MAKUENI COUNTY INVESTMENT PROSPECTUS (IP):

AVAILABLE INVESTMENT OPPORTUNITIES IN PRODUCTIVE USE OF RENEWABLE ENERGY (PURE) IN MAKUENI COUNTY

YEAR: 2024

Table of Contents

Authors

Anderson Chembe (WRI), Victor Otieno (WRI)

Contributors and Reviewers

1. Douglas Ronoh (WRI)
2. Benson Ireri (WRI)
3. Patrick Mwanzia (SU)
4. Brian Wamukoya (SU)
5. Dominic Kemei (SU)
6. Naomi Nthambi (GMC)
7. Stanlus Muthoka(GMC)
8. Jacky Mbula (GMC)
9. Dimitris Mentis (WRI)
10. David Njugi (WRI)
11. Harrison Mwololo (GMC)

Disclaimer

This document has been prepared with all due diligence and care, based on the best available information at the time of publication. Whilst informative, this analysis was limited to a sample size of the 15 project sites visited. More site visits and further feasibility studies are needed to validate the key findings. Neither WRI Africa, Strathmore University, nor their partners or affiliates, hold responsibility for any errors or omissions within it, regardless of the cause, or for the results obtained from the use of such information. Any decisions made by other parties based on this document are solely the responsibility of those parties, and the liabilities thereof not transfereable to the authours of this Investment Prospectus.

Acknowledgement

The successful completion of this Investment Prospectus would not have been possible without numerous individuals and organizations' concerted efforts and dedication.

We extend our deepest gratitude to the technical working group, whose tireless efforts and expertise have been instrumental. This group was appointed with the invaluable assistance of the Chief Officer and the Executive Committee Member in charge of the Energy Directorate, whose support and guidance have been pivotal.

We also appreciate the cooperation and input from various departments within the Makueni County Government, particularly the Agriculture, Livestock, and Fisheries departments, and the Department of Trade. Their collaboration has been essential in providing the necessary data and insights to develop a comprehensive and actionable prospectus.

Special thanks go to the World Resources Institute (WRI) and the Strathmore Energy Research Centre (SERC) for their technical support and collaboration during the field visits, data collection and analysis phases. The primary data collection team; WRI, SERC, and Makueni County, executed their tasks with utmost diligence and professionalism.

Our gratitude also goes to the farmers' groups and cooperatives who participated in the surveys and focus group discussions. Their willingness to share information and insights of the existing energy gaps has provided a solid foundation for the investment opportunities highlighted in this prospectus.

Finally, we acknowledge the support of development partners who have continually believed in the potential of Makueni County and invested resources to support our developmental goals especially the UK Government through the UK Partnering for Accelerated Climate Transitions (UK PACT) programme. Your contributions have been invaluable in shaping a sustainable and prosperous future for our county.

Foreword

I am delighted to present the Makueni County Investment Prospectus for Green Energy, a ground breaking initiative that underscores our dedication to sustainable development and economic resilience. As an Arid and Semi-Arid Land (ASAL) County, Makueni is blessed with abundant sunshine which is a free and inexhaustible resource that we consider key to our future prosperity.

Our vision is to establish Makueni County as a beacon of green energy innovation, showcasing how sustainable practices can drive economic growth and environmental stewardship while building our resilience to climate change. The potential of solar energy in our county is vast and its benefits are manifold ranging from reduced energy costs, increased agricultural productivity to a cleaner and healthy Environment.

For too long, our County has borne the burden of high electricity costs, significantly impacting our operational expenses and limiting our growth potential. This prospectus not only highlights the immense opportunities within the realm of Productive Use of Renewable Energy (PURE) but also provides a strategic pathway to harness solar energy, reduce huge operational costs, and boost productivity across various development sectors in the County.

Through a meticulous research and active stakeholder engagement, we have identified critical value chain within the Agriculture sector in our County that can be revolutionized through renewable energy solutions to bring a tremendous growth in both development and service delivery for the County. These are; fish, dairy, green grams, poultry, fresh fruits and vegetables. By adopting solar-powered irrigation, cold storage and value addition technologies, we aim to transform this sector, enhance food security, and create new economic opportunities for our residents.

The successful realization of this prospectus hinges on collaborative efforts. We invite investors, development partners and all stakeholders to join us in this transformative journey. Together, we can unlock Makueni County's full potential, ensuring a sustainable and prosperous future for all.

In conclusion, I extend my gratitude to everyone who contributed to the development of this comprehensive document. Your dedication and vision have laid a strong foundation for a brighter, greener tomorrow.

With utmost optimism,

H.E Mutula Kilonzo Junior CBS,
Governor, Makueni County

EXECUTIVE SUMMARY

With support from the UK's Partnering for Accelerated Climate Transitions (UKPACT) - a programme funded by the UK Government through the Foreign, Commonwealth, and Development Office (FCDO), World Resources Institute (WRI) and Strathmore University (SU) collaborated with the Government of Makueni County (GMC) to develop a pipeline of bankable projects in the Productive Use of Renewable Energy (PURE) sector. This Investment Prospectus (IP) presents PURE opportunities identified across Makueni County, specifically in agriculture and health sectors.

Agriculture is key to the county's economic growth. In 2022, the sector contributed 27% and 1.1% of the County and national GDP respectively[1]. It also accounts for 78% of the total household income in Makueni County.[2] However, productivity of the sector in the county has not been at optimal, largely due to depressed rains and declining agricultural profitability and commercialization which can be attributed to lack of adequate irrigation and food loss due to lack of cold storage and agro-processing. On the other hand, the GMC has prioritized the health sector, demonstrated through the launch of Makueni Care - a universal health program that aims to improve access to promotive, preventive, curative and rehabilitative health services and reduce the population's high out-of-pocket expenditure[3].

Access to affordable, reliable, and clean energy is key to the realization of development ambitions under these two sectors. With only 34.9% of households in Makueni having access to electricity (national grid and mini grid), the social and economic development of the county is negatively impacted. For example, the ability of farmers and agri-business enterprises to raise productivity, reduce losses and cope with the impacts of a changing climate and other shocks is limited. Similarly, limited access to affordable and reliable energy by healthcare facilities negatively impacts the quality of services provided by these institutions. For the county government to achieve its ambition of improving healthcare infrastructure as captured in its Vision 2025, reliable access to affordable energy will be key.

Application of Productive Use of Renewable Energy (PURE) through interventions like solar-powered irrigation systems, agro-processing to add value to agricultural produce, drying, cooling, as well as cold storage – among others, has the potential to increase productivity of the agriculture sector in the county, while improving food security and increasing rural incomes. Livestock sub-sector including fish, dairy, and poultry; pulses including green grams, and horticulture including fresh fruits & vegetables were identified as priority value chains based on the assessment that was conducted by WRI and SU, in collaboration with the county government's departments of infrastructure, transport, public works & energy; agriculture, irrigation, livestock, fisheries & cooperative development; and energy, during the development of the County Energy Plan (CEP).

Primary data collection (field assessments) was carried out by a team drawn from WRI, SU, and GMC using semi-structured questionnaires targeting the selected value chains across the county. Fifteen (15) farmer groups and co-operatives of smallholder farmers identified with the help of the Makueni County Agriculture, Livestock and Fisheries department were visited. The data collected were integrated and analysed on an open-source interactive online platform called Energy Access Explorer to showcase the opportunities.

---

[1] https://www.knbs.or.ke/wp-content/uploads/2023/10/GCP-report-2023.pdf
[2] Makueni-County-Annual-Development-Plan-2023_2024.pdf
[3] About health - Government of Makueni County

On the other hand, two of the biggest health facilities in the county - Makueni County Referral Hospital (MCRH), and Makindu Level Four (4) Hospital were also prioritized by the county government for investment in solar energy. While both facilities are connected to the grid, the decision to invest in solar power was informed by the high cost of electricity that the county government incurs, coupled with power reliability and quality challenges experienced in the region necessitating the operation of diesel generators to supply critical loads. A team from SU and WRI undertook energy needs assessments to inform system sizing and investment requirements for both facilities. Based on the outputs of the analysis, the county government, with support from the UK Government invested in a 205.6kW AC grid-tied, captive solar system on MCRH. This will help save electricity costs for the facility by USD 42,857, from its current annual spending of USD 131,579 as well as reduce carbon footprint from the gensets. The county is also keen to identify partners to finance and invest in solarisation of the Makindu level 4 facility.

Summary Solarisation Needs for the 2 Healthcare facilities:

Project Name	Makueni County Referral Hospital	Makindu Level 4 Hospital
Energy Investment Needs	Installation of BESS system @45% self-sufficiency ratio	Installation of Solar PV with BESS system @45% self-sufficiency ratio
Proposed Investment Cost (1$≈ KES 133)	$491,671	$386,710
Simple Payback Period	16.02 years	17.81 years

1.0 BACKGROUND AND OBJECTIVES OF THE INVESTMENT PROSPECTUS

This Investment Prospectus (IP) highlights the priority Productive Use of Renewable Energy (PURE) investment opportunities in Makueni County under extension of the Makueni County Energy Plan (CEP) Project. According to the Energy Act of 2019, counties in Kenya are required to develop their energy plans. This presents an opportunity to not only map out counties' energy resources but also integrate ways to utilize the energy resources productively to generate incomes and boost livelihoods at a subnational level. The main aim of the IP is to improve energy access for productive use and to help attract finance and investment, by showcasing tangible PURE opportunities that exist in the County specifically within the agricultural value chain. Additionally, this IP serves as an investment enabler whose overall objective is to contribute to the realization of access to modern energy services for the people in Makueni. This IP complements Makueni County's broader Investment Prospectus that covers investment opportunities across all the sectors within the County. Table 1 below provides a summary of priority projects by value chains.

Table 1: Summary of Priority Projects by Value Chain (1USD ≈ 133KES)

SUMMARY OF PURE INVESTMENT OPPORTUNITIES BY THE COUNTY GOVERNMENT OF MAKUENI				
Sector	**Value Chain**	**Project(s) Name**	**Energy Investment Needs**	**Energy Investment Size ($)**
Agriculture	Fresh fruits & vegetables	Makueni Fruit Processing Plant, Kalamba	• Purchase and installation of solar PV • Mango Puree evaporator	**$1.4 million**
		Utangwa Irrigation Scheme	• Grading shade nets on 1 acre with 55% shade • Solar-powered container cold-room • 2,000 surface solar water pumps and 1 submersible pump	**$1 million**
		Makasa Irrigation Scheme	• 700 solar water pumps	**$342,105**
		Cold-rooms solarisation for 1. Kanoto Farmers; 2. Kilungu Farmers; 3. Muoni Investors (Kavuthu Cold room) 4. Emali modern Market	• Purchase and installation of solar PV system	**$367,024**
	Hybrid: Fish; Fresh fruits & vegetables	Kiboko integrated Farmers	• Multipurpose feeds processing machines. • 173 universal portable chiller boxes for fish storage. • Surface Solar pumps for 132 fishponds • Walk in Cold storage • Solar powered fish cold-room at Kiboko market for fish	**$616,129**
	Dairy	Kaiti Dairy	• Solar-PV modules for existing pasteurizer and e-bikes load • 5 e-bikes singular battery @ $1500 each • 5 chiller boxes (100L capacity) @USD 977.44 • Solar PV system to replace upgrade of equivalent capacity of generator. • Refrigerated truck.	**$39,887**
		Kitise Rural Development	• 5 e-bikes singular battery @ $1500 each • 5 chiller boxes (100L capacity) @USD 977.44 • Borehole construction ((150m*USD 52.63) plus installation of submersible pump (USD 3,383.46) plus water storage tank 10K litres and plumbing work (USD 902.25) = Approximately USD 12,180.21. (Power about 4KW to be drawn from the solar system). • Multipurpose feed processing machine.	**$454,050**
	Green Grams	Makueni Integrated Grain Value Addition Plant	Solarisation of the grain processing plant	**$550,000**

	Poultry	Aggregated Poultry Enterprises e.g. Kambu Poultry Farmers + Poultry Queen aggregated under 42 groups	Solar powered egg incubators	**$134,447**
Health	Energizing Healthcare facilities	Makueni County Referral Hospital (Wote)	Installation of BESS system @45% self-sufficiency ratio	**$491,671**
		Makindu Level 4 Hospital	Installation of Solar PV with BESS system @45% self-sufficiency ratio	**$386,710**

What is Productive Use of Renewable Energy (PURE):

There is no universally agreed definition of PURE.[4] This IP however defines Productive Uses of Renewable Energy (PURE) as the application of energy (mainly electricity) generated from renewable sources (e.g. solar) to increase income or productivity. In rural contexts like Makueni County, typical productive uses can be found in agricultural value chains e.g. irrigation, drying, cooling solutions, grain milling, etc. Social uses of electricity e.g. in education and healthcare sectors, add productive value to a region and are sometimes included under productive uses.[5]

[4] Conceptualization and antecedents of productive use of electricity: A systematic literature review - ScienceDirect
[5] 111031_euei_productive_use_manual_inhalt_rz_02.indd (energypedia.info)

MAKUENI COUNTY OVERVIEW

Makueni County is one of the 47 counties in Kenya. It is situated in the South-eastern part of the country. The county lies between Latitude 1º 35´ and 3° 00´ South and Longitude 37º10´ and 38º30´ East with an area of 8,176.7 KM2. Administratively, Makueni County has six constituencies and 30 wards. Demographically, the has a population of 987,653 consisting of 489,691 males, 497,942 females, and 20 inter-sex, and an annual population growth rate of 1.1% (KNBS, 2019). Youthful population of ages 15-34 was 33.9% in 2019.[6] This presents a vibrant market for the adoption of PURE within the county.

