahi District Smallness of the water trough, which requires to be expanded and the construction of the second water trough, Lack of grid electricity for supporting water pumping in the rural areas
Project Enablers	Enabling environment in terms of policies, agricultural and business environment, Extension services and credits, which may expand the water supply for livestock for pastoralists
Investment Needs	Naiman Kileo Livestock Watering Project has an existing 160-meter depth borehole, which provides $3m^3$ of water per hour, and it operates for 5 hours a day. This means it pumps $15m^3$ per day. Given that the existing capacity is exceeded, it is working in overcapacity. The solar PV system has no backup, meaning that it operates only during the day (peak sun hours). This means we will have to augment the system to accommodate additional capacity, increasing the size of the submersible water pump and the size of the solar PV system. The average diesel consumption per day is 20 litres. With an average cost of TZS 2800 per litre (\$1.11 x 20=\$22.2 per day). Per year, this is around \$8,103, just for diesel purchases. ***Sizing the Solar Water Pump*** Estimating the pump's energy consumption per day, considering the pump runs for 8 hours twice the current situation. 10HP x 0.746 x 8hours = 29.68 kWh/day. We consider 70% pump efficiency. 59.68 kW ÷ (5 x 0.7) = 17kWh' By these values, a 10 HP water pump with a flow rate of $10m^3$ per hour is required to cater to the needs.

Proposed Investment Ticket Size	*Solar Water Pumping System Cost* Total system = 17 Kw Cost per W = $2.75 Total cost (PV System) = 17kW x 1000 x 2.75$/W = **$46,750** Cost of installing a 10 HP water pump = $3,000 Total cost of solar water pumping system = $49,750 Simple Payback period = Initial Investment/Annual savings Annual Savings = Annual fuel savings (litres) x Fuel Cost per litre Annual saving = 20litres/day x $1.11/litre x 365 days = $8,103 Payback period = $49,750÷ 8,103 = 3.5 **years.**
Proposed Investment Structure	• **Models: Public-Private Partnerships; Lease-to-Own** High upfront costs of solar PV systems encourage the enterprise to use a Public-Private Partnership Model or a lease-to-own model. Through the lease-to model, the enterprise will rent a solar PV system and pay by installments with the option to purchase it at a later date. Otherwise, arrangements can be facilitated by the government or LGAs to practice PPP for supporting pastoralists to water their livestock. • **Instruments**: Grant (90%) and Loan (10%) are instruments required for the proposed investment in the solar PV system and expanding water troughs.
Potential Impact	• Large Solar PV system will also provide energy capacity for more water supply to the livestock and domestic use. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Some jobs and income are and will be created through solar PV installation, and watering the livestock in the miombo woodlands

7.2.6 Mango

i) Project Name	**Huzi Mango Irrigation Farm**
GPS Coordinates	Longitude: 35.54522667, Latitude: -6.602611667
Project Description	Huzi Mango Irrigation Farm is owned by Huzi Agriculture Marketing Cooperative Society (Huzi AMCOS, SESCOM, and CDC), has established a small-scale commercial mango farming at its farm located at Huzi in Mpunzungulu village, Chamwino District in Dodoma Region. The initiatives started in 2013 by Chamwino District Council (CDC) with the objectives are to support the establishment of a 200-acre mango farm that will be owned and managed by small-scale farmers; supporting the formation of a cooperative organization through which the farmers can embark on commercial production of mangoes; and supporting the establishment of a mango juice processing plant. Other objectives of this initiative are to support the establishment of a Special Purpose Vehicle in the form of a company that will be owned by the cooperative, CDC, and another partner, such that it can undertake business ventures for operating the mango processing plant and facilitate marketing. The company is anticipated to enter into joint ventures for the expansion of mango production, processing, and marketing at the farm and other places. About eight hundred (800) acres were allocated for the mango farm. Only 200 acres have been developed. Diesel was the main source of energy used for pumping water from the borehole for the irrigation of the mango farm. Replacement of the diesel pump with solar and the use of drip irrigation have minimized water use while contributing to increased farm productivity and environmental conservation. The cost involved in the installation of the system to cover 20 acres amounts to TZS 78,600 million, equivalent to USD 34,000 (solar water pump with capacity of 18 m3/hour costs TZS. 48,300 million, equivalent to USD 20,900, and the drip irrigation system costs TZS 30,300 million, equivalent to USD 13,100). The source of water for irrigation is a borehole with a water pump used to lift water for irrigating mango plants. The energy used for pumping water is solar PV system.

Photos



Project Risks

- Fluctuation of prices due to Mango market saturation, which lowers the profit of mangos in the market.
- Incidences of pests and diseases of tomato plants
- perishability of mango on the farm and after harvesting, a situation that forces the mango farmer to sell at a low price.
- variability of weather since the farm is located in the arid areas of the Miombo Woodlands

Project Enablers

- Enabling environment in terms of policies, agricultural and business environment,
- Expanding Mango farming by increasing production and using renewable energy to power irrigation

Investment Needs

- Details and justification on the use of funds – Working capital needs; asset acquisition for productive use, etc.
- System sizing of PURE equipment needs.

Huzi Mango Irrigation Farm is in the same village as Mpunzungulu Livestock Watering facilities, and the owners are the same. In that regard, the characteristics of the area are the same. Dodoma experiences a **semi-arid climate**, with **annual rainfall** between **500–800 mm**, a distinct **dry season**, and hot temperatures averaging around **20–30 °C.** The 200 acres are equal to 81 hectares. At 100 mango trees per hectare, this translates to 8,100 trees in total. If Evapo-Transpiration (ETc) = 5.5 mm/day, this equals 5.5 liters per m^2/day. But mango trees don't use water across the full hectare — only a portion around the root zone. For drip irrigation, the wet area per tree was considered, which is ~30–40% of the 100 m^2 per tree → ~30 m^2 of effective water area/tree, therefore, **5.5 liters × 30 m^2 = 165 liters/tree/day. So, the total** water requirement is 165 liters/tree/day × 8,100 trees = 1,336,500 liters/day. This translates to 1,336.5 m^3/day; this is a lot of water to be pumped per day.

Through the utilization of drip irrigation, the irrigation system is 90–95% efficient. If the factor of 5% losses is used, the total requirement will be around 1,400 m^3/day. Sizing the water pumping system that can produce that amount of water per day is required for this scheme.

	To lift 1,500 m^3 (or 1.5 million liters) of water per day through a total head of 150 m: • **Mass of water per day** = 1,500 m^3 × 1,000 kg/m^3 = **1.5 × 10 kg** • **Gravitational energy** = mass × g × head = 1.5 × 10 kg × 9.81 m/s^2 × 150 m ≈ **2.21 × 10 J/day** ≈ **614 kWh/day** (dividing by 3.6 MJ/kWh) To account for pump and motor inefficiencies (~50–70% efficient), let's apply a 60% efficiency estimate: • **Required electric energy** ≈ 614 / 0.6 ≈ **1,023 kWh/day.** **Sizing the Solar Water Pump** Estimating the pump's energy consumption per day, considering the pump runs for 8 hrs: 171hp × 0.746 × 8 = **1,023kWh/day** Sizing the PV system considering 70% pump efficiency, we get **1,023**÷ (8 ×0.7) = **182.67 kWh** Total system size: 182.67kW. Cost per watt = $2.75 **Total cost (PV System)** = 182.67kW x 1000 x $2.57 = **$469,462** There needs to be several boreholes (possibly four) for the whole 200-acre farm in order to accommodate the large volume of water needed for the farm. It should be noted that the farm is not connected to grid electricity. The estimated costs are not inclusive of the drip irrigation system.
Proposed Investment Ticket Size	**Total cost (PV System)** = 182.67kW x 1000 x $2.57 = **$469,462**
Proposed Investment Structure	• **Models: Public-Private Partnerships** High upfront costs of solar PV systems encourage the enterprise to use a Public-Private Partnership model. Through the PPP, the project has a plan to use a Special Purpose Vehicle (SPV) facilitated by Chamwino District Council, SESCOM, through WRI to support Mango Farming in the rural areas of Chamwino District • **Instruments:** Grant (70%), Loan (20%), and Equity (10%) are financial instruments required for the proposed investment in the solar water pumping facilities and expanding irrigation facilities in the farm.

Potential Impact	• Large Solar PV system will also provide energy capacity for more water supply to livestock, domestic use, and irrigation. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Some jobs and income are and will be created through solar PV installation, watering the livestock, and irrigation

ii) Project Name	**Aithan Lucas Chaula Mango Farm**
GPS Coordinates	Longitude: 35.77548525, Latitude: -6.18018018
Project Description	Aithan Lucas Chaula Mango Farm is owned by Aithan Limited Liability Company. The farm was established on March 15, 2017, and it is located in the rural areas of Dodoma District. The company has seven (7) shareholders and ten (10) employees. Apart from Mango farming, other activities include packaging and transport of mango from the farm to the market using hired non-refrigerated vehicles that have the capacity to carry 220 mangos. Only minor processing activities, including Cleaning, Grading, and Packaging, are performed. Some mangoes are sold as ripe fruits, and others are used to process juice in a kiosk located in Dodoma Municipality. The facility can process up to 50 mangos using juicers and blenders. The objective is to establish a three-acre mango farm with 200 plants to support the formation of an enterprise for the commercial production of mangoes. The value proposition of mango farming in arid areas of Dodoma provides economic benefits and contributes to food security for the people in the rural and urban areas. It can boost the creation of employment and improve rural livelihoods. The cost involved in the investment in the Mango farm 3 acres amounts to TZS 9 million, equivalent to USD 3,462. The revenue per day is TZS 110,000 for selling raw mango fruits and TZS 230,000 for selling processed mango juice, with profit margins of TZS 45,000 and TZS 134,000, respectively. The source of water for irrigation is a borehole with a water pump used to lift water for irrigating the mango farm. The energy source for mango processing is grid electricity, a solar PV system, and a diesel generator. Grid electricity, a solar PV system, and a diesel generator are used to pump water from a borehole for irrigating the mango farm manually.

	Additional information • The borehole is 160 meters deep. • Submersible water pump 6HP • They have a solar PV system with a capacity of 5,760 watts. • The diesel generator is 6HP (4.48 kW) • They pump 40,000 litres per day. • The generator consumes 20 litres of diesel per day. • The plan is to have a new borehole with its solar PV system. • They plan to have a juice factory and • Mango crisps by using a solar dryer
Photos	  
Project Risks	• Fluctuation of prices due to Mango market saturation, which lowers the profit of mangos in the market. • perishability of mango on the farm and after harvesting, the situation that forces the mango farmer to sell at a low price, • Difficulty in processing due to lack of solar drying facilities, • Small capital for expanding the farm, installing water pumping, and drip irrigation. • Unregulated mango market in the local and urban areas, which is also influenced by mango vendors from other regions, • Processing facilities are still poor, and the enterprise lacks solar drying facilities
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Expanding Mango farming by increasing production and using renewable energy to power irrigation • High market for mango, especially during the off season, if mango is produced by using irrigation.