While Agriculture is the main economic activity in the county, there are other activities including, small-scale trade, eco-tourism, and commercial businesses (KNBS, 2023b[7]). With 63% of Makueni's total area (504,269 ha) as arable land, Makueni County is endowed with rich agro-ecological zones across the county. Farmers engage in the cultivation of different crops including maize, beans, millet, sorghum, fruits (mangoes, oranges, bananas), and vegetables. Livestock rearing, including cattle, goats, and poultry, is also widely practiced. Makueni County is largely arid and semi-arid and prone to frequent droughts due to unreliable and erratic rainfall. Thus, the smallholder farmers who highly depend on rain-fed farming systems are exposed to drought and unpredictable weather patterns caused by climate change.

> Makueni County contributes 1.1% to Kenya's GDP based on a 5-year average from 2018 to 2022. This translates to USD 902 Million as of 2022.

Contribution of the Agriculture Value Chains

The agriculture sector is critical to Kenya's economy and has been identified as a priority area in national strategy and policies. In addition to its contribution to food security and nutrition[8], the sector also contributed about 21.3% of the country's average GDP during the[9], and while employing over 40% of the total population and more than 70% of the rural populace.

According to the Kenya National Bureau of Statistics 2023a[10], Makueni County contributes 1.1% to Kenya's GDP based on a 5-year average from 2018 to 2022. This translates to USD 902.26 Million as of 2022. The county's contribution towards Agriculture, Forestry, and fishing activities stood at 1.3% of the national output on average between 2018 and 2022. This translates to USD 251.1Million with current prices as of 2022. Agriculture as a standalone sector contributed 27% of the USD 902.26 Million county economy in 2022. (Kenya National Bureau of Statistics, 2023b[11]). Cumulatively, agriculture and related activities account for 78% of the total household income in Makueni County.[12]

---

[6] Revised-Final-CIDP-2023-27(Makueni) (1).pdf (kippra.or.ke)
[7] https://www.knbs.or.ke/wp-content/uploads/2024/02/Makueni-CSA-2023.pdf
[8] UTF KEN 083 KEN Terminal Report 20-01-2023.pdf (gafspfund.org)
[9] 1273062951_Agricultural Sector Survey January 2024.pdf (centralbank.go.ke)
[10] https://www.knbs.or.ke/wp-content/uploads/2023/10/GCP-report-2023.pdf
[11] https://www.knbs.or.ke/wp-content/uploads/2024/02/Makueni-CSA-2023.pdf
[12] Makueni-County-Annual-Development-Plan-2023_2024.pdf

Unlocking agricultural value chains through productive use of energy and financial access

Productive use of Renewable Energy (PURE)

- Energy and agri-food value chains are closely intertwined. Energy is needed at all stages of the agri-food system to produce food, transport it, store it, and prepare it (post-harvest handling) for markets, etc. Thus, energizing the agri-food system by ensuring that reliable, affordable, and environmentally sustainable energy is available is a key enabler of higher yields, increased incomes, lower losses, and greater climate resilience.[13] Yet in Makueni County, according to the Draft Makueni County Energy Plan, only 34.9% of households have access to electricity that can potentially stimulate productive uses (i.e. electricity from the grid and minigrids). This limited access to energy limits the ability of farmers and agri-enterprises to raise productivity, cut losses, and cope with a changing climate and other shocks.[14]
- Some of the agricultural development issues in the County e.g. declining agricultural production and productivity due to depressed rains and declining agricultural profitability and commercialization,[15] can be addressed through access to energy e.g. solar energy for irrigation, value addition, cooling, and cold storage, etc. The figure below shows points along the agri-food chain where clean energy technologies e.g. solar pumps, cold rooms, solar dryers, milk chillers, etc. can be implemented (FAO and USAID, 2015).
- Using these technologies can have several environmental as well as socio-economic benefits. Nevertheless, there are also significant barriers to the uptake and adoption of the identified technology options. Since agri-food chains are a set of integrated individual activities that span several steps that also vary across the different food value chains. Faults at any step of the agri-food chain impact the efficiency and operation capacity of the entire chain. Therefore, it is important to emphasize that the success of the identified technology does not solely depend on the technical potential but is also linked to all actors and processes in other stages of the agri-food chain. To successfully develop a well-functioning agri-food value chain, that has access to dependable clean energy and that promotes social and economic benefits, all actors across the chain, including policymakers, the private sector, financing agencies and, most importantly, the value chain operators themselves need to be included.[16].

---

[13] Renewable energy for agri-food systems – Towards the Sustainable Development Goals and the Paris agreement (irena.org)
[14] Renewable energy for agri-food systems – Towards the Sustainable Development Goals and the Paris agreement (irena.org)
[15] Makueni-County-Annual-Development-Plan-2023_2024.pdf
[16] The small-scale fisheries and energy nexus (fao.org)

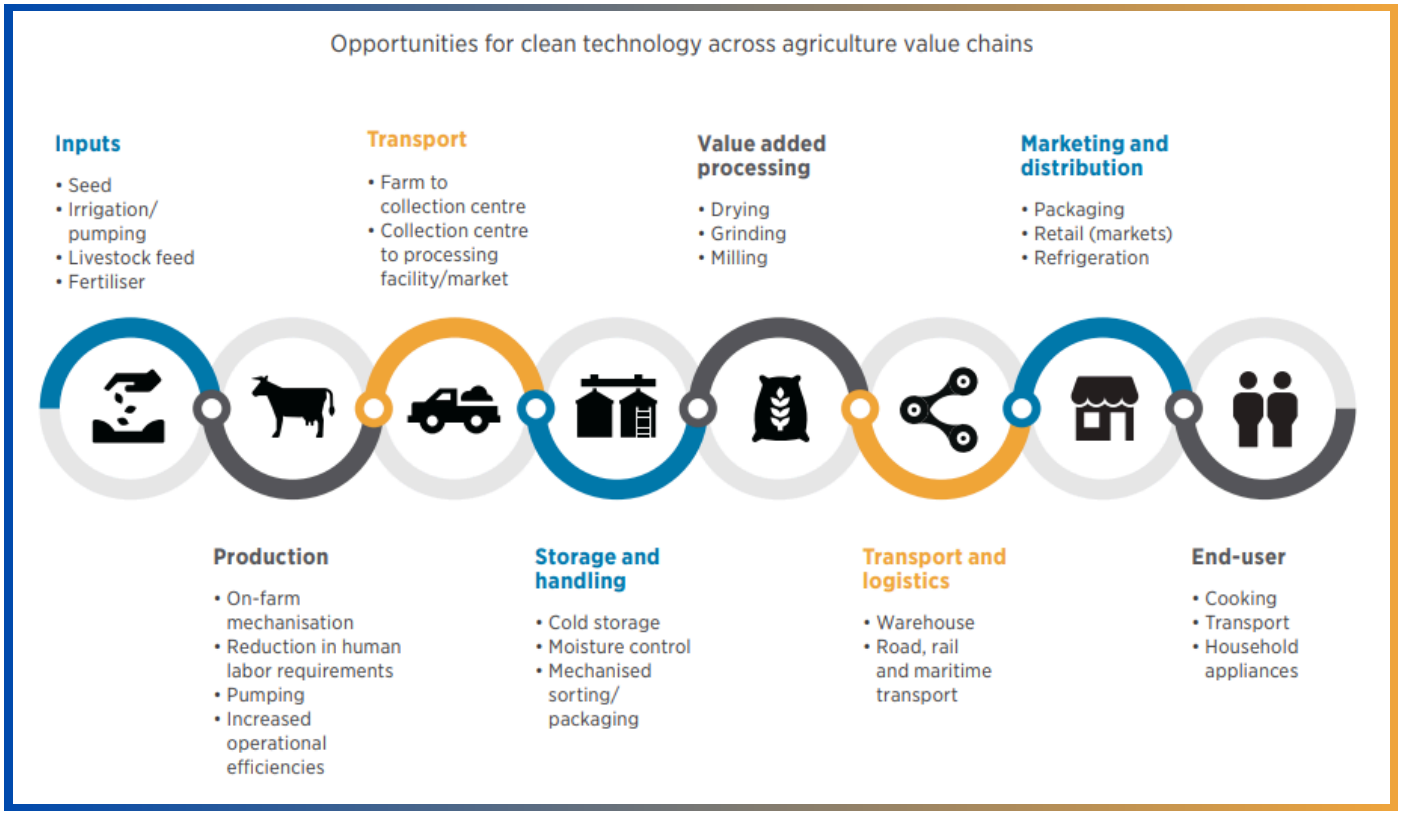


Figure 1 Stages along the agri-food chain where clean energy technologies can be implemented (Source: FAO and USAID).

Finance

Generally, formal financial inclusion stands at 87.5% of the population within Makueni County. Even so, Makueni is also among the counties where the usage of informal groups (Chamas) to access finance is prominent, signaling the high presence of small businesses and agricultural activities. The main source for financing agriculture is 52% from informal sources (Central Bank of Kenya et al., 2022[17]). The county's ADP highlights that creating linkages between smallholder farmers, agri-SMES, and financial institutions for tailored agricultural financial products is key to enhancing access to finance and in turn; boosting agricultural production and productivity.

The presence of commercial banks and SACCOs within the County is a potential avenue that smallholder farmers could tap into to access more financing in addition to the informal channels of finance. This can be realized through linkages with cooperatives of smallholder farmers across the agricultural value chains. One of the ADP's strategic interventions is to enhance cooperative development to mobilize the adoption of clean energy by cooperative members and enable access to credit for the installation of solar power at business premises. As renewable energy technologies usually require high upfront costs, the county's plan to enhance public finance management to facilitate access to affordable credit for green energy stands to address the affordability challenge faced by most smallholder farmers when procuring productive use equipment thus potentially reducing production costs and ultimately increasing agricultural production and productivity.

[17] https://www.centralbank.go.ke/finaccess/FINACCESSCOUNTIES.pdf

MAKUENI COUNTY'S INVESTMENT READINESS

Incentives for Investors

Makueni County presents untapped investable opportunities with the potential to boost economic growth but also offer attractive returns to investors. The county has developed an Investor Handbook (draft) which this IP complements. The Handbook prioritizes sectors where opportunities lie, including the agriculture sector. The county provides an enabling environment with favourable policies for investors. Such incentives, according to the draft Handbook, covering multiple sectors, include:

- Offer of One-Stop-Shop services that serve as an Information Hub and where interested investors are walked through orientation, license applications, development control, and permits applications as well as connections to other relevant government agencies besides offering aftercare services.
- The county actively promotes investment opportunities across various sectors through marketing campaigns, investment forums, and outreach programs.
- Makueni has dedicated teams that provide advisory services to investors, offering guidance on investment procedures, regulatory requirements, and potential incentives.
- Makueni offers online licensing services and a unified billing system to facilitate licensing processes for businesses, streamlining procedures and reducing administrative burdens.
- The County assists investors in navigating regulatory processes and obtaining permits, licenses, and approvals from relevant government authorities.
- Strategic Intervention under ADP 2023/2024: Promotion of Agri-entrepreneurial skills: The government has established a model Agriculture Training Centre(ATC) at Kwa Kathoka by constructing and equipping workshops, establishment of a fisheries hatchery, livestock feeding tree nursery as well as the construction and equipping of a dairy unit. This model training centre supports the training of trainers in improved value chain curricula for mango, avocado, dairy, aquaculture & French beans as well as animal feed formulation.[18]

Financial Resources in Makueni County

The financial year 2022/2023 saw the county receive an estimated total of USD 79.70 Million for both its recurrent and development expenditure. Of this, only USD 2.48 million were grants, demonstrating the county's ability to raise funds from other sources such as Equitable share from the national government (USD 60.9 Million) and own-source revenue (USD 6.7 million). In 2024, Augusto & Co. assigned Makueni County a credit rating that reflects the County's stable political environment, increasing capital spending on infrastructure development projects & technological innovation as well as modest financial flexibility owing to low leverage. (FSD Kenya, 2024[19]).

[18] Makueni-County-Annual-Development-Plan-2023_2024.pdf
[19] https://www.fsdkenya.org/wp-content/uploads/2024/04/Green-finance-assessment-of-Makueni-County.pdf

According to Makueni's annual development plan 2024/2025, the county seeks to further strengthen its resource mobilization efforts. It has identified strategic interventions including:

a) Optimal collection of Own Source Revenue by broadening the revenue streams and exploiting untapped own revenue potential.
b) Enhancing externally mobilized resources and capital investments funded by development partners.
c) Strengthening Public Private Partnerships (PPP) coordination.
d) Building strategic partnerships with development partners.
e) Capacity building county sectors to develop proposals for funding by development partners.

2.0 METHODOLOGY FOR INVESTMENT PROSPECTUS DEVELOPMENT

The development of the 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. Incorporation of investment opportunities on the IP is structured per each high-impact priority value chain within the county's PURE ecosystem, particularly in the agricultural value chain. Based on the initial PURE assessment conducted by WRI and SERC under the CEP development, and the Baseline Survey by the Ministry of Agriculture, Livestock, Fisheries & Co-operatives, and the Kenya County Governments[20], consultations with the Makueni County Department of Agriculture and Livestock, the priority value chains in agri-food considered for PURE technologies adoption are:

- Fish
- Dairy
- Green grams
- Poultry
- Fresh fruits & vegetables

The highlighted PURE opportunities span across PURE applications in irrigation, cold storage, value addition, and energy generation to power productive uses using solar.

SELECTION OF PRIORITY VALUE CHAINS

Selecting priority value chains was a critical step in ensuring that the value chain projects are set to provide a suitable return on investment. Identification of the opportunities listed on this IP was based on the following criteria:

- Reviewing secondary information to understand production, market trends, etc. Anchor documents reviewed included but were not limited to the draft Makueni CEP, and Baseline Survey by the Ministry of Agriculture, Livestock, Fisheries & Co-operatives, and the Kenya County Governments.
- Data collection and analysis through the Energy Access Explorer (EAE); an online, open-source, interactive platform that uses mapping to visualize and identify priority areas where energy markets can be expanded.
- Priority projects identified under the CEP, especially those in the Agriculture value chains to scale renewable energy interventions;
- Consultations with Makueni Nexus departments i.e. Department of Agriculture, Livestock and Fisheries, and Department of Trade to validate the priority value chains.

DATA COLLECTION (FIELD VISITS)

Primary data collection (field assessments) was carried out by a team, divided into 2 groups, consisting of WRI, Strathmore Energy Research Centre (SERC), and Makueni County officers. The team designed study tools (semi-structured questionnaires) targeting the selected value chains across the county. The data collection tools were uploaded onto mobile applications to be used in the surveys and focus group discussions (FGDs) for collecting both the project details and its location.

Before the actual survey/FGDs, the team conducted key informant interviews with key informants from various departments aligned to the agricultural value chains. The Surveys/FGDs were conducted with farmer groups and co-operatives of smallholder farmers which the Department of Agriculture, Livestock, and Fisheries helped to identify. A total of 15 farmer groups/cooperatives were surveyed as shown in Table 2 below. Data to support biophysical and infrastructure analyses for suitability mapping came from county, national, and international maps through the energy access explorer.

15

Number of farmer groups/ cooperatives surveyed.

Table 2: Summary of Famer Groups/ Cooperatives Surveyed during Field Visits

Name of Value Chain	Farmer Group/Coop Visited	Sub county	Gender distribution of farmers per group	
			Male	Female
Dairy	Kaiti Dairy Co-op Society	Kaiti	4	0
	Kitise Rural Development		9	2
Poultry	Kambu Poultry Farmers	Kibwezi East	2	9
Fish	Kiboko Fish Farmers	Kibwezi West	7	3
Fresh Fruits and Vegetables	Athi Farmers Group	Kibwezi East	8	7
	Utangwa Irrigation Scheme	Mbooni	5	2
	Muuoni Investors	Kibwezi West	9	4
	Kanoto Horticultural Farmers	Mbooni	4	0
	Kilungu Farmers	Kaiti	10	1
Fresh Fruits and Vegetables	Emali Modern Market	Kibwezi West	4	11
Fruits (Mangoes)	Cage Vineyard Small-scale mango dryers	Makueni	2	0
	Kalamba Fruit Processing Plant	Makueni	6	4
Pulses	Grain Plant	Kibwezi West	9	4
Maize	Kikima Millers	Mbooni	3	1
Bodaboda	Wote Boda Boda	Makueni	17	1

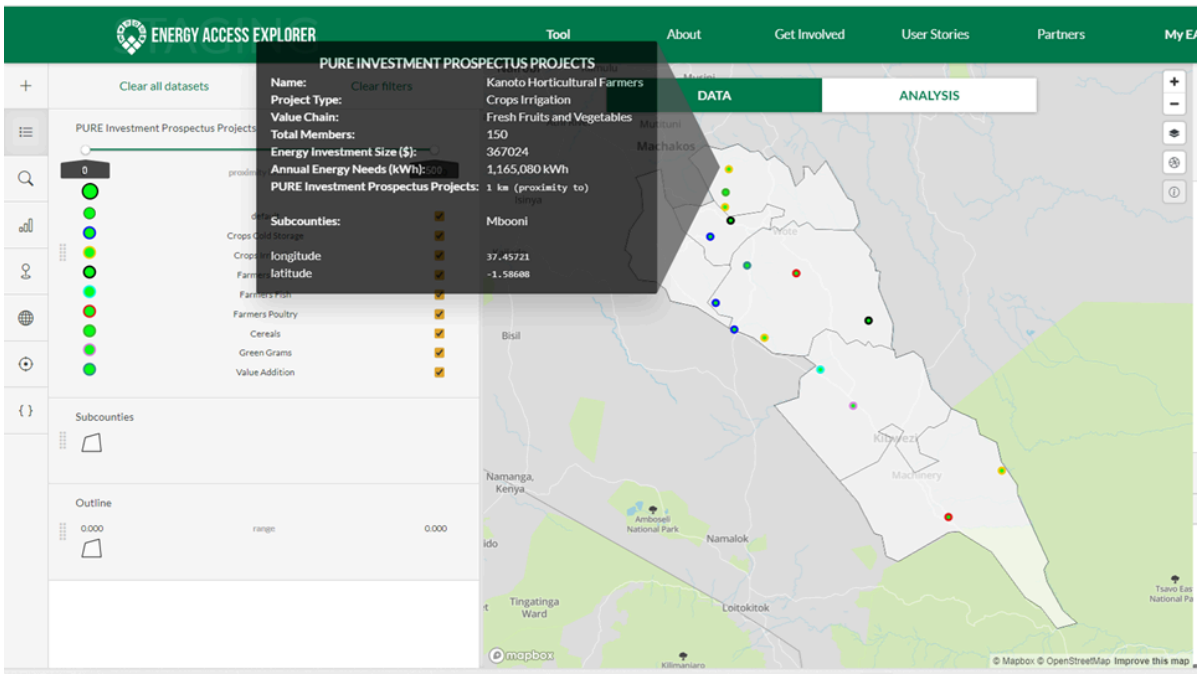
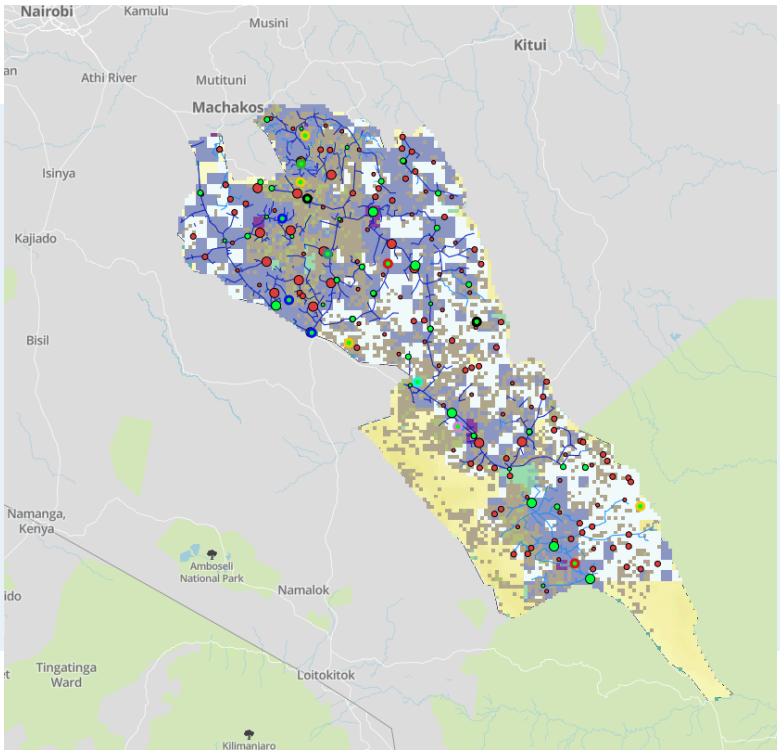


Figure 2: EAE Map showing the PURE sites visited in Makueni with their energy needs and investment opportunities details.

Locations of PURE projects in Makueni where the primary surveys to inform the detailed investment prospectus was conducted.



Map in EAE showing additional data loaded alongside the PURE projects to be used in a GIS Analysis to test the viability of the projects based on additional geographic factors. The datasets used, the weights assigned to them, and the geographic filters assigned are listed in Table 3 below.

Table 3: PURE Project Prioritization Index

Data Added	Weight	Filters
PURE Projects (IP)	5	<2km proximity (Analysis 1) / >5km proximity (Analysis 2)
Population Density	3	
Relative Wealth Index	3	>-1
Livestock and Agriculture Markets	5	<5km proximity
Cropland	5	
Distribution Lines	5	<5km
Solar Potential (Global Horizontal Irradiation)	5	>1,800kWh/m2
Wind Potential (Wind speed)	5	
Accessibility to Cities	4	<90 mins
Financial Institutions	5	<15km proximity

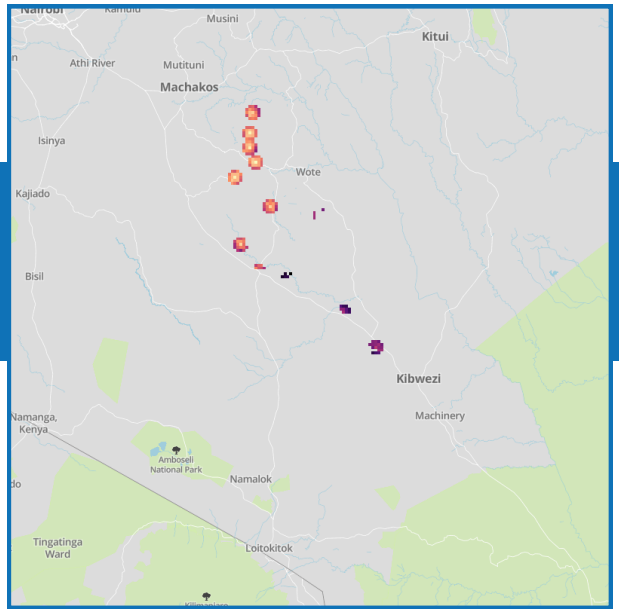
Data Analysis

- Building on data from existing literature and data collected from the field visits, quantitative and qualitative data analysis was then used to identify themes or patterns classified under the following aspects: project description, production capacity of the projects, project challenges & enablers, estimated energy investment needs, proposed investment structure, and projected impact.
- Gender, Equality and Social Inclusion (GESI) components were also a key consideration in the entire process of developing and analysis of projects in this IP. According to the results of the field assessment, 63% of the respondents were men while 37% were women. The highlighted projects stand to directly benefit both young women and men in the County.
- Based on the field assessments, appropriate technologies were identified targeting key stages within the priority value chains where renewable energy interventions or technologies are needed the most to increase productivity and reduce losses. Some of the technologies identified to improve energy access for better production, storage, processing, and transport include e.g. solar pumps, chiller boxes, solar-powered cold rooms, refrigerated transport, etc.
- Key project costing assumptions were made as highlighted in Annex 2 based on the needs of the various projects. The costing assumptions formed a basis for the computation of the investment ticket size per project.
- The project appraisal techniques used to assess the viability of the projects from the investors' perspective include payback period, and estimated Return on Investment (ROI) based on set assumptions as indicated in Annex 3.
- Two geospatial analyses were done on EAE using the combination of datasets and filters in Table 3 above. These were:

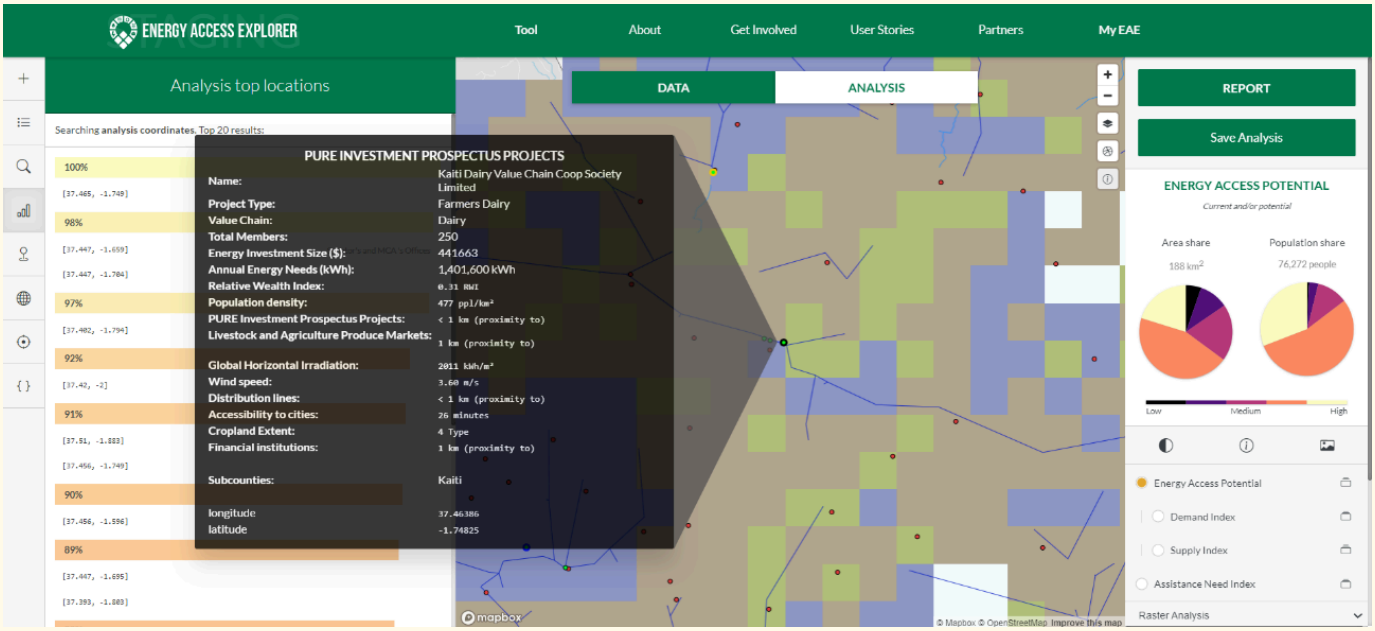
✓Analysis 1: Identifying the most geographically viable projects from the PURE projects assessed using the aforementioned datasets and filters.

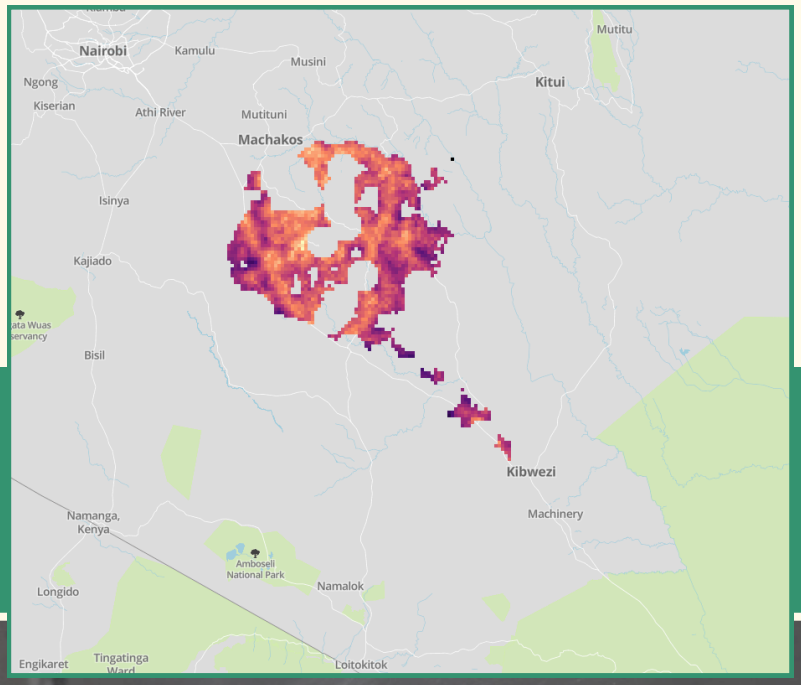
✓Analysis 2: Identifying other areas in Makueni more than 5km away from the PURE projects assessed that meet the above geographical criteria using the same datasets and filters.

Analysis 1 results showing the PURE project locations that were found to be geographically viable having met the criteria in table 3.



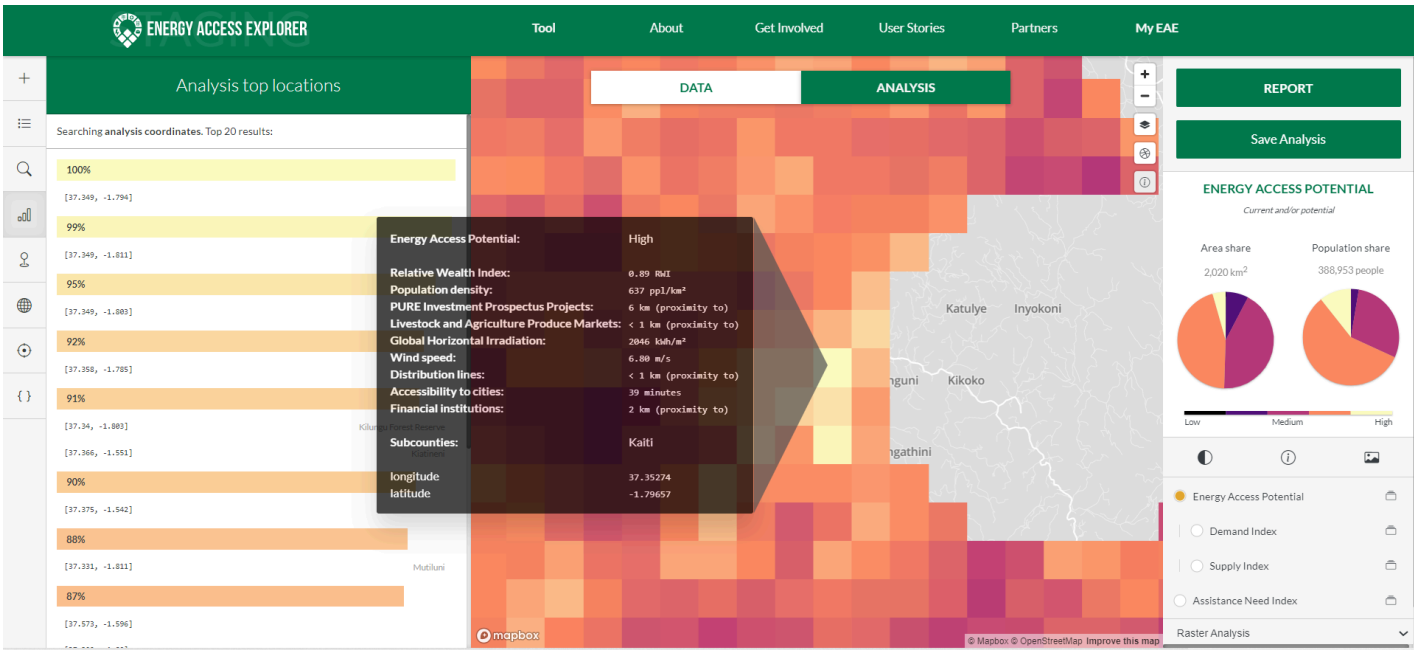
Top most viable project location from Analysis 1 findings.





Analysis 2 results showing the PURE project locations that were found to be geographically viable having met the criteria in table 3.

Top most viable project location from Analysis 2 findings.



- Additionally, the investment prospectus was also subjected to validation by County officials in the departments of Energy; Trade; & Agriculture, Livestock and Fisheries.

3.0 INVESTMENT PROJECTS ACROSS PRIORITY VALUE CHAINS

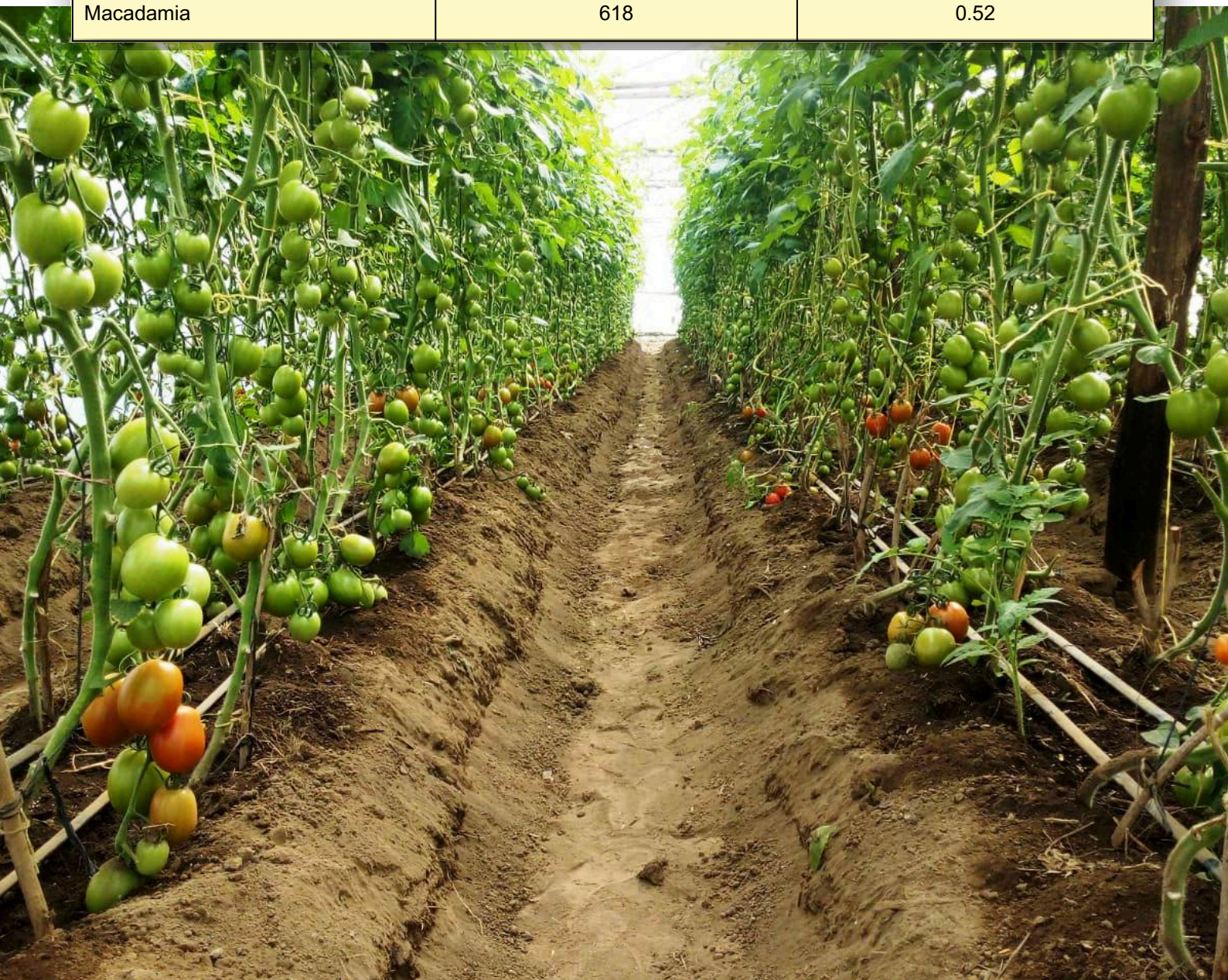
This section highlights the county status for the priority value chain and then proceeds to provide details of the farmer groups of cooperatives visited and for which the investment projects are developed. **While the proposed projects include overall project-specific investments needs, the IP only provides estimates for the energy-related investment needs.**