Investment Needs	**Sizing a solar dryer for mango crisps** The moisture to be removed is around 70%. 500kg x 70% = 350 kg of water/day Drying energy requirement Given that the energy required to evaporate 1kg of water = 2,260kJ/kg Total energy = 350 kg water x 2,260kJ/kg = 791,000 kJ/day. To change kJ/day into kWh, we therefore get: 791,000 ÷3596=~220 kWh/day A typical solar collector produces 1kW of useful energy per m^2 per day. The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh. • Required area for a solar collector = Total energy/useful energy per square meter. • Required area = 220 kWh/day ÷ 3 kwh/day = 73.3 m^2 • If we adjust for the required area for drying efficiency of 80%, the final solar collector area will be 73.3 ÷ 0.8 = **91.6 m^2** The approximate cost of a forced convection solar dryer per m^2 is $11.33. So, the cost will be 91.6 x 11.33 = **$1037.8 ~1038.** ***Sizing the Solar Water Pump*** Estimating the pump's energy consumption per day, considering the pump runs for 8 hours twice the current situation. 10HP x 0.746 x 8hours = 59.68 kWh/day. We consider 70% pump efficiency. 59.68 kW ÷ (5 x 0.7) = 17kWh' By these values, we will need to select a 10 HP water pump with a flow rate of $10m^3$ per hour to cater to the needs. ***Solar Water Pumping System Cost*** Total system = 17 Kw Cost per W = $2.75 Total cost (PV System) = 17kW x 1000 x 2.75$/W = $46,750 Cost of installing 10 HP water pump = $3,000 Total cost of solar water pumping system = **$49,750**

	Simple Payback period = Initial Investment/Annual savings Annual Savings = Annual fuel savings (litres) x Fuel Cost per litre Annual saving = 20litres/day x $1.11/litre x 365 days = $8,103 Payback period = $49,750÷ 8,103 = **6.1 years.**
Proposed Investment Ticket Size	• Solar dryer = $1038 • Solar water pumping system = $ 49,750 **Total investment amount = $ 50,788**
Proposed Investment Structure	• **Models: Lease to Own** High upfront costs of solar PV systems encourage the enterprise to use a Lease-to-Own model. Through this model, the project has a plan to procure and install solar dryers, large solar PV systems, water pumps, and drip irrigation, which are currently not affordable to the company. • **Instruments:** Grant (95%) and Loan (5%) are financial instruments required for the proposed investment in the solar water pumping facilities and expanding irrigation facilities in the farm.
Potential Impact	• Large Solar PV system will also provide energy capacity for more water supply to livestock, domestic use, and irrigation. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Some jobs and income are and will be created through solar PV installation, watering the livestock, and irrigation. • Investment in solar drying facilities is required for producing solar-dried products. • Investment in solar water pumping and drip irrigation will increase the yield of mango and provide water for domestic uses. • Increased production will create a surplus stock of mango, which will meet the requirements of processing and be supplied to the local and distant markets.

iii) Project Name	**Mohamed Mwinyiumadi Shite Mango Farm**
GPS Coordinates	Longitude: 35.3159, Latitude: -5.98304
Project Description	Mohamed Mwinyiumadi Shite Mango Farm was established on March 30, 2014, and it is located in the rural areas of the Bahi District. The farm is owned by Juma Abdallah Mzee and has seven (7) shareholders and eight (8) employees. The objective is to establish a 15-acre mango farm with 3 plants to support the formation of an enterprise for the commercial production of mangoes. Apart from Mango farming, other activities include packaging and transport of mango from the farm to the market using hired non-refrigerated vehicles that have the capacity to carry 3,000 mangos. Only minor processing activities, including Cleaning, Grading, and Packaging, are performed. Some mangoes are sold as ripe fruits to local and urban markets in Dodoma. The value proposition of mango farming contributes to food security and employment for the people in rural and urban areas. It has enabled the improvement of rural livelihoods for mango farmers in the Bahi District. The cost involved in the investment in the Mango farm 15 acres amounts to TZS 12 million, equivalent to USD 4,615. The revenue per season is TZS 4,500,000 for selling raw mango fruits with profit margins of TZS 2,850,000. The source of water for irrigation is a borehole with a water pump used to lift water for irrigating the mango farm. The energy source for mango processing is grid electricity and diesel generator. Grid electricity and a diesel generator are used to pump water from a borehole for irrigating the mango farm manually.
Photos	  

Project Risks	• Fluctuation of prices due to Mango market saturation, which lowers the profit of mangos in the market. • Difficulty in processing due to lack of processing facilities, • Small capital for expanding the farm, installing water pumping, and drip irrigation. • Unregulated mango market in the local and urban areas, which is also influenced by mango vendors from other regions,
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Expanding Mango farming by increasing production and using renewable energy to power irrigation
Investment Needs	**NOTE:** Provided that there is insufficient data to perform calculations for water pump size, borehole depth, and generator power rating, sizing the solar PV system to suit the needs is not possible. What we will provide here are some local price estimates for drip irrigation equipment and a mango juice processing plant. ***Drip Irrigation System*** Drip irrigation systems typically cost between **US $1,500 and $3,000 per acre** for installation, depending on system complexity and crop type. For a 15-acre farm, we can calculate that the drip irrigation system might cost between $22,500 - $45,000 as follows: Lower-End Scenario (1 line per bed) • **$ 500 per acre × 15 acres = $ 7,500** Mid-Range Scenario (2 lines per bed) • **$ 870 per acre × 15 acres = $13,050** Upper Mid-Range (higher complexity or partially subsurface) • Assume **$ 1,500 per acre** × 15 acres = **$ 22,500** Full, high-end turnkey (global average) • **$ 3,000 per acre × 15 acres = $ 45,000** ***Mango juice processor***

	Complete mango juice processing plant, with a capacity between 5 to 20 tons a day, ranges between **\$46,000 - \$55,000** depending on customization. The price is Free-on-board (FOB) China. Drip irrigation system = \$**45,000** **Mango juice processor = \$55,000** ***Sizing the solar system for the water pumping system*** Estimating the pump's energy consumption per day, considering the pump runs for 6 hours per day to pump water from a borehole with a depth of 160 metres. 5 HP x 0.746 x 6hours = 22.38 kWh/day. We consider 70% pump efficiency. 22.38 kW ÷ (6 x 0.7) = 5.33 kWh By these values, we will need to select a 5 HP water pump with a flow rate of at least 5 to 6m^3 per hour to cater to the needs. ***Solar Water Pumping System Cost*** Total system = 5.33 Kw Cost per W = \$2.75 Total cost (PV System) = 5.33 kW x 1000 x 2.75\$/W = \$ 14,657.5 Cost of installing a 10 HP water pump = \$3,000 Total cost of solar water pumping system = **\$17,657.5**
Proposed Investment Ticket Size	Total investment for the solar water pumping system = \$17,657.5
Proposed Investment Structure	• **Models: Lease-to-Own** High upfront costs of solar PV systems encourage the enterprise to use a Lease-to-Own model. Through this model, the project has a plan to use a procure solar water pumping facilities and drip irrigation. • **Instruments**: Grant (90%) and Loan (10%) are financial instruments required for the proposed investment in the solar water pumping facilities and expanding irrigation facilities in the farm.

Potential Impact	• Large Solar PV system will also provide energy capacity for electrifying the farm and centre. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Some jobs and income are and will be created through solar PV installation, and irrigation. • Investment in solar water pumping and drip irrigation will increase the yield of mango and provide water for domestic uses. • Increased production will create a surplus stock of mango, which will be supplied to the local and distant markets

iv) Project Name	**William Engeo Mango Farming Project**
GPS Coordinates	Longitude: 35.72129428, Latitude:-6.094745555
Project Description	William Engeo Mango Farming Project is in the Dodoma Rural District of Dodoma Region, established on March 18, 2023. The project is owned by William Engeo and has seven (7) shareholders and fifteen (15) employees. The objective is to boost mango production and establish a major mango hub for customers, increasing farmer incomes and the rural economy of Dodoma District. Apart from Mango farming, other activities include packaging and transport of mango from the farm to the market using hired non-refrigerated vehicles that have the capacity to carry 350 mangos. Only minor processing activities, including Cleaning, Grading, and Packaging, are performed. Some mangoes are sold as ripe fruits to local and urban markets in Dodoma. The value proposition of mango farming contributes to food security and employment for the people in rural and urban areas. The mango farming project in Dodoma's rural district offers a strong value proposition rooted in economic opportunity, improved livelihoods, and sustainable development. It taps into the growing market demand for mangoes, offering farmers a pathway to increased income and improved living standards. The cost involved in the investment in the Mango farm, 15 acres, amounts to TZS 12 million, equivalent to USD 4,615. The revenue per season is TZS 6,800,000 for selling raw mango fruits with profit margins of TZS 3,450,000.

	The opportunities available for expanding the project are the land for expanding the mango farm, high solar isolation for solar energy generation, and the availability of Mango varieties for arid areas. The source of water for irrigation is a borehole with a water pump used to lift water for irrigating the mango farm. The energy source for manual irrigation of mango is grid electricity and a diesel generator. Grid electricity and a diesel generator are used to pump water from a borehole for irrigating the mango farm manually.
Photos	  
Project Risks	• Fluctuation of prices due to Mango market saturation, which lowers the profit of mangos in the market. • Damage to mangos during transportation due to the rough roads to the city • Roads that are not passable during the rainy season • Unregulated mango market in the local and urban areas, which is also influenced by mango vendors from other regions.
Project Enablers	• Enabling environment in terms of policies, agricultural, and business environment. • Expanding Mango farming by increasing production and using renewable energy to power irrigation • The Mango farming is directed towards market expansion by investing in more processing of secondary products and venturing into exports

Investment Needs	Sizing a solar dryer for mango crisps

The moisture to be removed is around 70%.

400kg x 70% = 280 kg of water/day

Drying energy requirement

Given that the energy required to evaporate 1kg of water = 2,260kJ/kg

Total energy = 280 kg water x 2,260kJ/kg = 632,800 kJ/day.

To change kJ/day into kWh, we therefore get:

632,800 ÷3596=~176 kWh/day

A typical solar collector produces 1kW of useful energy per m^2 per day. The solar collector will be used for at most 6 hours a day, so the useful energy per m^2 will be 6 kWh.

Required area for a solar collector = Total energy/useful energy per square meter.

- Required area = 176 kWh/day ÷ 6 kwh/day = 29.33 m^2
- If the area for drying efficiency is adjusted to 80%, the final solar collector area will be 29.33 ÷ 0.8 = **36.67 m^2**
- The approximate cost of a forced convection solar dryer per m^2 is $11.33.