Fresh fruits & vegetables (Horticultural crops)

County Status:

- Production levels for major horticultural crops over a land size of 43,383 hectares stood at 570,812 metric tonnes valued at USD 71.24 Million as of 2022. The breakdown of the production levels as of 2022 is as follows:

Fruit/Vegetable Type	Production level (Metric tonnes)	Revenue (USD Millions)
Mangoes	297,327	33.1
Citrus fruits	123,953	24.4
Watermelons	98,392	3.8
Tomatoes	26,336	5.9
Kales	19,352	3.0
Avocado	4,833	0.52
Macadamia	618	0.52



The County has mapped out 124 irrigation sites where 4,159 acres of land is currently irrigated. The potential land area for irrigation by these schemes stands at 28,471 acres. The irrigation sites/schemes were however not visited thus, not analysed in this IP. Key projects for investment under this value chain include:

Makueni Fruit Processing Plant, Kalamba

Project Name	**Makueni Fruit Processing Plant, Kalamba**
Project Description	• It is a Mango processing factory located in Kalamba, established by the County government in 2017 with a grant support of USD 827,068 from the European Union. • The plant has 3 production lines for Water purification, Juice (began in 2024) and Puree. • Conversion rate of Mangoes to Puree is 50%-70% • In Q1 (Jan to March, which is the typical high season) of 2023, they collected 1 million kgs of mangoes while in Q1 of 2024, they collected 600,000 kgs. • The average price of puree per kg is approximately USD 0.59 • The puree line has a processing capacity of 5tonnes per hour; water purification line 12,000 litres per hour; juice 8,000 litres per hour. • Maintenance costs for the processing machines is USD 150,375.94 annually; out of the USD 451,127.82 annual allocation from the county. • Water utilization amounts to 400,000 litres per month on average. • The plant employs over 90 staff as of 2022, 55 male, 35 female.
Challenges	• Power instability and unreliability. There are daily outages. The installed transformer capacity can only handle one production unit. • The plant has a backup generator, but it is expensive and can only handle one unit as well. • Limited budget allocation for procurement of mangoes and other operations making the plant to be underutilized. • The plant is not yet autonomous. Thus, the revenue goes to the county government's exchequer and does not properly plough back due to the county government's procurement process. • Mangoes in Lower Makueni (the Kibwezis) mature earlier before the government's procurement process and budget approval is completed hence making it difficult for the plant to buy mangoes when the season begins around October as it cannot issue Local Purchase Orders (LPOs) before budgets are approved. • There are some wastages during loading and offloading of mangoes.
Enablers	• Increased budget allocation to absorb at least 25% of total mango production in Makueni. • The county and partners to build aggregation centres in every subcounty. The centres can be used for other fruits during mango off-peak periods. • Develop/procure an App or platform that Cooperatives can use to key in the number of kgs bought from customers. The cooperatives get their cut e.g. USD 0.022 and the rest paid directly to the farmers. • Make the plant semi-autonomous.
Investment Needs	• Transformer upgrade from the current 315Kva and stabilization power grid from KPLC Mango purchase • Solarisation of the plant (Estimated need of 400kW solar PV system) to minimize electricity costs that currently stand at USD 6,541.35 monthly.

	• Need evaporator to concentrate puree further and enable expansion of production to tomato puree. • Partnership with Export Processing Zone (EPZ) to establish a production zone to enhance tax incentives for the export of mangoes.
Proposed Investment Ticket Size	***Total USD 1.4 million** • Purchase and installation of solar PV: USD 1.1 million • Mango Puree evaporator (3000 litres per hour capacity, complete set to installation): USD 300,751
Investment Structure	• Public-Private Partnership – The annual county allocation is not autonomously sufficient to optimize operations of the processing plant. There is need to onboard a private investor to cater for the investments in the energy needs. • An option for lease agreement arrangement would also be ideal whereby the monthly electricity expenditure is redirected toward lease payments for the project.
Impact	• Reduction of post-harvest losses: The post-harvest loss reduction following establishment of the plant is estimated at 3,789 metric tonnes valued at USD 588,227 (FSD Kenya, 2024[21]) • Provision of reliable and cost-effective electricity access. • Emissions reduction by reducing dependence on diesel genset. • Increased revenue from increased production and lower electricity costs.

Left: Processed fruit juice. Right: Mangoes set for processing at the Makueni Fruit Processing Plant, Kalamba (Photo: Makueni County)

Utangwa Irrigation Scheme

Project Name	**Utangwa Irrigation Scheme**
Project Description	• Started in 2013, operated by the Utangwa Water Users Irrigation Association with support from SIVAP of USD 586,466 in grants. • Farmers plant numerous crops including French beans, cabbages, capsicum, green maize, spinach, kale, avocado, and macadamia. All the crops are grown for cash all year round. • This scheme is targeted to serve 485 acres of smallholder farmers' land. • 565 farmers benefitted from the SIVAP project (Membership comprises 345 women and 10 persons living with disabilities) • Each farmer owns an average of about 1 acre, with an average farm-level cost of USD 375.94 and a net profit of USD 526.31 monthly. Each farmer intends to expand ownership to 5 acres on average in the future, with landowners generally female. • Estimated aggregated produce 100kgs per day, harvested 3 days per week. The price per kg is USD 0.52. The association only aggregates French beans daily, while vegetables are sold directly to markets. • Members relied on irrigation by gravity and the use of sprinklers. Other members outside the association use petrol-powered irrigation pumps with a river as their main source of water. • Distance to nearby market is about 2km. • Each member spends an average of USD 15 on energy costs per month. Members are willing and able to pay for energy services which are needed the most during the day. • Members prefer to procure their equipment using loans with pay-as-you-go as their preferred business model. • Solar pumping increased the quantity of produce by 3 times, according to the farmers interviewed. • French beans market for Utangwa farmers: 10% sold in local markets, 90 percent exported.
Investment Needs	• Grading shade improvements. • Cooling needs – Cold room fitting within 8m by 8m. • Solar water pumps for 2000 farmers (to be used 8 hours per day) with the river as the source of water. • Borehole/sump, Water storage tanks, and distribution pipes are needed but this would require a feasibility study to understand the design and cost parameters. There is an ongoing construction of a borehole, but the association needs an extra borehole to sell water to the community.
Proposed Investment Ticket Size	• ***Total USD 1 million** • Grading shade nets on 1 acre with 55% shade: USD 2,651.12 • Solar powered container cold room with power rating of 4KW: USD 38,000 • 2000 surface solar water pumps: USD 977,443.60 • Submersible pump for the ongoing construction of borehole: USD 960.15

Investment Structure	• Grant for Grading Shade and Submersible Pump: To serve as an incentive for crowding in investors for the other investment needs. • Lease-to-Own structure for Cold room: Since the Cold room would serve most farmers under this scheme, the scheme can procure the Cold room under a lease-to own structure that will be refinanced by farmers' subscription fees for storing their produce (Fee-for-service). • PAYGO for solar water pumps: This business model will reduce the financial burden of the smallholder farmers given their current average income levels.
Impact	• 2000 farmers stand to be benefit from increased yields by 3 times[22]; and avoided carbon emissions by approximately 16g-32g CO2 equivalent per KW of consumption[23]
Enablers	• The project has received both the national & county government endorsements, as well as partnerships from the SIVAP initiative. • Feasibility study to understand the design and cost parameters of water storage and piping systems.

Utangwa Irrigation Scheme (Photo: Makueni County)

Makasa Irrigation Scheme

Project Name	**Makasa Irrigation Scheme**
Project Description	• There are about 700 farmers doing irrigation (mainly furrow) farming in Makasa along River Muooni all year round. • No farmer groups exist in the scheme yet, but farmers are willing to be in groups. • Farmers operate individually, mostly on leased land from the locals. • Farmers in Makasa major in farming watermelons, capsicum, African Indigenous Vegetables (AIV) (kienyeji), green maize, with the major crop being tomatoes. • The crops are grown for both the local and national markets. • Transport from farms to local Masimba market done using motorbike @USD 1.50-1.88 per trip. • Most farmers produce around about 2000 crates from a 4-acre farm. • A crate is sold @ USD 7.52-37.59, sometimes up to USD 105.26 • Post-harvest loss is about 13.3% at the farm gate. • Grading and sorting are done at the farm. Most of the produce produced is collected at the farm by buyers. • Market is readily available. The area is known for tomato farming. **Challenges** • Market access is done through brokers, sometimes farmers don't get the best deal. • There are no aggregation centres where farmers can hold the produce before selling. • There are no farmer groups to help address farmers' plights collectively. • Lack of sufficient water storage infrastructure like water pans. Proposal to construct a sump tank for irrigation. The temporary sumps are normally washed away during floods. • High cost of pumping using petrol or diesel. The farms require 6 hours of pumping per acre to be fully irrigated. • Flooding during the rainy season limiting the ability to transport the produce to the market hence the need for storage. • High-quality seedlings for tomatoes can only be sourced from Egerton- Njoro.
Enablers other than energy	• Support with the establishment of farmer groups/farmer service centres. • Production of quality seedlings nearby in Makueni e.g ATC • Construction of permanent sump since the temporary ones currently used are carried away during rainy seasons. • Training on and application of digital technology to directly connect with clients, and reduce dependence on brokers. • Establishment of an aggregation centre in the nearby market where farmers can hold the tomatoes and vegetables. • Use water-saving techniques and efficient irrigation. • Improving access to affordable credit mechanisms for farmers.
Investment Needs	• 700 solar-powered irrigation pumps to replace the diesel and petrol-powered pumps. The farmers' preferred mode of financing is debt. • Establishment of aggregation hub or fruits and vegetables pack house.
Proposed Investment Ticket Size	**Total USD 342,105** 700 surface solar-powered irrigation pumps: USD 342,105

Investment Structure	PAYGO for solar water pumps: This business model will reduce the financial burden of the smallholder farmers given their current average income levels.
Potential Impact	• 700 farmers stand to be benefit from increased yields by 3 times1 translating into increased income. • Avoided carbon emissions by approximately 16g-32g CO2 equivalent per kWh of consumption [25]. • Reduced food loss. • Improved market access and better prices for the produce.

Kanoto Horticultural Farmers Society

Project Name	**Kanoto Horticultural Farmers Society**
Project Description	• Currently has 87 active members. The group specializes in horticultural farming with production of the following crops: French beans, kales and spinach. • Framers have an average of 7 acres. • Currently irrigate using solar pumps. • Average profit per month at farm level is USD 300.75. • Average jobs created 140 (direct and indirect).
Investment Needs	• Existing container cold room to be solarized with assumed generating capacity of 4.7KW
Proposed Investment Ticket Size	***Total: USD 12,925** Solar PV system: 4.7W*1000*$2.75 per watt = $ 12,925
Investment Structure	Build-Operate-Transfer model: This project would require a private developer to design and install the solar PV system for the Cold room, monitor its operations and performance, and transfer ownership to the society once installments are cleared and operating skills are imparted on the society members.
Impact	Over 150 farmers (over the active membership) will be able to store their produce and minimize wastage as market linkages for export are established.
Enablers	There has been a lucrative export market for off-take of French beans within the County. The County can enhance market promotions activities to international markets to enhance the offtake.

Kilungu Farmers

Project Name	**Kilungu Farmers (Cold Room visited)**
Project Description	• The farmers grow French beans, snap beans, and other horticulture mainly under irrigation using pump and gravity. Most farmers have an acre under French beans. • The Sacco has a contract with an exporter who buys pulses (this case French beans) at 80/- per kg. The contract is for a minimum of 1 tonne and a maximum of 9 tonnes. • Through World Bank (WB) support at a total cost of USD 270,676.69, the County Government built Kalongo cold room of 20 tonnes capacity to provide aggregation and cold solution to the farmers. • The cold room is however not yet operational due to lack of power. Currently, the farmers use charcoal for cold storage. The cold room is designed to be operated by the community. Farmers average distance to cold room is 7km.
	Estimated Production • Framers harvest French beans twice a week for a duration of 3 weeks i.e. 6 picks per growing cycle. • From an 1/8 acre, farmers pick on average 100kg of French beans per pick. • For an acre, the production is approximately = 100*6*8 = 4800 Kg per growing season. • Of the production, farmers sell on average 15% at local and national markets and consume about 5% at home. The percentage that goes to waste was not provided but is estimated to be significant if the offtake delays. • If the beans stay more than a week, they are sold at the local market at USD 0.3759 per kg. **Revenue Estimation** • The farmers did not provide average operational costs but reported that they get an average profit per kg of USD 0.2632. • Thus, on average, they make a profit = USD 0.2632*4800 = USD 1,263.36 per acre per harvesting cycle. **Intended Cold room use** • Each farmer intends to use the cold room for 2 days per week in line with the French beans picks per week and to store an average of 100kg per farmer. • The farmers will take the produce to cold room still and ready to pay a service fee of up to 5% per 1kg price. • They prefer to have a private service provider operate the cold room. **Energy Use** • There is a generator that is estimated to consume about 120 litres per day, thus expensive. • The cold room is rated at 11.97KW
Investment Needs	• The cold room is not connected to power as there is no transformer. • Potential solution: PV system of 16KW capacity (for cold room, borehole pump, and other small loads). • Equipping the cold room with additional sorting tables. • Rainwater harvesting was proposed as a solution for water to service the cold room operations. • Pump, assuming 70% of the farmers need pumps • Fencing needed for the cold room premises. • Needs a vehicle to collect produce from farmers to the aggregation centre where the cold room is located.

	• Need water storage system (e.g. water pan) for dry season. Currently, during the dry season they irrigate in turns since water is less. This would require a feasibility study. • Need solar powered system to be able to pump to the water pan/storage during the rainy season.
Proposed Investment Ticket Size	**Total cost: USD 122,947** • Offgrid-PV system of 16KW capacity: USD 44,000 • Surface solar pumps for approximately 150 farmers (USD 488.72*150= 73,308.27) • Transformer 25KVA: USD 5,639.10
Investment Structure	Public-Private-Partnership: To optimize operations of the cold room, the county can lease the cold room to a private investor while ownership is maintained at the county level. In this case, a Public-Private-Partnership arrangement is ideal.
Impact	This project will minimize spoilage of farm produce for Kilungu farmers and beyond.
Enablers	• Provision of farm inputs to farmers which is currently given by the exporter and deducted from the anticipated revenue. • Provision of training on modern agricultural practices and standards to meet export market qualities. • Need for a feasibility study on power reliability, water harvesting, and storage systems*

Kilungi cold room not operational due to lack of power, water and PMC operationalization. (Photo: WRI)

Kavuthu Cold room

Project Name	**Kavuthu Cold room**
Project Description	• The County supported with provision of a cold room facility at a cost of USD 300,752 • However, the cold room has not been operational since 2020. • The cold room would benefit many farmers including Muoni Investors; a farmer group with 53 members growing French beans. The farmer group, producing an average of 300kgs per harvest per farmer, have been using a small charcoal-based cold room with a storage capacity of 1000kgs. However, average losses of between 10% and 40% of produce are experienced due to inadequate storage facilities.
Investment Needs	• Solarisation of the cold room • Support with off-take market for exports. • Farm-level solar water pumps
Proposed Investment Ticket Size	Total: **USD 94,652** Solar water pumps = 488.72*53= **USD 25,902.16** Solarisation of cold room assuming 25kW rating based on-site assessment: **USD 68,750**
Investment Structure	Public-Private-Partnership: To ensure cold room is functional and optimize operations, the county can lease the cold room to a private investor while ownership is maintained at the county level. In this case, a Public-Private-Partnership arrangement is ideal.
Impact	Substituting the use of charcoal for cooling will result in reduced deforestation.

Kavuthu cold room. (Photo: WRI)

Emali modern market

Project Name	**Emali modern market**
Project Description	• The modern market comprises of 30 wholesale stalls, 96 retail stalls, 2 open air market blocks with a capacity to accommodate 500 vendors. Water harvesting system with 240,000 Litres has also been installed to ensure availability of water.[26] • During the data collection, green grocers were interviewed at the market. The grocers are grouped in a self-help group known as Emali green groceries. The group has about 180 members who are all women. The traders are sellers of: Cereals (source: Makueni, Busia, Eldoret), fruits (source: Tanzania, Makueni, Kajiado), vegetables (source: Malili, Senet, Oloitoktok) and potatoes (Tanzania, Riftvalley, Kenya). • Traders buy produce directly from farmers in bulk. For vegetables, the average distance to the farms is about 15km- 50km. The utilized mode of transport is motor vehicle and petrol motorbikes. **Constructed cold room** • There exists a constructed cold-room that is not currently functional. Cold room already seen as not enough to meet all traders' need in the market. • The cold-room is needed to preserve perishable stock. Traders sometimes lose up to half their stock of perishables due to lack of proper storage. • Traders are willing to pay for services provided by the cold room once operational. They estimate they will be using the cold room for at least 2 days in a week per grocer. **Challenges** • The market still lacks a reliable, sufficient, and desired quality of power. There is need for backup power during blackouts also for the cold room. • Being a new market, sales are still low as customers are yet to familiarize with new places of their preferred vendors. • More sensitization needs to be done on how the cold room will be used and which products will be accommodated.
Investment Needs	• Installation of additional cold room, with an estimated capacity of 10 metric tonnes • Solarisation of existing cold room, assuming 11 KW power rating for each of the 2 cold rooms. • Transformer/grid connection.
Proposed Investment Ticket Size	**Total: $136,500** Solarisation of existing and additional (grid tied): $60,500 i.e. 2 Cold rooms *$2.75/W*11KW Purchase and installation of two (2) 5MT additional solar powered cold room: $38,000 *2= $76,000.
Investment Structure	• Public-Private-Partnership: To ensure cold room is functional and optimize operations, the county can lease the cold room to a private investor while ownership is maintained at the county level. In this case a Public-Private-Partnership arrangement is ideal. Other options (cooling as a Service, CaaS models)[27]. The service provider owns the cold room. The operator of the room is an employee of the service provider. The full project risk lies with the service provider. The provider offers CaaS to grocers/farmers.

	• The service provider sells the cold room to a Farmer/Grocers Group (FG), which takes the commercial risk by offering CaaS to farmers. The service provider is still responsible for proper maintenance of the cold room. • The service provider leases the cold room to the FG and includes maintenance in the agreement. The FG offers CaaS to farmers and takes on the commercial risk.
Impact	• Minimization of food loss which is currently estimated at: Tomatoes (30%), Spinach (50%), Capsicum (50%), Fruits (50%), Watermelons (50%), Bananas (50%) • Increased incomes due to reduced food loss • Decreased GHG emissions due to offsetting fossil fuel or grid electricity powered cold storage. • Extended shelf life strengthens market position for the fruits and vegetable sellers • Generation of employment due to additional care, supervision, and logistics.

Dairy

County Status:

- There are 14 Dairy cooperatives in the county.
- There are approximately 28,649 dairy cattle in Makueni as of 2021.
- Milk production within the county was approximately 22 million litres in 2022 (Up from 17 million litres in 2014). The milk production potential in the County is 30 million litres.
- Domestic demand for milk is strong and stood at 87 million litres in 2023. Meaning there is a huge deficit for milk even in Makueni alone. Spoilage rates in Kenya of milk are high and can reach up to 50% in informal markets[28]. This is assumed to be applicable in Makueni and creates an opportunity for cooling.
- There is one active and two inactive milk processing plants in the county.
- There were 25 milk coolers operated by dairy cooperatives as of 2022.
- Key projects for investment under this value chain include:

Pasteurizer at the Kaiti Dairy Value Chain Co-operative Society Limited (Photo: WRI)

[27] Instrument-Analysis-Report_CaaS.pdf (climatepolicyinitiative.org)
[28] PULSE-Report.pdf (lightingglobal.org)

Kaiti Dairy Value Chain Co-op Society Limited

Project Name	**Kaiti Dairy Value Chain Co-op Society Limited**
Project Description	• Consists of 250 members; 80 women and 170 men; of which 3 are People Living With Disabilities (PLWD). • County provided pasteuriser and 2 milk coolers and a refrigerator with support from DANIDA and implementation by Micro Enterprises Support Program Trust • Other loads for running the daily operations of the collection centre (with the exception of pasteurization) are solar-powered. • The average daily milk collection by the cooperative is 300litres • The society offtakes milk from farmers at USD 0.38 from farmers and sells to the public at USD 0.45 depending on demand and supply. • Members of the society are paid monthly through Universal Traders Sacco(UTS) where farmers hold accounts. **Challenges the cooperative needs support in** • Support with connection to the grid. They paid KPLC but have not been connected for over 2years despite the constant follow-up. The biggest challenge is land ownership. • Support with ICT systems for enhanced record-keeping. • Certification to produce yoghurt. • Need 5 tanks of 1000 litres each for water harvesting.
Investment Needs	• Solarisation of milk pasteurizer with a capacity of 50litres and 5 e-bikes assuming 10kW[29] power consumption. • Additional pasteurizer with capacity of 300L to meet demand. • E-bikes: Since some farmers produce milk 15km away from collection centre and utilize USD 7.52 for transport daily.
Proposed Investment Ticket Size	***Total USD 39,887** • Solar-PV modules for existing pasteurizer and e-bikes load: $27,500 • 5 e-bikes singular battery @ $1,500 each: $7,500 • 5 chiller boxes to be used with e-bikes for milk collection (100L capacity) @USD 977.44 : USD 4,887.22
Investment Structure	Strategic investor with capital injection to a Revolving Fund in partnership with Universal Traders Sacco to benefit farmers with financial access.
Impact	27g CO2 / KM of emissions will be saved by using e-motorbikes instead of fossil-fuel based motorbikes[30] Incomes saved from reduced and directed to increase farmer incomes or expansion. Losses avoided due to more reliable power supply to enable cooling on site and transit.

[29] https://www.irjet.net/archives/V9/i12/IRJET-V9I12112.pdf
[30] https://www.roam-electric.com/motorcycles

Kitise Rural Development

Project Name	**Kitise Rural Development** **Website:** https://kitiserural.org/
Project Description	• Kitise Rural Development is a Community-Based Organization (CBO) currently operating in Makueni County. The organization was started by community members in 2005 to address the problem of water scarcity. Later, its mandate expanded to cover other key sectors in development e.g. health and livelihoods. • The dairy cooperative has 536 members. • The average distance from farm to cooperative is 8km. Farmers are charged a max of USD 0.015 per litre for transport from aggregation centres to the processing plant. Motorbike is used. • Average milk per farmer is 60 litres. • Cooperative collects raw milk from farmers daily (@USD 0.38 per Litre) and sells (@ USD 0.53 per Litre) on behalf of farmers. • Milk cooperative capacity is 2500 litres. • Potential milk collection per day is approximately 4500 litres. • The plant has a 1500 litre capacity cooler, 2 pasteurisers of 200 and 500litres respectively. • With value addition, the cooperative sells yoghurt and mala @ USD 0.75 and USD 0.68 per litre respectively. • Milk is sold within Makueni. Makindu is the furthest market., and is about 50Km from Kitise. • Currently, a Toyota probox is used for distributing the milk. The cooperative needs refrigerated milk transport system. • Initial investment on milk technologies was USD 42,105.26 for chillers and pasteurisers from partners including Dorcas Aid, MCG, FAO, Mastercard .

	Energy needs • Energy bills is around 40k per month. • 7.5HP 1PH compressor motor which cannot run with available 8.5KVA Generator. • A 3KW 3PH Heater which cannot operate on available 1ph KPLC power. • The coop sometimes uses firewood to meet the energy need for pasteurization. Three tonnes per month, mostly supplied by farmers is used. • Lighting, printers, and computer which require back-up system. • We therefore propose for upgrade in the generator from 8.5KVA to 15KVA which will be able to cater for all the load requirements.
Investment Needs	• Power back up system. • Refrigerated milk transport for collecting and distributing milk. • Sustainable biomass and solar heating system for milk pasteurization. • Solar powered borehole. • Pasture processing machinery.