So, the cost will be 36.67 x 11.33 = **$415.47**

Sizing the Solar Water Pump

Estimating the pump's energy consumption per day, considering the pump runs for 8 hours twice the current situation.

10HP x 0.746 x 8hours = 59.68 kWh/day. We consider 70% pump efficiency.

59.68 kW ÷ (5 x 0.7) = 17kWh'

By these values, we will need to select a 10 HP water pump with a flow rate of $10m^3$ per hour to cater to the needs.

Solar Water Pumping System Cost

Total system = 17 Kw Cost per W = $2.75

Total cost (PV System) = 17kW x 1000 x 2.75$/W = $46,750

Cost of installing a 10 HP water pump = $3,000

Total cost of solar water pumping system = **$49,750**

	Simple Payback period = Initial Investment/Annual savings Annual Savings = Annual fuel savings (litres) x Fuel Cost per litre Annual saving = 20litres/day x $1.11/litre x 365 days = $8,103 Payback period = $49,750÷ 8,103 = **6.1 years.**
Proposed Investment Ticket Size	Total cost for solar dryer = **$415.47** Total cost of solar water pumping system = **$49,750** **Total ticket size = 50,165.47**
Proposed Investment Structure	• **Models: Lease-to-Own** High upfront costs of solar PV systems encourage the enterprise to use a Lease-to-Own model. Through this model, the project has a plan to use a procure solar water pumping facilities and drip irrigation. • **Instruments**: Blended financial models comprising Grants (60%), Equity investment (10%), and Technical Assistance (30%) are instruments required for the proposed investment in installing the solar water pumping facilities and expanding irrigation facilities in the farm.
Potential Impact	• Some jobs and income are and will be created through mango farming, solar PV installation, and irrigation. • Large Solar PV system will also provide energy capacity for electrifying the farm and enterprise. • Investment in solar water pumping and drip irrigation will increase the yield of mango and provide water for domestic uses. • Solar energy reduces greenhouse gas emissions by avoiding the use of fossil fuels for water pumping. • Increased production will create a surplus stock of mango, which will be supplied to the local and distant markets. • The irrigated mango farming with smart agriculture using drip irrigation will create secondary businesses for processing and retailers of mangos.

7.2.7 Tomatoes

i) Project Name	**Tall (Ibrahim Moshi) Horticultural Farm (THF)**
GPS Coordinates	Longitude: 37.55299333, Latitude: -3.453458333
Project Description	Tall Horticultural Farm is a limited liability company owned by the Ibrahim Jared Moshi family, located in Mwanga District in Kilimanjaro. The company is engaged in the production and marketing of tomatoes to boost the farmers' income and food security. Almost 90 % of the business of this company is in the production and marketing of tomatoes. The company has seven (7) shareholders and twenty (20) staff members. The company has adopted sustainable practices and innovative technologies to boost tomato production, particularly near wetlands and riverbanks of Kileo Ward. The value proposition of this tomato enterprise is multifaceted, offering opportunities for increased income, improved food security, and potential for local processing and export. Buyers of tomatoes are the wholesalers, retailers, and exporters who purchase tomatoes directly from the farm, send them to the local, national, and some are exported to Kenya. Tomatoes are harvested at an interval of three (3) months. The initial investment capital of the company in the tomato farm was TZS 5,000,000 (USD 1,924). This is capital that was acquired from other formal businesses of the company. Tomatoes are grown in different plots with a total area of 40 hectares. The total quantity of tomatoes transported from the farm during harvesting to the market is 720,000 Kgs. The monthly revenue from the production of tomatoes is over TZS 8,000,000 (USD 3,077). The monthly net profit is TZS 2,500,000 (USD 962), which is synonymous with the annual profit of TZS 30,000,000 (USD 11,538.5). The main competitors are other tomato growers from other regions.

	Initial skills and knowledge of establishing and producing tomatoes were acquired from friends in Kenya, where the owner had a study tour for training on horticultural farming. The knowledge was used to train his staff in the farm who have received training for tomato crop husbandry, crop protection, and seedbed preparation. More trainings are required in the areas of irrigation of the horticultural crops. The source of water for irrigation is a borehole with a water pump used to lift water for irrigating and for spraying pesticides on the tomato plants. The energy used for pumping water is grid electricity backed up with diesel generator.
Photos	  
Project Risks	• Low prices due to market saturation of tomatoes in July and August, which lowers the profit of tomatoes in the market. • Incidences of rodents and pests on the farm damage tomato fruits and reduce yield. • Incidences of power unreliability, cuts, and expensive costs of electricity, • High costs of pumping water from a borehole due to the use of a diesel generator • High costs of hiring the tractor for tilling the land
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • High possibility of expanding tomato farming to other potential areas. • Reduce the cost of production in the tomato farm, through subsidies in seeds and fertilizers
Investment Needs	Solar water pumping and drip irrigation are required for irrigating tomatoes in the tomato farms during power blackouts. The sizing of PURE equipment needs is as shown hereunder:

	Mwanga district has ample solar energy, with peak sun hours reaching up to 6.5. This is a suitable environment for a solar PV system that can generate several kilowatt hours a day, with power storage during the night and rainy days. Estimating the pump's energy consumption per day, considering the pump runs for 6 hours per day to pump water from the borehole. ***Sizing the Water Pump*** 8 HP x 0.746 x 6hours = 35.8 kWh/day. We consider 70% pump efficiency. 35.8 kW ÷ (6 x 0.7) = 8.52 kWh By these values, we will need to select an 8 HP water pump with a flow rate of 8m^3 per hour to cater to the needs. ***Solar Water Pumping System Cost*** Total system = 8.52 Kw Cost per W = $2.75 Total cost (PV System) = 8.52 kW x 1000 x 2.75$/W = $23,430 Cost of installing an 8 HP water pump = $3,000 Total cost of solar water pumping system = $26,430 Drip irrigation systems typically cost between **US $1,500 and $3,000 per acre** for installation, depending on system complexity and crop type. We assume Mr. Ibrahim has 5 acres, each acre costing $2,000; the cost for a drip irrigation system will be **$10,000**
Proposed Investment Ticket Size	The cost of a solar water pumping system **= $26,430** The cost for a drip irrigation system = **$10,000** **The total investment ticket = $36,430**
Proposed Investment Structure	• Models: Lease-to-Own, and Energy-as-a-Service • High upfront costs of solar PV systems will encourage the enterprise to use a lease-to own-model, whereby the enterprise will rent solar PV systems with the option to purchase them at a later date. Otherwise, someone can invest in a solar PV system and supply electricity during blackouts (energy as a service). The system of TANESCO (grid electricity) is also Energy as a Service because electricity is generated and supplied to the end-users. • Instruments: • Grant (80%) and Loan (20%) are financial instruments required for the proposed investment in solar PV systems. The owner is avoiding to put cooperation in the liabilities.

Potential Impact	• Solar PV system will offset the high costs of diesel used in the generators for pumping water from the borehole for irrigation, • Solar PV system will also provide energy freedom and reduce the risk of electricity cuts and unreliability. • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs and income will be created through solar PV installation

ii) Project Name	**Selemani Shabani Tomato Farm (SSTF)**
GPS Coordinates	Longitude: 37.57336666, Latitude: -3.478496213
Project Description	Selemani Shaban Tomato Farm started on March 08, 2017, with the aim of producing and marketing raw tomatoes for income generation and increased food security in Mwanga District. This tomato enterprise is a family business with six (6) shareholders and 3 employees who support horticultural products like tomatoes on the farm. The SSTF is located at Kileo Ward, in Mwanga District of the Kilimanjaro region, Tomato farming contributes about 70% of shareholders' income compared to other business enterprises. The value proposition of this tomato farming business includes obtaining horticultural products (tomato) for marketing, contributing to a more balanced and nutritious diet, providing access to high-value tomato crops, and empowering in terms of income to the enterprise. The enterprise has a horticultural farm and facilities for tomato farming and marketing to the nearby markets. The farm can produce up to 6,000 kg per season. The van is a type of vehicle used for transporting tomatoes and inputs. The total capacity of the transportation fleet for tomatoes is 10,000. Tomato during harvesting is collected from the farm by wholesalers. The initial investment costs for tomato production are TZS 1,000,000. The monthly revenue from the production of tomatoes is over TZS 18,500,000 (USD 7,115). The monthly net profit is TZS 50,000 (USD 173), which is synonymous with the annual profit of TZS 5,400,000 (USD 2,077).

The source of water for irrigation is a borehole with a water pump used to lift water for irrigating and for spraying pesticides on the tomato plants. The energy used for pumping water is grid electricity backed up with a diesel generator

Photos



Project Risks

- Low prices due to market saturation of tomatoes in July and August, which lowers the profit of tomatoes in the market.
- Incidences of rodents and pests on the farm damage tomato fruits and reduce yield.
- Incidences of power unreliability, cuts, and the high costs of electricity,
- Impassable road during the rainy season

Project Enablers

- Enabling environment in terms of policies, agricultural and business environment,
- Expanding tomato farming by increasing production and using electricity or renewable energy to power irrigation
- Credit services for tomato farmers

Investment Needs

This project, like other tomato projects in Mwanga District in Kilimanjaro, has almost similar environment, with six peak sun hours. Therefore, the calculations will be based on those parameters.

Sizing the Water Pump

3 HP x 0.746 x 6hours = 13.43 kWh/day. We consider 70% pump efficiency.

13.43 kW ÷ (6 x 0.7) = 3.2 kWh

By these values, the 3 HP water pump with a flow rate of 5m^3 per hour will be selected to cater to the needs of water pumping requirements.

	Solar Water Pumping System Cost Total system = 3.2 Kw Cost per W = $2.75 Total cost (PV System) = 3.2 kW x 1000 x 2.75$/W = $8,800 Cost of installing a 3 HP water pump = $1,000 Total cost of solar water pumping system = $9,800 Drip irrigation systems typically cost between **US $1,500 and $3,000 per acre** for installation, depending on system complexity and crop type. We assume Selemani Shabani has 3 acres, each costing $2,000; the cost for a drip irrigation system will be **$6,000**
Proposed Investment Ticket Size	• **Models: Lease-to-Own, and Energy-as-a-Service** High upfront costs of solar PV systems will encourage the enterprise to use a lease-to own-model, whereby the enterprise will rent solar PV systems with the option to purchase them at a later date. Otherwise, someone can invest in a solar PV system and supply electricity during blackouts (energy as a service). • **Instruments:** A grant and a loan are the only instruments required by 70% and 30% for the proposed investment in solar PV systems.
Potential Impact	• Solar PV system will offset the high costs of diesel used in the generators for pumping water from the borehole for irrigation, • Solar energy reduces greenhouse gas emissions by avoiding the use of diesel generators in cooling facilities and the processing of dairy products. • Some jobs and income will be created through solar PV installation.