Proposed Investment Ticket Size	***Total Cost: $454,050**
	• Solar PV system to replace upgrade of equivalent capacity of generator: 12 (i.e 15kVA * 0.8)*1000*2.75= $ 33,000
	• Refrigerated truck: Truck at USD 75,188 and 1000L chiller at USD 8,271
	• 5 e-bikes singular battery @ $1500 each: $7,500
	• 5 chiller boxes to be used with e-bikes for milk collection (100L capacity) @USD 977.44: USD4,887.2
	• Borehole construction (150m*USD 52.63) plus installation of submersible pump (USD 3,383.46) plus water storage tank 10K litres and plumbing work (USD 902.25) = Approximately USD 12,180.21. (Power about 4KW to be drawn from the solar system).
	• Multipurpose feed processing machine:
	  ○ USD 51,774 for 500kg/h fish feed line.
	  ○ Power needed-95kW: USD (95000*2.75)=$261,250

Investment Structure	For the solar PV system upgrade, a development grant is ideal to meet the community ownership model of the cooperative society.
Impact	• The co-operative sometimes uses firewood to meet the energy need for pasteurization. With the investment to solarize the operations of the milk aggregation centre, natural resources/forests will be preserved and carbon emissions avoided. • Reduced milk spoilage with refrigerated transport both from farm and from collection centre. • Improved milk safety and quality by maintaining freshness during transportation.

Fish Value Chain

In 2019, Kenyan total fisheries production was 147000 MT valued at USD 237 million, with aquaculture accounting for 12.8%. Aquaculture is viewed as an alternative to bridging the widening gap between fish demand and its supply in Kenya[31]. The sector supported an approximate total of 65,000 people directly as fishermen and 70,000 fish farmers in Kenya.[32]

County Status:

In Makueni County, the annual fish production as of 2022 stood at 14 tonnes, valued at USD 47,368.42million.[33] Annual fish demand in the county was 105 metric tonnes. According to Maina et al. (2017), the average price per kilogram was USD 3.01 of fresh tilapia or catfish.[34]

Fish value chain encompasses the following practices in the county:

1. Capture fishery – Fish existing in water bodies.
2. Aquaculture – Fish cultivated in ponds (There are 237ponds operational)
3. Dam fisheries – There are 45dams within Makueni.

A section of fish ponds in Makueni County. (Photo: WRI)

[31] State of Aquaculture in KENYA 2021 BOOK. ResearchGate
[32] Fisheries Annual Statistic 2022.pdf (kefs.go.ke)
[33] Makueni-County-Statistical-Abstract-2023.pdf
[34] hrpub.org/journals/article_info.php?aid=5528

Table 4. Farmers and pond statistics, 2022 in Makueni County[35]

Item/Subcounty	Mbooni	Kilome	Kaiti	Makueni	Kibwezi West	Kibwezi East	County Totals
No of farmers	75	18	11	41	15	15	175
No of operating ponds	52	31	13	30	85	26	237
No of inactive ponds	36	10	4	26	80	20	176
No of new ponds	10	4	2	8	27	6	57
No of ponds stocked	22	9	10	8	32	16	97
No of hatcheries	0	1		2	2	0	5
No of stocked dams	1					0	0

There are 6 major concentration points: Thwake, Mbooni Cluster, Kilome/Kilungu, Kiboko, Kibwezi, Wote. The table above shows the number of farmers directly engaged in aquaculture and the status of the ponds in 2022.

Fish is increasingly an important source of protein in Makueni County. However, it is a delicate food that spoils easily and can become unsafe. Therefore, it should be refrigerated from the time it is caught until it reaches a consumer's stove. After fish is harvested in Makueni County, it is either eaten locally at home, sold in the local markets or transported to supermarkets, and to the Kenya's capital, Nairobi. Farmers do not have sufficient facilities for cold storage of the fish, leading to high spoilage.

A Key project for investment under this value chain is:

Kiboko Integrated Farmers

Project Name	**Kiboko Integrated Farmers**
Project Description	Kiboko farmers carry out mixed farming: mainly fish, poultry, vegetables, and fruits. They have groups specific to value chains e.g. fish affiliated; fruits affiliated etc. So, one farmer can be in several groups. **Fish farming** • They rear Tilapia and Catfish, taking about 6-8 months. • The group has 35 ponds, with individuals having about 2 pounds each. Membership: • 127 members; male 67 and female 60. • Members who are 35 years and below (youth) are 52, while those above 35 years are 75. • People Living With Disabilities (PLWD) are 5 of which 2 are below 35 and 3 above 35 years.

[35] Makueni-County-Statistical-Abstract-2023.pdf

Fishponds:

- Active fishponds=58;
- Fishponds which need water pumping = 132;
- Fish ponds that need rehabilitation = 242.
- Source of water -permanent River Kiboko;

Source of water and energy for fish farming:

- Permanent spring which is about 200-300 metres away.
- Most ponds are within a 1 km range from the spring.
- Productive spring length is 4 km.
- Most people use gensets to pump water to farms; some have solar
- Poultry farmers need energy for hatcheries.
- Machines for feeds production need electricity; electricity from the grid is not reliable.

Production:

- Agricultural activities happen throughout the year.
- The average pond size is 300m.
- Production Costs from 1 fish pond): estimated at USD 1,938.35.

For Tilapia:

- 3500-4000 fingerlings / pond.
- Each is harvested at a mass of 350-500g after 6 months and sold at USD 4.51 per kg to hotels and supermarkets.
- Local market: $2.26-$3.76 per piece.
- Potential revenue: Assuming 3500 tilapia are harvested and sold @ USD 3.01 a piece of average 400g= 3500*0.4*3.01= 4,214 (losses neglected).
- Potential profit=Revenue-production cost=$4,214 - $1,938.35= USD 2,275.65

For Catfish

- 300 cubic metres contains about 5000 catfish.
- Mature in 6 months.
- 1 catfish weighs 7-8kg and is sold at USD 2.26
- Potential revenue: Assuming 4000 catfish are harvested and sold @ USD 2.26 per kg= 4000*2.26= $9,040
- Potential profit=Revenue-production cost=$9,040-$1,938.35= Approx USD 7,101.65 (losses neglected).

Wastage

- Losses majorly occur during harvesting due to lack fishing nets and cold storage, which is shared among several farmers.

Once fish is caught or farmed, it needs to be stored in chilled or frozen form to avoid biological spoilage. Ideally, fish should be cooled on board the vessel as soon as it is caught.[36]

[36] The small-scale fisheries and energy nexus (fao.org)

	Processing • Cutting, smoke, packaging. • Make fillets demand high in supermarkets. No machine for filleting and energy to power it. Currently do so manually. ***Market:*** • Other farmers and fish farmers themselves. • Demand is high at the local markets and supermarkets. ***Main challenges facing fish farmers:*** • Cost of production, difficulty accessing inputs. • Poor handling practices especially during harvesting. • Limited access to energy to use in the production, storage and harvesting, pumping and cold storage. • Water recharge during dry seasons is low. • Lack of power to pump water to ponds. • Some ponds need dam liners. • Lack of trainings on dam liners, quality, and quacks in the market. • Lack of chiller boxes to take the fish to market. Currently hire the boxes at USD 4.51 per day (need at least 3 cool boxes per pond each taking 200-300 fish). • The refrigerated vehicle is hired at USD 75.19 and need to cover 2-3 ponds at the same time. **Crop production** Apart from fish farming the farmers in Kiboko also grow tomatoes, chillies, and watermelon [generally fruits and vegetables]. • Each farmer has about 3-4 acres of land under farming. • The market is easily accessible as the area is along Mombasa Road, export processing zone. • the area is leading in horticulture production. *Main challenge-* • Lack of water pumping system. • Lack of cold storage for holding the produce. This will help reduce losses especially for price fluctuations e.g. tomatoes and watermelon.
Investment Needs	***Mixed: Fish, Fruits, and Vegetable Farming*** • Multipurpose feeds processing machines that can produce feeds for poultry, fish, dairy etc. • Scale up cool boxes (3 per fishpond) for fish storage. • Surface Solar pumps irrigation and fishponds = 374. • Cold storage/aggregation centre for crops at Kiboko market. • Solar powered fish cold store at Kiboko market for fish / Kiboko farmer cooperative premises. • Solar-powered ice machine with a water purification unit for cooling during transport and storage.
Proposed Investment Ticket Size	***Total: USD 616,129** • Multipurpose feeds processing machines. USD 51,774 for 500kg/h fish feed line. Power needed-95kW: USD (95,000*2.75) = $261,250 • 173 (58 active ponds*3) universal portable chiller boxes for fish storage. 173*1,939.85: USD 162,594.05

	• Surface Solar pumps for 132 fishponds: USD 64,511.28 • Walk in Cold storage for crops - USD 38,000. • Solar powered fish Cold room at Kiboko market for fish/Kiboko farmer cooperative premises: USD 38,000
Investment Structure	Structured debt facility for collective ownership of chiller boxes and Cold room that will be refinanced by per-per use model, whereas individual farmer ownership of pumps will be refinanced on a PAYGO basis.
Impact	• Reduction of food loss by a quarter or more[37] • Jobs creation, 4: at least 2 operators for both Cold rooms and at least 2 skilled graders and packers.
Enablers	• Training of farmers to operate the Cold room and Fish Cold Store so that little energy is lost, and efficiency achieved. • Rehabilitation of the 242 fishponds to increase production.

Spoilt tomatoes abandoned in Makueni County (Photo: WRI)

[37] Renewable energy for agri-food systems – Towards the Sustainable Development Goals and the Paris agreement (irena.org)

Green grams

County Status:

- Most of the pulses, specifically green grams, pigeon peas, and cowpeas consumed in the country originate from the lower eastern part of Kenya (Kitui, Machakos and Makueni), with Makueni being the largest producer of green grams in Kenya. In fact, one of the most preferred green gram varieties is locally known as 'Makueni'.
- Makueni green grams production is estimated at 51,000 metric tonnes annually (Source: Makindu Business plan).
- The county prides itself with a World Bank-funded Grain Factory Plant in Makindu launched in 2019
- The grain value addition Plant whose cost was USD 1.58 million has a storage area of 170 metric tonnes of processed grains, and a processing capacity of 2 metric tonnes per hour.
- As greening the operations of the factory is part of its long-term strategy the investment project is highlighted below:

Makueni Integrated Grain Value Addition Plant

Project Name	**Makueni Integrated Grain Value Addition Plant**
Project Description	• The Makueni Integrated Grains Value Addition Plant is a project company under the County Government of Makueni. It was established in 2019 to provide an alternative market for pulse farmers in the County. The plant aggregates, processes, and packages pulses in Makueni, Machakos, Kitui, Embu, Meru and other pulse-producing regions. The plant offers off-farm job opportunities from the value addition and marketing sectors, stabilizes pulse prices in the County and reduce exploitation by intermediaries and promotes utilization of pulses in the County, hence improving nutritional status. • The plant operations are supported grid connection and a diesel backup generator with a 250kva capacity, water supply with a storage capacity of 50,000 litres, rainwater harvesting line with a storage tank with a 1 million litres capacity. • The plant's production capacity is 40 bags of sorted and polished grain per hour.
Investment Needs	Based on documentation from the plant the following are the overall projected needs for the plant are: • USD 75,188 for the installation of the retail packaging line, • USD 45,113 for double cab pick up to aid in sales and marketing activities, • USD 112,782 working capital, • USD 1,58 million will be used to purchase the raw materials during the harvest period. (There also exists energy needs to transit from the 250KVA diesel backup generator)
Proposed Investment Ticket Size	**Total cost: USD 550,000** Solarization of the operations of the plant by replacing the 250KVA diesel backup generator: 250*0.8*2.75*1000

Investment Structure	A lease model where the plant is operated by private investor to optimize operations of the grain plant would be ideal.
Impact	The plant once fully operationalized will contribute towards social empowerment and poverty reduction among residents.
Enablers	• Operationalization of the project management committee. • Operationalization of green gram farmer groups. • Initial budget allocation to buy green grams.