7.2.8 Poultry (Chicken)

i) Project Name	**Tashimwa Women Poultry Project**
GPS Coordinates	Longitude: 39.04657167, Latitude: -6.929485
Project Description	The Tashimwa Women Poultry Project is a business established on March 18, 2023, located in the Peri-urban of Kisarawe Township, Kisarawe District, in the Pwani Region. The business is operated by a women's economic group with six (6) members, who are undertaking poultry farming and producing other products like dairy products, pig meat, and organic manure disposed of through the local markets. The aim is to empower women with alternative income-generating opportunities through poultry farming, thereby improving their livelihoods and contributing to food security. The Poultry project contributes about 55% of the group's income compared to other business enterprises. The cooperative members can rear up to around 24,000 birds and collect up to 125,105,000 eggs per year. The group can generate an annual revenue of TZS 114 million (USD 43,846). The central function of poultry farming requires heating and lighting of chicken pens. The group uses economies of scale to send their products (eggs, meat, and others) to the market. Those products are packed, and joint transport is hired to move them to the market. Focused enterprise is operated by a social group of smallholder farmers rearing livestock such as poultry, pigs, and dairy cows for selling to the local markets of Kisarawe and distant markets of Dar es Salaam. Poultry farming offers a compelling value proposition due to its potential for income generation, improved livelihoods, and food security. This initiative addresses both economic and social needs, empowering women while contributing to the overall development of the women and their families in the group. The initial investment of the project was TZS 8,000,000. The average daily revenue for the poultry project is TZS 30,000. The total annual revenue is TZS 12,000,000 per household (TZS 60,000,000 for five households). The profit margin for this enterprise is 55 percent, which is equal to TZS 33,000,000 (USD12,692.3).

Energy used for lighting is grid electricity. Average daily consumption: 228.57 kWh. The primary uses are for lighting chicken pens and warming chicken chicks. Secondary loads are used for lighting, for other domestic activities, and for customer operations. They have a desire to have a solar PV system for backup during power blackouts to continuously power chicken pens for lighting and heating. It is expected that TZS 25,0000 will be saved every month by introducing solar PV systems.

Photos



Project Risks

- High electricity bills of TZS 150,000 (USD 57.7) per month and a bag of charcoal for warming chicken chicks, TZS 350,000 (USD 134.5) for each month
- Fluctuation of prices due to poultry products market saturation, which lowers the profit of meat or eggs sold to the market.
- Unreliable electricity due to power cuts, which makes them use kerosene lamps for lighting and charcoal appliances for heating.
- High incidences of chicken diseases, which means high costs for rearing and poultry farming

Project Enablers

- Enabling environment in terms of policies, agricultural and business environment,
- Extension services and credits, which may expand poultry farming in Tanzania

Investment Needs

This poultry project needs at least 260 kWh per day for heating chicken pens and lighting. They will need to add a 1 kW egg incubator so that the project can have a hatchery project at the same location, with several lights when grid electricity is not available.

Sizing the Solar PV System

Designing a solar PV system that produces 260 kWh/day and powers a 1 kW incubator involves two parts:

- Solar PV system to generate 260 kWh/day (for any general load or water pumping)
- Powering a 1 kW incubator continuously or as needed
- The project has to be divided into four (4) different enterprises existing within the women's group.

Poultry Enterprise 1

Estimated energy demand = 65 kWh for this project

If the system will operate for 12 hours a day (with battery storage)

During blackouts, solar will provide 100% of power, but during ordinary days, it will provide 50%.

Power required = 65 kWh, assuming 25% losses, which is 65kWh/1-loss fraction

65/0.75 ~ 86.7 kWh/day

PV power required = 86.7/peak sun hours (PSH) = 86.7 ÷ 6 = 14.45 kW

Total system size = 14.45 Kw, cost per watt = $2.75

Total cost = 14.45 kW x 1000 x $2.75 = $ 39,737.5

Every month, the group pays $4.67 for electricity bills.

Annual energy generation = 65 kWh/day x 365 days = 23,725 kWh

1kW in the national grid is bought at $0.139, so 23,725 x 0.139 = $3,297.77 saved

Poultry Enterprise 2

Estimated energy demand = 65 kWh for this project

If the system is assumed to operate for 12 hours a day (with battery storage)

During blackouts, solar will provide 100% of power, but during ordinary days, it will provide 50%.

Power required = 65 kWh, assuming 25% losses, which is 65kWh/1-loss fraction

65/0.75 ~ 86.7 kWh/day

PV power required = 86.7/peak sun hours (PSH) = 86.7 ÷ 6 = 14.45 kW

Total system size = 14.45 Kw, cost per watt = $2.75

Total cost = 14.45 kW x 1000 x $2.75 = $ 39,737.5

Every month, the group pays $4.67 for electricity bills.

Annual energy generation = 65 kWh/day x 365 days = 23,725 kWh

1kW in the national grid is bought at $0.139, so 23,725 x 0.139 = $3,297.77 saved

	Poultry Enterprise 3 Estimated energy demand = 65 kWh for this project If the system is assumed to operate for 12 hours a day (with battery storage) During blackouts, solar will provide 100% of power, but during ordinary days, it will provide 50%. Power required = 65 kWh, assuming 25% losses, which is 65kWh/1-loss fraction 65/0.75 ~ 86.7 kWh/day PV power required = 86.7/peak sun hours (PSH) = 86.7 ÷ 6 = 14.45 kW Total system size = 14.45 Kw, cost per watt = $2.75 Total cost = 14.45 kW x 1000 x $2.75 = $ 39,737.5 Every month, the group pays $4.67 for electricity bills. Annual energy generation = 65 kWh/day x 365 days = 23,725 kWh 1kW in the national grid is bought at $0.139, so 23,725 x 0.139 = $3,297.77 saved **Poultry Enterprise 4** Estimated energy demand = 70 kWh for this project. This project will have a 1-kilowatt egg incubator to supply chicks for the other projects. If the system is assumed to operate for 12 hours a day (with battery storage) During blackouts, solar will provide 100% of power, but during ordinary days, it will provide 50%. Power required = 70 kWh, assuming 25% losses, which is 65kWh/1-loss fraction 70/0.75 ~ 93.33 kWh/day PV power required = 93.33/peak sun hours (PSH) = 93.33 ÷ 6 = 15.56 kW Total system size = 15.56 Kw, cost per watt = $2.75 Total cost = 15.56 kW x 1000 x $2.75 = $ 42,790 Every month, the group pays $9.73 for electricity bills. Annual energy generation = 70 kWh/day x 365 days = 25,550 kWh 1kW in the national grid is bought at $0.139, so 25,550 x 0.139 = $3,551.45 saved
Proposed Investment Ticket Size	• For solar PV investment, for the four poultry enterprises, and incubators. • Total investment = $39,737.5 + 39,737.5 + 39,737.5 + 42,790 = **$162,002.5**

Proposed Investment Structure	• **Models: Lease-to-Own,** High upfront costs of solar PV systems encourage the cooperative to use a lease-to-own model, whereby the cooperative will rent six solar PV systems with the option to purchase them at a later date. • **Instruments**: Grant and Loan are the financial instruments required (in 40% and 60% respectively) for the proposed investment to cater for the high upfront cost of solar photovoltaic (PV) systems.
Potential Impact	There is a strong community impact by providing additional income to the members and food security to farmers: • Installing solar PV (photovoltaic) systems in poultry pens can significantly impact energy costs, operational efficiency, and environmental sustainability. • Solar power can reduce or eliminate reliance on the grid, potentially leading to substantial savings on electricity bills. • Solar PV systems will also offer a more reliable and stable energy source, protecting farmers from fluctuating grid prices. • Solar power contributes to a more sustainable and environmentally friendly poultry operation.

ii) Project Name	**Mselea Poultry Farming Project**
GPS Coordinates	Longitude: 36.02140167, Latitude: -6.120691667
Project Description	The Mselea Poultry Farming Project is a business enterprise established on March 18, 2015, located in the Peri-urban area of Kondoa Township, Kondoa District, in the Dodoma Region. The business is operated by Mr. Mselea and Family with five (5) members, who are undertaking poultry farming. The primary aim of a poultry farming business plan is to establish a sustainable and profitable poultry production system. This involves raising poultry for both meat (broilers) and eggs (layers), while also addressing potential challenges and opportunities in the Tanzanian market.

The initial investment for the project was TZS 53,850,000 (USD 20,712). The products that are produced and sold in the market include eggs, meat, and live chickens. The poultry project contributes about 65% of the family income compared to other businesses. Members can raise approximately 60,000 birds per year (5,000 birds per month). The total cost of the project is TZS 75 million (USD 28,846). The enterprise can generate an annual revenue of TZS 35 million (USD 13,462). Proper poultry farming requires heating and lighting in chicken pens.

The chicken farming enterprise offers value propositions such as access to a growing market for poultry products, potential income generation, and opportunities for value addition, leveraging the increasing demand for both meat and eggs in urban areas, as well as the possibility of sourcing feed and other inputs locally.

Energy sources used for lighting and heating are grid electricity and charcoal. Monthly electricity consumption: 2,13kWh. The primary uses are for lighting chicken pens at night. Secondary loads are used for lighting, heating, and other domestic activities. The enterprise has a desire to install a solar PV system to reduce energy bills and provide backup during power blackouts, to continuously power chicken pens for lighting and heating chicks. It is expected that TZS 450,000 will be saved every month by introducing a solar PV system.

Additional information

- Annual energy consumption is 2,560 kWh, which means they consume 213 kWh per month, i.e., 7 kWh/day.
- Water usage is 200,000 per month on average.
- There is a 100-watt solar PV system for lighting chicken pens

Photos




Project Risks	• High electricity bills of TZS 896,000 (USD 344.6) per month and a bag of charcoal costing TZS 80,000 (USD 30.8) for warming chicken chicks, TZS 976,000 (USD 375.4) for each month • Fluctuation of prices due to poultry products market saturation, which lowers the profit of meat or eggs sold to the market. • Unreliable electricity due to power cuts, which makes them use kerosene lamps for lighting and charcoal appliances for heating. • High incidences of chicken diseases, which means high costs for rearing and poultry farming
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Extension services and credits, which may expand the poultry farming in Tanzania. • Poultry Farming Training for members of the family
Investment Needs	Improve and expand facilities for poultry farming and alternative energy from renewable sources (solar PV system) ***Sizing the solar PV system*** Daily energy demand If the plant will operate for 12 hours a day So, the total energy demand = 7 kWh x 12 hrs. = 84 kWh/day Provided that this will operate as a standalone system (not integrated to the grid), solar contribution will be 100%. Therefore, the solar capacity required for the system, with 6 peak sun hours, will be as follows: - System size = 84 kwh ÷ 6 = 14kW. Cost per watt = $2.75 **Total cost = 14kW x 1000 x 2.75 = $38,500**
Proposed Investment Ticket Size	Solar PV cost for this project will be **$38,500**

Proposed Investment Structure	**Models: Lease-to-Own,** High upfront costs of solar water pumps for supplying water from boreholes and lighting are required by using a lease-to-own model, whereby the enterprise will rent a solar PV system with the option to purchase it at a later date. **Instruments**: Blended finances from Grant and Loan are the financial instruments required (in 65% and 35% respectively) for the proposed investment to cater for the high upfront cost of solar photovoltaic (PV) systems
Potential Impact	There is a strong community impact by providing additional income to the members and food security to farmers: • Installing solar PV (photovoltaic) systems in poultry pens can significantly impact energy costs, operational efficiency, and environmental sustainability. • Solar power can reduce or eliminate reliance on the grid, potentially leading to substantial savings on electricity bills. • Solar PV systems will also offer a more reliable and stable energy source, protecting farmers from fluctuating grid prices. • Solar power contributes to a more sustainable and environmentally friendly poultry operation.

iii) Project Name	**AtuChick Kuku Farming Project**
GPS Coordinates	Longitude: 37.64341833, Latitude: -3.927456667
Project Description	The AtuChick Kuku Farming Project is a business enterprise established on June 25, 2020, located in the rural area of Mgagao, Mwanga District, Kilimanjaro Region. The business is operated by Ms. Diana Raphael and her family for poultry farming. The primary aim of poultry farming is to produce and supply poultry products such as eggs and meat to meet market demand, while also providing economic opportunities and improving food security for individuals and communities.

The initial investment for the project was TZS 400,000 (USD 153.8). The products that are produced and sold in the market are eggs, which are supplied at around 28,000 eggs per month, and live chickens, which are vended at the age of 18 months after they have stopped laying eggs. The poultry project contributes about 72% of the family income compared to other businesses. Members can raise approximately 44,400 birds per year (3,700 birds per month). The total cost of the project is TZS 95,000,000 (USD 36,538). The enterprise can generate an annual revenue of TZS 10,500,000 (USD 4,038). The average of TZS 70,000 (USD 26.9) is used for energy services in the poultry farm for heating and lighting in chicken pens.

The value proposition of a poultry farming project lies in its ability to provide a consistent, affordable, and nutritious source of protein, coupled with opportunities for income generation and livelihood improvement. The project offers a diversified revenue stream from eggs, meat, and the sale of day-old chicks, while also contributing to food security and economic development within the community.

Energy sources used for lighting and heating are grid electricity and charcoal. The monthly electric units consumed by the enterprise are 2,400 kWh. The primary uses are for lighting chicken pens at night. The energy is also used for powering a small electric motor for water pumping, an incubator used rarely, and a petrol-powered generator as backup during power cuts. The enterprise also requires an animal feed-making machine, solar water pumps for pumping water from a borehole, and other domestic uses. The enterprise has a desire to have a solar PV system for backup during power blackouts to continuously power chicken pens for lighting and heating. It is expected that TZS 350,000 will be saved every month by introducing a solar PV system.

Additional information

- They have a 500-watt small water pump for pumping tap water into raised small water tanks for attaining higher pressure.
- There are 3 water tanks, each with 1000 litres.
- Electricity consumption 200,000 TZS to 300,000 TZS when egg incubators are in operation (250 watts, these are 10 in total)
- Incubators, 2 in total of 1,056 eggs (800-watts) and another one is 2112 eggs (900-watts)
- Petrol generator is 5,000 watts in capacity.

	• Electricity consumption per month varies depending on whether the incubators are in operation or not. Without incubators, they consume 560 kWh; with incubators, they consume 840 kWh.
Photos	  
Project Risks	• High electricity bills of TZS 840,000 (USD 323) per month and a bag of charcoal costing TZS 70,000 (USD 26.9) for warming chicken chicks, TZS 909,740,000 (USD 349.9) for each month • Fluctuation of prices due to poultry products market saturation, which lowers the profit of meat or eggs sold to the market. • Unreliable electricity due to power cuts, which makes them use kerosene lamps for lighting and charcoal appliances for heating. • High incidences of chicken diseases, which means high costs for rearing and poultry farming. • Incidences of rodents that attack chicken and eat chicken feed,
Project Enablers	• Enabling environment in terms of policies, agricultural and business environment, • Extension services and credits, which may expand poultry farming in Tanzania and provide access to resources like quality feed and improved breeds, • The establishment of a robust infrastructure for poultry keeping. • Poultry Farming Training for members of the family
Investment Needs	Improving and expanding facilities for watering cattle and an alternative energy supply (solar PV system) ***Sizing the Solar PV System*** Daily energy demand It is assumed that the plant will operate for 12 hours a day. So, the total energy demand = 28 kWh x 12 hrs. = 336 kWh/day Provided that this will operate as a standalone system (not integrated to the grid), solar contribution will be 100%. Hence, the solar capacity required for the system, with 6 peak sun hours, will be as follows: - System size = 336 kwh ÷ 6 = 56 kW. Cost per watt = $2.75 **Total cost = 56 kW x 1000 x 2.75 = $154,000**

Proposed Investment Ticket Size	The estimated solar PV cost for this project will be **$154,000**
Proposed Investment Structure	**Models: Lease-to Own** High upfront costs of solar water pumps for supplying water from boreholes, solar PV systems for lighting, and improved wood fuel appliances for heating are required by the enterprise. The lease-to-own model will be used to allow an enterprise to rent solar PV systems and solar water pumps with the option to purchase them at the end of the lease period. It will combine elements of renting and buying, providing flexibility at the time of procurement and potential for poultry businesses to exploit, market, and reach a wider audience. **Instruments**: Grant and Loan are the financial instruments required (in 75% and 25% respectively) for the proposed investment to cater for the high upfront cost of solar water pumps, solar photovoltaic (PV) systems, etc.
Potential Impact	There is a strong community impact by providing additional income to the members and food security to farmers: • Solar PV systems will significantly lower or eliminate reliance on expensive grid electricity or diesel generators, leading to substantial cost savings for poultry farmers. • Solar energy systems will provide a more stable and reliable power supply, reducing disruptions caused by grid outages or fuel shortages, which are critical for maintaining consistent temperature and lighting in poultry pens. • Solar PV systems will contribute to a smaller carbon footprint by reducing reliance on fossil fuels, promoting cleaner air and water, and reducing noise pollution. • Consistent power supply from solar energy will lead to better living conditions for the birds, potentially resulting in lower mortality rates, faster growth, and higher egg or meat production. • Reduction of monthly energy costs and improvement of the production of solar projects can increase the profitability of poultry farming operations. • Solar projects will create new economic opportunities in rural areas, contributing to overall community development.

8.0 Integration of Investment Prospectus Projects into the Energy Access Explorer (EAE)

The Energy Access Explorer (EAE) is an online, open-source, and interactive geospatial platform developed by the World Resources Institute (WRI) to help identify and prioritize areas for expanding energy access, particularly in sub-Saharan Africa and South Asia. This is the first open-source, online, and interactive geospatial platform that enables energy planners, clean energy entrepreneurs, donors, and development institutions to identify high-priority areas for energy access interventions. It enables stakeholders to visualise and analyse high-priority areas where access to energy should be expanded for equitable development.

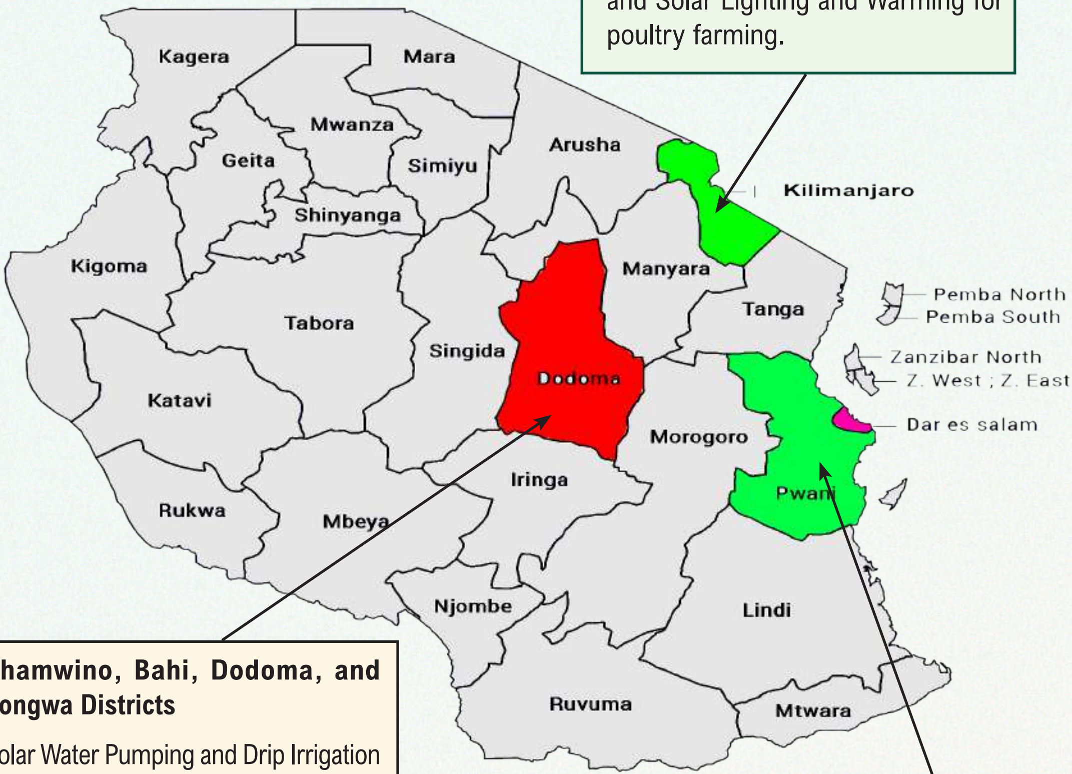
8.1 Data Collection

The process of integrating the high-impact, high-potential projects into the EAE for Tanzania began with developing detailed questionnaires for projects across various agriculture, livestock, and fisheries value chains, which have the highest potential for economic, social, and environmental benefits and require energy to enhance their productivity in four surveyed regions of Dar es Salaam, Pwani, Dodoma, and Kilimanjaro in Tanzania.

The questionnaires covered specific information or profiles of the projects, including ownership, total members, types of products handled, market accessibility, total outputs or yield, income generated, energy-requiring appliances, and proposed renewable energy solutions that would improve productivity, annual energy requirements, and proposed financing models, among others. The sample of the questionnaire is shown in Figure 2 below:

Moshi Rural, Mwanga, and Hai Districts:

Solar Drying for Banana, Dairy Products Cooling and processing, and Solar Water Pumping for Tomato farming, and Solar Lighting and Warming for poultry farming.



Chamwino, Bahi, Dodoma, and Kongwa Districts

Solar Water Pumping and Drip Irrigation for Mango, Solar Water Pumping for Livestock (Cattle), and Solar Lighting and Warming for Poultry Farming

Mkuranga, Kisarawe, Bagamoyo, Ubungo Districts

Solar lighting, Cooling, and water pumping for fisheries, Solar drying for Cassava, and Solar Lighting and Warming for poultry farming

Fig. 1: Map showing different agriculture, Livestock, and Fisheries value chains coverage by project regions

Sample of Survey Questionnaire.

Dairy Enterprise Questionnaire

1. Enterprise Profile

1.1 What is the name of your enterprise? (text)
1.2 What is the legal structure of your enterprise? (select_one: Cooperative, Community-Based Organization, Limited Liability Company, Partnership, Other)
1.3 When was your enterprise established? (date)
1.4 Where is your enterprise located? (gps)
1.5 Who is the primary contact person for your enterprise? (text)
1.6 What is the ownership structure of your enterprise? (select_multiple: Community-owned, Member-owned, Privately-owned, Other)
1.7 How many members/shareholders does your enterprise have? (integer)
1.8 How many employees does your enterprise have? (integer)
1.9 What is the gender and age breakdown of your employees?
1.9.1 Adult men (integer)
1.9.2 Adult women (integer)
1.9.3 Youth (18-35 years) (integer)
1.9.4 Persons living with disabilities (integer)
1.10 What type of services do you provide in the dairy value chain? (select_multiple: Milk Collection, Cooling, Processing, Packaging, Transportation, Other)
1.10.1 What other services do you provide that are not related to diary value chain? Explan
1.11 Do you have partnerships with local farmers or other enterprises? (yes_no)
1.11.1 If yes, please describe the nature of these partnerships. (text)

2. Milk Collection and Cooling Services

2.1 Do you provide milk collection and cooling services? (yes_no)
[If no, skip to section 3. Processing Services]
[If yes, continue with the following questions]

2.2 What is the total capacity of your milk cooling facilities? (decimal)

Fig. 2: Questionnaires used to interview various projects across different agriculture value chains

The questionnaires were then converted into digital mobile-based surveys using the ArcGIS Survey123 online application to be used by the project teams in the field for data collection during the interviews. This simplified the process of data collection through the intuitive and responsive design of the digital surveys, which had constraints that minimized errors when entering data responses. Additionally, the digital surveys enabled the collection of GPS coordinates for each project, supporting later integration into the Energy Access Explorer (EAE).

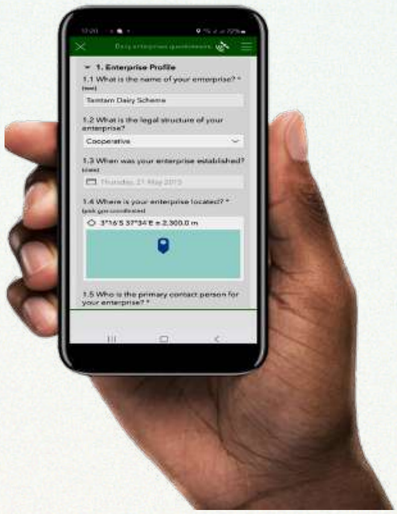
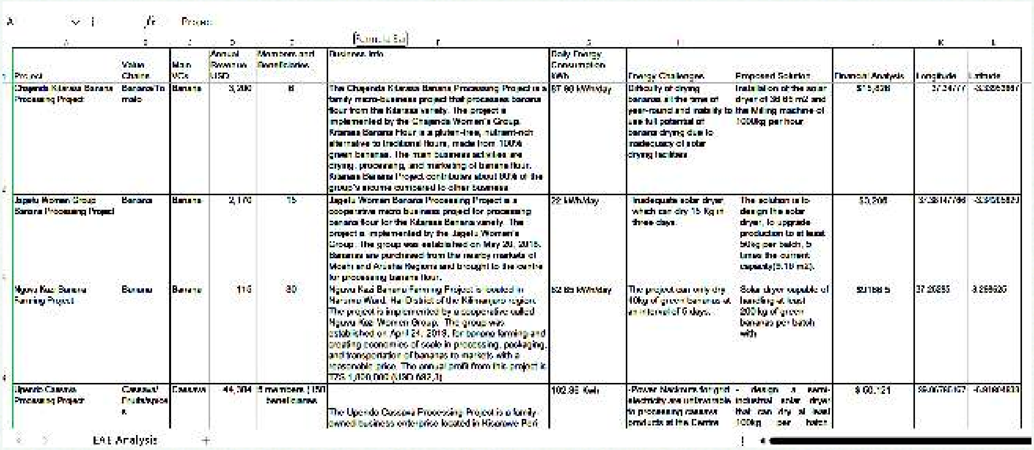


Fig. 3: Interphase of the digital mobile-based survey used for one of the questionnaires for the interviews of the project owners and members

8.2 Analysis and Integration of Collected Data into the EAE

After data collection, the project team assessed and analysed the responses to extract key project attributes that will easily categorize the projects based on their value chains, energy requirements, energy challenges, proposed energy solutions, and costs, plus GPS coordinates for integration into the EAE.

The next figure shows an extract of some of the top projects analysed for integration into the EAE. These were later used to also develop an Investment Prospectus document to guide investors on the top projects to invest in the different counties.



Project	Value Chains	Main VCs	Annual Revenue USD	Members and Beneficiaries	Business Info	Daily Energy Consumption kWh	Energy Challenges	Proposed Solution	Financial Analysis	Longitude	Latitude
Chagenda Kitarasa Banana Processing Project	Banana/Tomato	Banana	3,280	8	The Chagenda Kitarasa Banana Processing Project is a family micro-business project that processes banana flour from the Kitarasa variety. The project is implemented by the Chagenda Women's Group. Kitarasa Banana Flour is a gluten-free, nutrient-rich alternative to traditional flours, made from 100% green bananas. The main business activities are drying, processing, and marketing of banana flour. Kitarasa Banana Project contributes about 80% of the group's income compared to other business	87.60 kWh/day	Difficulty of drying bananas all the time of year-round and inability to use full potential of banana drying due to inadequacy of solar drying facilities	Installation of the solar dryer of 38.85 m2 and the Milling machine of 100kg per hour	$15,828	37.24777	-3.3285887
Jagelu Women Group Banana Processing Project	Banana	Banana	2,170	15	Jagelu Women Banana Processing Project is a cooperative micro business project for processing banana flour for the Kitarasa Banana variety. The project is implemented by the Jagelu Women's Group. The group was established on May 20, 2015. Bananas are purchased from the nearby markets of Moshi and Arusha Regions and brought to the centre for processing banana flour.	22 kWh/day	Inadequate solar dryer which can dry 15 Kg in three days.	The solution is to design the solar dryer, to upgrade production to at least 50kg per batch, 5 times the current capacity(5.18 m2).	$3,298	37.38147786	-3.3905582
Nguvu Kazi Banana Farming Project	Banana	Banana	110	30	Nguvu Kazi Banana Farming Project is located in Narumu Ward, Hai District of the Kilimanjaro region. The project is implemented by a cooperative called Nguvu Kazi Women Group. The group was established on April 24, 2018, for banana farming and creating economies of scale in processing, packaging, and transportation of bananas to markets with a reasonable price. The annual profit from this project is TZS 1,030,000 (USD 442.1)	52.85 kWh/day	The project can only dry 10kg of green bananas at an interval of 5 days.	Solar dryer capable of handling at least 200 kg of green bananas per batch with	$21168.5	37.20855	-3.266620
Upendo Cassava Processing Project	Cassava/ Fruits/spices	Cassava	44,304	5 members (150 beneficiaries)	The Upendo Cassava Processing Project is a family owned business enterprise located in Kisarawe Peri	102.95 Kwh	-Power blackouts for grid electricity are unfavorable to processing cassava products at the Centre	- design a semi-industrial solar dryer that can dry at least 100kg per batch	$ 60,121	[illegible]	[illegible]

Fig. 4: Analysed outputs of top projects after data collection for integration into the EAE.

After analysis of the data collected, it was then processed and harmonized to meet the required standards for integration into the EAE. The integration process also included automated data processing functionalities of the EAE, such as assigning the correct coordinate system to match other datasets in the EAE, clipping it to extract only the datasets within the regional boundaries down to the ward boundaries, and ensuring the data is within the correct resolution required in the EAE.

For purposes of this project, the combined data list of all the projects at the national level was added to the EAE version of Tanzania.

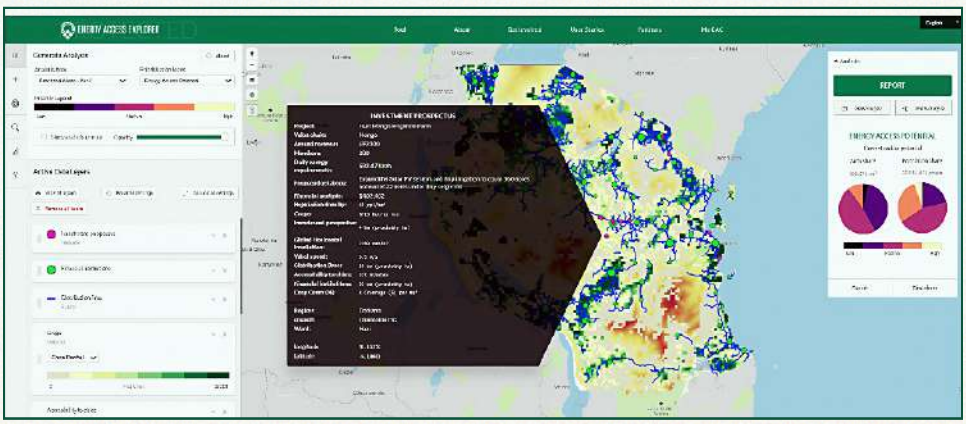


Fig. 5: Combined investment prospectus projects for all regions loaded to the EAE Tanzania version. All investment prospectus points show their attributes when clicked as can be seen in the example above.

Users of this and other data can filter, visualize, and analyze areas at the subnational level extracted from the main EAE version of Tanzania. This includes, but is not limited to, location-specific resource availability and infrastructure data to represent energy supply, demographic data, and data on social and productive uses of energy to visualize demand for energy services.

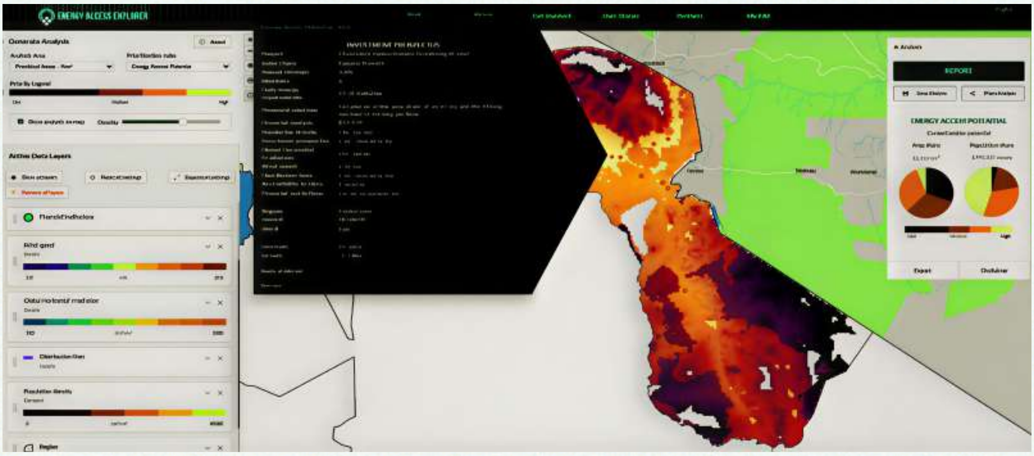


Fig. 6: Investment prospectus projects for the Kilimanjaro Region. Users can visualize all investment prospectus points in the Kilimanjaro Region and click on any of the investment prospectus points to see specific attributes of each as can be seen in the example above.

8.3 Sample Analysis Done in the EAE Using the Uploaded Investment Prospectus Projects

Building on EAE's multi-criteria decision analytical algorithm, users can also carry out custom analysis, which will allow stakeholders (district council, Productive Use of Renewable Energy (PURE) financiers, technology providers, etc.) to identify priority areas/projects for PURE interventions based on a list of criteria.

Such criteria could include geographic information on the selected projects proximity to or accessibility to markets, existing agricultural activity near the projects, population density and distribution, wealth index (or similar income level indicators or asset ownership), renewable energy potential in the project area, proposed technology costs and others which can be found in datasets already available in the EAE or can be uploaded into the EAE from other sources.

These criteria or datasets, when included in a multi-criteria analysis alongside the projects uploaded into the EAE, can be used to test the geographic viability of these projects by investors or other PURE stakeholders to simulate which projects are more ready for investment due to their proximity to the supporting ecosystem for success to de-risk investments.

The figure below shows an example of such a multi-criteria analysis done on the projects from one of the project regions alongside other geographic datasets on the supporting ecosystem.

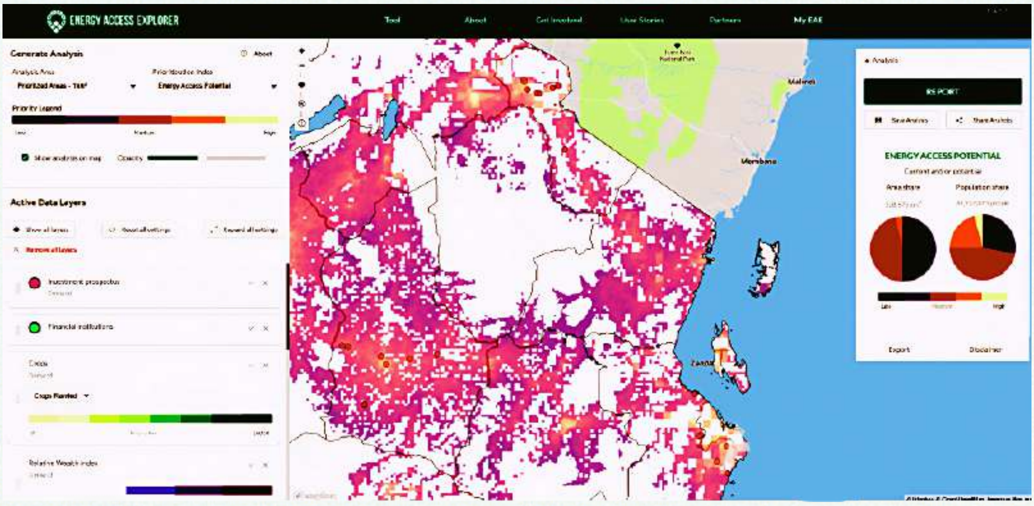


Fig. 7: Investment prospectus projects from one of the regions loaded alongside other datasets, including population density, agriculture markets, croplands, relative wealth index, distribution lines, global horizontal irradiation, windspeed, accessibility to cities, and financial institutions to be used in a multi-criteria analysis to explore the geographic viability of these projects.

The next table further lists the datasets used in this analysis, plus filters applied to them.

Table. 1: List of datasets used in the multi-criteria analysis to explore the geographic viability of the agriculture projects

Dataset	**Filters Used**
Investment Prospectus Projects in Agriculture	Filter map to retain areas less than 2km proximity to these projects
Population Density	Filter to populated areas
Relative Wealth Index	Filter map to retain project areas with populations close to or above the average household wealth in Makueni (likely able to pay for proposed solutions)
Agriculture Markets	Project areas less than 5km to agriculture markets (to show existing markets for produce and reduced costs of transportation)

Dataset	Filters Used
Existing Croplands	Useful to check proximity to projects requiring inputs from farms (agro-processing) or requiring energy appliances for the farms to increase productivity
Distribution Lines	To filter projects within 5km proximity to existing distribution lines to check which ones already have access to electricity from the grid, or would not be too expensive to connect to the grid
Global Horizontal Irradiation	To filter project areas with good solar potential, greater than 1,800 kWh/m2, for those that have been proposed for electrification with solar, or to use appliances using solar
Windspeed	To filter project areas with good wind speed, greater than 5m/s, to illustrate areas that could also use wind as a potential electrification supply option
Accessibility to cities	To filter project areas where access to the nearest city or populated place is less than 90 minutes. This illustrates potential for access to supplies for projects, ease of maintenance of appliances, and access to markets.
Financial Institutions	To filter project areas where the proximity to financial institutions is less than 15 km. This illustrates potential ease of access to potential financiers for proposed electrification solutions and appliances.

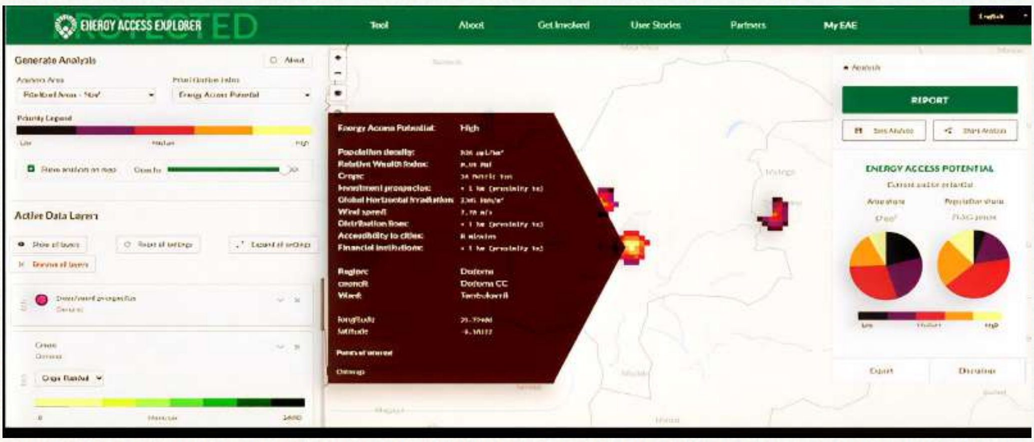


Fig. 8: Analysis output showing the locations of the projects that met the sample geographic analysis criteria used to show they have a supporting PURE ecosystem within their proximity, thus more likely to do well upon investment. One of the top project locations was identified from this analysis, with a pop-up showing reasons why it met the defined geographic criteria.

As has been highlighted, EAE can support investment decision-making for identifying the most viable PURE project to implement, which has the most likelihood of success based on their geographic proximity to other supporting factors such as markets, finance, energy resources, among others. Such analysis can help to de-risk project investments by pre-screening certain key factors for project success before implementation. It is also important to note that the example analysis illustrated here can also be modified to remove some datasets used or add other useful datasets of interest or change some of the filters used as per the need or interest of the investor.

9.0 Summary of Proritized Value Chain Projects

9.1 Prioritized Value Chains Projects

S.No	PURE Technology	Investment Needs (USD)	Project
1.0	Banana		
1.1	Solar Dryers	15,828	Chajenda Kitarasa Banana Processing Project
2.0	**Cassava**		
2.1	Solar PV System and Semi-Industrial Solar Dryer.	50,121	Upendo Cassava Processing Project
2.2	Solar dryer and Solar PV system	70,941	Inuka Cassava Processing Project
3.0	**Dairy Farming**		
3.1	Solar PV System for milk chillers Solar PV system for a milk processing plant	62,500	Nronga Women Dairy Cooperative Society (NWDCS)
3.2	Solar PV System for Lighting and Processing Plant	39,125	Kalali Women Dairy Cooperative Society (KWDCS)
3.3	Solar PV System for Supporting Processing Plant and Lights	174,080	Dream Light Women Group (DLWG)
3.4	Solar PV System 10 kW and Efficient Stoves	81,500	Tam-tam Dairy Farming Enterprise (TDFE)
4.0	**Fisheries/Aquaculture**		
4.1	Solar PV System for Ponds Lighting	24,283	Fahari Fish Aquaculture Business Project
5.0	**Livestock**		
5.1	Solar Water Pump with PV system	12,320	Chipukizi Hakika Kyando Cattle Watering Project
5.2	Solar Water Pumping System	46,750	Naiman Kileo Livestock Watering Project

S.No	PURE Technology	Investment Needs (USD)	Project
5.3	Solar Water Pumping System	44,250	Mpunzungulu Livestock Watering Facilities
6.0	**Mango**		
6.1	Solar Water Pumping System and Drip Irrigation	469,462	Huzi Mango Irrigation Farm
6.2	Solar dryer Solar water pumping system	50,788	Aithan Lucas Chaula Mango Farm
6.3	Solar water pumping system	17,658	Mohamed Mwinyiumadi Shite Mango Farm
6.4	Solar water pumping system and Drip Irrigation	50,165	William Engeo Mango Farming Project
7.0	**Tomatoes**		
7.1	Solar Water Pumping System	36,430	Tall (Ibrahim Moshi) Horticultural Farm (THF)
7.2	Solar Water Pumping System	15,800	Selemani Shabani Tomato Farm (SSTF)
8.0	**Poultry (Chicken)**		
8.1	Solar PV systems for Lighting and an incubator	162,003	Tashimwa Women Poultry Project
8.2	Solar PV system for Lighting in Chicken Pens	38,500	Mselea Poultry Farming Project
8.3	Solar PV System for lighting	154,000	AtuChick Kuku Farming Project

9.2 Project Return Analysis

S. No	Project	Investment Needs (USD)	Simple Payback Period (months)	Estimated Return on Investment (ROI)	Instrument
1	Chajenda Kitarasa Banana Processing Project	15,828	59.4	5%	Blended: Grant (80%), Loan (20%)
2	Upendo Cassava Processing Project	50,121	88.8	32%	Blended (Grants (60%) and loans (40%))

S. No	Project	Investment Needs (USD)	Simple Payback Period (months)	Estimated Return on Investment (ROI)	Instrument
3	Inuka Cassava Processing Project	70,941	170.5	8%	Blended: Grant (50%), Technical Assistance (10%), Loan (40%)
4	Nronga Women Dairy Cooperative Society (NWDCS)	62,500	10	123%	Blended (80% Grant and 20% Loan)
5	Kalali Women Dairy Cooperative Society (KWDCS)	39,125	46.6	53%	Blended: Grant (75%), Loan (25%)
6	Dream Light Women Group (DLWG)	174,080	47.5	34%	Blended (20% loan, 40% grant, 10 %equity, 30% technical assistance)
7	Tam-tam Dairy Farming Enterprise (TDFE)	81,500	24.4	84%	Blended (90% Grants,10% Loans)
8	Fahari Fish Aquaculture Business Project	24,283	50.2	24%	Blended (Grants (33%), Loan (15%), and Technical Assistance (52%))
9	Chipukizi Hakika Kyando Cattle Watering Project	12,320	35.04	19%	Grant (85%), Loan (15%)
10	Naiman Kileo Livestock Watering Project	46,750	53.16	24%	Grant (90%), Loan (10%)
11	Mpunzungulu Livestock Watering Facilities	44,250	42.0	29%	Grant (70%), Loan (20%), Equity (10%)
12	Huzi Mango Irrigation Farm	469,462	13.2	96%	Grant (70%), Loan (20%), Equity (10%)
13	Aithan Lucas Chaula Mango Farm	50,788	29.16	37%	Grant (95%), Loan (5%)
14	Mohamed Mwinyiumadi Shite Mango Farm	17,658	68.4	31%	Grant (90%), Loan (10%)
15	William Engeo Mango Farming Project	50,165	55.6	25%	Blended (Grants (60%), Equity investment (10%), and Technical Assistance (30%))

S. No	Project	Investment Needs (USD)	Simple Payback Period (months)	Estimated Return on Investment (ROI)	Instrument
16	Tàll (Ibrahim Moshi) Horticultural Farm (THF)	36,430	31.7	40%	Blended (Grant (80%), and Loan (20%))
17	Selemani Shabani Tomato Farm (SSTF)	15,800	26.6	45%	Blended (Grant 70% and Loan (30%))
18	Tashimwa Women Poultry Project	162,003	78.8	50%	Blended (Grant 40% and Loan 60%)
19	Mselea Poultry Farming Project	38,500	46.3	21%	Blended (Grant 65% and Loan 35)
20	AtuChick Kuku Farming Project	154,000	76.9	9%	Blended (Grant 75% and Loan 25%)

*Footnote: The simple payback period was calculated by using (**Payback Period = Initial Investment ÷ Cash Flow Per Year**) cumulatively until the year the cash flow is positive. This implies that i) Initial Investment → Cash Outflow in Period 0, while Cash Flow Per Year → Annual Cash Flow Generated*.

*Estimates of Return on Investment (ROI) were calculated by using the formula: (**ROI = (Gain from Investment - Cost of Investment) / Cost of Investment)**. Gain from Investment -Cost of Investment is also known as **net profit**. The result was multiplied by 100 to get a percentage. This calculation measures an investment's profitability relative to its cost.*

10.0 Policy Recommendations to Unlock PURE Investments at Scale

Based on the opportunities and potential available in the Productive Use of Renewable Energy (PURE) initiatives, all stakeholders are supposed to join efforts to promote the productive use of renewable energy in Tanzania. The development of the Productive Use of Renewable Energy (PURE) involves specific policy, financial, institutional, and capacity-building measures. These are crucial for fostering PURE applications, especially in rural and low-income areas.

i) Policy Environment

- Government support is vital for creating a market for PURE.
- Policies and strategies should prioritize the use of renewable energy and energy efficiency.
- This can involve the creation of rules, regulations, and guidelines to manage environmental impact, with a focus on prevention and sustainability.
- Mandating the use of renewable energy and implementing tax incentives for PURE investments.
- Supportive and stable policies are important for encouraging investments in clean energy technologies.

ii) Financial Environment

- High upfront costs for PURE applications are a major barrier, particularly for small- and medium-sized enterprises (SMEs) and end users.
- Local Financial Institutions (LFIs) are key to providing tailored financing options.
- Mechanisms like blended finance, loan guarantees, and results-based financing can help de-risk PURE investments.
- Development partners can collaborate with LFIs to provide funding and increase access to capital.

iii) Institutional Environment

- The institutional environment involves creating frameworks and entities that support PURE development.
- Local Financial Institutions (LFIs) have expressed strong interest in expanding PURE lending, especially for agriculture, but require institutional support.
- This involves integrating PURE into existing institutions and creating new bodies or funds dedicated to PURE.

- There is a need for institutional initiatives that use results-based financing to expand off-grid energy access.

iv) Capacity environment

- Capacity refers to the skills, knowledge, and infrastructure needed to support PURE.
- Capacity-building for stakeholders like LFIs is necessary to overcome constraints like limited staff expertise in PURE.
- This includes training and technical assistance for end users, SMEs, and financial institutions.
- Developing effective data collection and analysis frameworks is also important for measuring progress and informing policy.

11.0 Conclusion

Investing in Productive Use of Renewable Energy (PURE) in Tanzania offers a significant opportunity for economic growth, climate resilience, and social development by leveraging abundant natural resources. While barriers like financing gaps and data availability persist, the Tanzanian government has demonstrated strong commitment and implemented supportive policies to attract private sector investment, creating an enabling environment for PURE technologies and projects that drive energy access, improve livelihoods, and reduce reliance on fossil fuels.

These prospects are supposed to attract more financing mechanisms for high-risk projects and small businesses, develop innovative business models for PURE services, use geospatial tools to identify opportunities, promote community-driven initiatives, and focus on specific high-impact agri-food value chains and unlock more opportunities in SME sectors like tailoring, welding, and refrigeration.

12.0. Annexes

12.1 Data Collection Survey Toolkit

- PURE Survey (Banana Solar Drying)
- PURE Survey (Dairy Farming)
- PURE Survey (Cassava Processing)
- PURE Survey (Fisheries and Aquaculture)
- PURE Survey (Livestock Watering)
- PURE Survey (Mango Irrigation)
- PURE Survey (Tomato Farming)
- PURE Survey (Poultry (Chicken) Rearing

12.2 Assumptions on PURE Equipment Costs

PURE Equipment	Product Specifications	Costs (USD)	Sources
Semi-Industrial Solar Dryer	Semi-Industrial solar dryers have a solar collector for capturing sunlight, a drying chamber with trays to hold food, and a transparent cover and cladding to trap heat. Key parameters also include the drying capacity of 100-300kg, area of around 30 m^2, target temperature range of 50-75°C, and the use of black, non-toxic absorber materials. Materials used are galvanized sheet 2 mm, visqueen sheet, plastic wire mesh, square pipe, angle section, etc.	15,000 to 50,000 (depending on size required)	INFORSE Catalogue
Milling Machines	A small flour milling machine's specifications typically include a production capacity of ≥180 kg/h, a power requirement of about 3kW, a spindle speed ranging from 4500-5500 rpm, and a net weight of around 29kg, though these vary significantly by model and intended use (home vs. small commercial).	Small to medium-sized maize milling machines range from $3,400 to $4,700	Made in China.com
Solar PV Systems	A solar PV system for lighting in chicken pens and other PURE enterprises requires a solar panel, a charge controller, a battery, and lights, all connected to a timer to regulate them. a small-scale system can use a single solar-powered, dusk-to-dawn bulb rated for 100 sq ft, while a larger farm might need multiple 5W to 7W high-efficiency panels. The solar PV system is expected to power a 5.5 HP (3.73 kW),chipping machine, a 3HP (2.24 kW) submersible water pump, 8 (15-watt) LED lights and 3 pcs of 90-watt fans.	USD 254 to USD 2,403, depending on the equipment to be powered	Local Solar Companies

PURE Equipment	Product Specifications	Costs (USD)	Sources
Milk Coolers/ Chillers	Milk cooler or chiller specifications include capacity (1000-30,000+ liters), cooling temperature (typically 3-4°C), material (AISI 304 food-grade stainless steel), power requirements (e.g., 415V, 20A), chilling time (e.g., 2-3 hours), insulation type (e.g., P.U.F.), design features (e.g., double-walled tank, laser-welded evaporator), and compliance standards	USD 562 to USD 2,053, depending on the sizing of the system	AlBaba
Solar Water Pump	Solar water pump specifications vary widely, but commonly include pump type (centrifugal submersible), power (120W to 5100W or higher), maximum head (the maximum vertical lift), and maximum flow rate (16.2 m^3/h), along with motor type (DC or AC, brushless DC is common), and material (stainless steel is often used).	USD 1,205 to USD 2,305, depending on the head of lifting water and PURE requirements	Davis and Shitliff
Drip Irrigation System	Drip irrigation systems required for PURE projects should include a filtration system to remove particulates to less than 120 microns. Common drip line diameters are 16mm, with varying wall thickness and emitter spacing (30cm or 20cm) depending on the plant's needs. The maximum drip line length is dictated by the available head at a rate of 10m of line per 1m of head, operating within a pressure range of 3m to 20m	USD 350 to USD 2,308, depending on the area to be covered	National Irrigation Commission
Efficient Biomass Warming Appliances	Chicken warming appliances specifications include fuel source (charcoal), capacity for heating a specific number of chicks or square meters, construction material (stainless steel, iron), safety features like ventilation and heat-resistant coating, and specific components such as ash/grease trays or rotating spits for roasters.	USD 10 to USD 30, depending on the size of the poultry pen	Local Poultry Appliance vendors
Chest Freezer	Chest freezers in Tanzania commonly feature specifications such as voltage (220-240V), 50Hz frequency, and capacities ranging from 95L to over 500L, with brands like Hisense and Westpoint offering models with manual or mechanical controls, varying energy efficiency ratings (e.g., Energy Class A), and features like fast cooling and 3D cooling.	USD 577 to USD 850, depending on cooling or storage capacity required	Jiji Tanzania

12.3 Assumptions on Project Return Analysis

The financial viability of the projects is calculated based on an amortization model that is customizable to different return assumptions. In general, below are the assumptions used per project:

The accuracy of the calculation depends on using historical data and making realistic estimates for future costs and revenues.

All direct and indirect costs associated with the investment were included in the calculations to ensure accurate coefficients were determined during return analysis.

The simplest formula for payback assumes that net cash flows are earned equally each year. This assumption is often relaxed to be more realistic, requiring a more detailed calculation for uneven cash flows.

A fundamental assumption is that the difference between income and costs represents the true net profit for the investment.

Account for inflation rates in Tanzania when forecasting future costs and revenues to ensure the analysis reflects the purchasing power of money.

Consider local market dynamics, regulatory changes, and consumer behavior specific to Tanzania, as these will not influence cash flows and project viability.

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