Poultry

1.56 Million
(No. of Poultry in the County)

County Status:

- There is currently 1.56 million poultry in the county in 2022 (Up from 975K in 2014). 95% of the poultry are indigenous.
- Per capita consumption is 0.7 chickens.
- The number of eggs produced in 2022 was approximately 35,208,360 valued at USD 4.41 Million.
- One model poultry farming group (11 members) and a 1 large-scale individual poultry farmer whose poultry projects are enlisted below:

Kambu Poultry Farmers

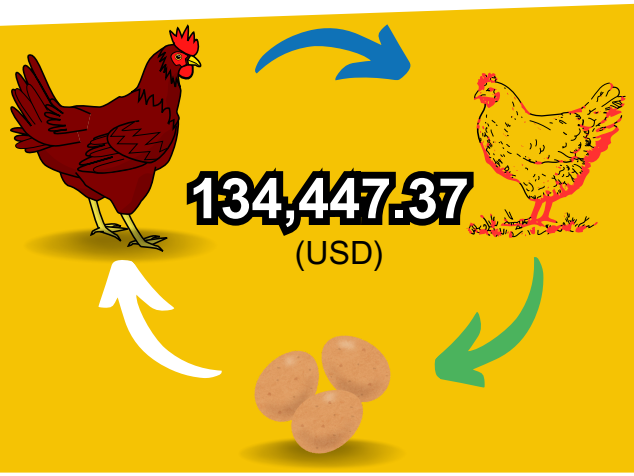
Project Name	**Kambu Poultry Farmers**
Project Description	• The group currently 1170 chickens. Some members also rear geese, turkey, and guinea fowls. • They acquired incubator for hatching under the National Agricultural & Rural Inclusive Growth Project (NARIGP). • The group is challenged by power unreliability. • Currently 40 eggs are hatched by the group daily.
Investment Needs	• Construction and solarization of poultry aggregation centre, especially for powering the egg incubators. • Fridge to store vaccines for poultry • Need feathering machine. • Need 2 more egg incubators

Poultry Queen

Project Name	**Poultry Queen**
Project Description	• Individual farmer who is a member of a CBO with keen interest in poultry. • Rears layers (main business) and improved Kienyeji (minority). • The farmer has about 6,500 mature birds on the farm mostly reared using the cage system for layers. • Deep litter system used for rearing Improved Kienyeji. **Production** • The farm collects about 120-150 egg trays from layers per day sold @USD 3.23. • Improved Kienyeji produces about 5-10 egg trays per day sold @ USD 6.02. • Wastages is about 1 tray every day. • The farm also produces about a tonne of chicken waste per day that can be used as manure and biogas production. • Production efficiency: 80 to 85% of chicken lay eggs. • Improved Kienyeji takes about 5-6 months to mature. • The farm uses about 5000 litres for 3 days @ USD 22.56 supplied by a water bowser. • Layers take up to 30 months on the farm before being disposed for meat when egg production reduces. • Production: The farm collects about 120-150 egg trays from layers per day sold @USD 3.23. Improved Kienyeji produces about 5-10 egg trays per day sold @ USD 6.02. Wastage is about 1 tray. **Operations & Maintenance** ***Day old chicks:*** • Layers are purchased @USD 0.82 per chick (Issa). • Improved Kienyeji @USD 1.05 per chick (Kenbro). ***Brooding:*** • Currently brooding about 4000 chicks. • Uses charcoal as a source of energy for heating/providing warmth for the chicks. • A sack of charcoal is used per day (@USD 11.3). • The farmer is NOT connected to the grid. ***Feeding:*** • The farm uses about 15 bags of 50Kg feed per day on feeding. • The average price per bag is USD 21.05. • Average cost of raising a single bird to maturity is USD 6.77. • The chickens are vaccinated often. I.e. 8 vaccines per chick and 9 dewormers per chick (after every 3 months). • Cost of vaccination is USD 0.04 per chick. **Energy currently in use** • Charcoal for brooding. • Petrol generator to pump water. Pumping is done twice a week and uses 0.5 litres for each day of pumping. **Direct employment** The farm has 4 permanent employees paid each USD 90 per month. Has 2 casual every week paid USD 3 per day. The farm has also provided opportunity for 5 attachés who are students from the neighbouring TVET institute

Investment Needs	• Water (solar powered borehole). • Affordable source of energy for heating during brooding. **Other information** • No preference on mode of financing. • Bookkeeping is done. • Biogas assessment has been done for the farm by some other firm and the initial costs were a big issue. • Solar queen is open to partners to expand the farm and address the challenges.

Proposed Aggregated Poultry Investment Ticket Size



At an aggregated level, a report[38] on the performance of chicken enterprises in Makueni County highlights the needs of 88 groups drawn from 10 wards with a total membership of 2,993 farmers. Based on the assessment, this potentially places the County-wide energy investment size in the poultry value chain as follows:

Project Name	**Makueni County Aggregated Poultry PURE Investments**
Proposed Investment Ticket Size	42 solar incubators for 42 groups (46 were already provided under the NARIGP project). USD 134,447.37
Investment Structure	Grant – The poultry sector in Makueni still needs to be catalysed to boost current production levels through enhanced feed formulation, incubation technologies, and efficient breeding practices.
Impact	With improved husbandry practices, the sector is poised to increase farmer incomes.

[38] https://makueni.go.ke/sandbox/site/files/2023/10/Performance-of-chicken-enterprises.pdf

4.0 SUMMARY OF PRIORITISED VALUE CHAIN PROJECTS (AGGREGATED BY TECHNOLOGY)

Table 5: Summary of prioritised value chain (*1 USD = KES 133)

PURE Technology	Investment Need	Projects
42 solar incubators for 42 groups	$134,447	Makueni County Aggregated Poultry PURE Investments.
Mango Puree evaporator	$300,751	Makueni Fruit Processing Plant Kalamba.
Grading shade nets on 1 acre with 55% shade	$2,651	Utangwa Irrigation Scheme.
Solar water pumps	$1,484,230	Utangwa Irrigation Scheme, Makasa Irrigation Scheme, Kilungu Farmers, Kavuthu Cold room, Kiboko Integrated Farmers.
Purchase and installation of solar PV systems to power various productive uses	$1,896,675	Makueni Fruit Processing Plant Kalamba, Kanoto Horticultural Farmers Society, Kilungu Farmers, Kavuthu Cold room, Emali modern market, Kaiti Dairy Value Chain Co-op Society Limited, Kitise Rural Development, Makueni Integrated Grain Value Addition Plant.
Transformer 25KVA	$5,639	Kilungu Farmers.
Purchase and installation of additional Cold rooms	$190,000	Utangwa Irrigation Scheme, Emali modern market, Kiboko Integrated Farmers.
Chiller boxes	$172,368	Kiboko Integrated Farmers, Kaiti Dairy Value Chain Co-op Society Limited, Kitise Rural Development.
Multipurpose feed processing machine (PV system installation included)	$626,048	Kitise Rural Development, Kiboko Integrated Farmers.
10 e-bikes singular battery	$15,000	Kaiti Dairy Value Chain Co-op Society Limited, Kitise Rural Development.
Refrigerated truck	$83,458	Kitise Rural Development.
Complete borehole construction plus installation of submersible pump, plus water storage tank 10K litres and plumbing work	$12,180	Kitise Rural Development.
TOTAL	**$4,923,447**	

Project Return Analysis[39]

Table 6: Project return analysis

Project	Investment Need in USD	Discounted Payback period (Months)	Estimated Return on Investment (ROI)	Instrument
Emali modern market	136,500	51	23%	Debt
Kaiti Dairy Value Chain Co-op Society Limited	39,887	105	48%	Blended: 70% grant or equity injection of equivalent value; 30% debt.
Kanoto Horticultural Farmers Society	12,925	25	11%	Debt.
Kavuthu Cold room	94,652	120	56%	Blended: 20% grant or equity injection of equivalent value; 70% debt with lease payments.
Kiboko Integrated Farmers	616,129	112	52%	Blended: 90% equity, 10% debt.
Kilungu Farmers	122,947	112	52%	Blended: 15% equity, 85% debt.
Kitise Rural Development	454,050	91	41%	Blended: 50% grant, 60% debt.
Makasa Irrigation Scheme	342,105	45	21%	Blended: 50% grant: 50% debt.
Makueni County Aggregated Poultry PURE Investments	134,447	-	-	100% grant.
Makueni Fruit Processing Plant Kalamba	1,400,751	91	42%	Blended: 30% grant, 40% equity, 30% debt.
Makueni Integrated Grain Value Addition Plant	550,000	84	38%	Blended: 40% grant, 45% equity, 15% debt.
Utangwa Irrigation Scheme	1,019,054	47	21%	Blended: 50% grant: 50% debt.
Grand Total	**4,923,447**			

[39] Return computations are based on assumptions indicated in Annex 3. Further due diligence by investors could yield different results based on different assumptions and scenarios.

5.0 RECOMMENDATIONS AND CONCLUSION

Given the complexity involved, growing the PURE sector requires policy action, market development, innovative partnerships, and greater coordination between energy, agriculture, and trade actors.[40] The following are some recommendations.

✓**Incorporate PURE in Policy and Regulatory documents:**

- The GMC to promote PURE appliances/technologies and incorporate them into electrification, water, and agricultural transformation strategies/plans, with the support of development actors. By mentioning PURE in policy/strategies/plans etc, the governments can send a signal to industry that there is a market opportunity and promote new entrants to the market in Makueni.
- Regulate and enforce minimum milk quality standards at milk collection points and consider introducing a price premium for cooled quality milk.

✓**Promote coordination and partnerships:**

- Through the Department of Trade and Cooperative, the GMC to promote partnerships and coordination among value chain actors to help unlock the market for PURE appliances—for example, between those with products (manufacturers, suppliers), those with capital (commercial banks, MFIs), and those who maintain touchpoints with farmers (cooperatives).
- Agricultural value chain issues intertwine with energy access issues. To unlock market opportunities, Agriculture, and Energy Departments as well as their stakeholders must break their silos and work together to break down these constraints.
- Adoption of a seamless PPP framework to provide an avenue for appropriate investment structures for key projects.

✓**Enhance affordability of PURE equipment and produce market access.**

- Financial Institutions to develop specific micro-credit lines coupled with support services for farmers and cooperatives wanting to adopt the clean energy technology, including instruments that hedge against production risk.
- Limited finances and affordability have been cited as the most common barrier to the adoption of on-farm solutions e.g. cold storage. To this end, solution providers should have a range of flexible payment solutions of up to 5 years, to maximize affordability and reduce the barriers to access.
- Facilitate business opportunities in the agrifood value chains sector, in particular for young, women and (PLWD) farmers.

[40] PULSE-Report.pdf (lightingglobal.org)

✓**Enhance Capacity Building:**

- PURE solution providers and partners to provide training to farmers on the financial benefits of clean technologies and raise awareness of financing opportunities.
- Train retailers so that they can complement their offer with support services.
- Organize knowledge-sharing events on e-commerce and real-time information systems.
- GMC to operationalize project committees, especially for Cold rooms and green grams projects. For sustainability, the committee members should on group dynamics, business skills, and leadership and governance.
- Development partners to facilitate technical assistance to county officials to ensure that they offer high-quality extension services to meet the needs and expectations of the PURE sector and end-users.

✓**Vegetable Value Chains:**

- Access (distance and price) to quality seeds was one of the challenges especially for tomatoes and vegetables. It is therefore recommended that the GMC, through the relevant department, supports farmer groups by carrying out seed multiplication, certification, and bulking to ensure accessibility of quality seeds. This is an opportunity that women and youth can take advantage of to improve their incomes. It can also be at the Makueni ATC.
- With the exception of French beans, the market system for most fruits and vegetables (tomatoes, kienyeji, watermelons) is underdeveloped with most farmers relying only on local markets and brokers. There is a need for the GMC to provide market linkages through the establishment of partnerships/contracts with key off-takers. Farmers should also embrace collective marketing to ensure an adequate and steady supply and prices.

✓**Further Research:**

- Further research or feasibility studies need to strengthen the evidence base of the impact of the technology, and piloting to identify additional value and reduce risk for all value chain stakeholders, should be conducted.

Annexes

Annex 1: Data Collection Survey Toolkit

1. PURE Survey (Crops Irrigation) - https://arcg.is/y0azG0
2. PURE Survey (Fish Cold Storage) - https://arcg.is/0XqOT40
3. PURE Survey (Crops Cold Storage) - https://arcg.is/1naHGu0
4. PURE Survey (Farmers Fish) - https://arcg.is/0e8KyP0
5. PURE Survey (Green Grams Value Chain) - https://arcg.is/0Xm9fW0
6. PURE Survey (Farmers Poultry) - https://arcg.is/CyHDT
7. PURE Survey (Farmers Dairy) - https://arcg.is/OLnqi0

Annex 2: Assumptions on PURE Equipment Costs

PURE Equipment	Product Specifications	Cost (1 USD ~ KES 133)	Source
Solar PV system	• Provides 2 to 6 hours of backup power for periods of extended grid outage, minimizing generator reliance.	*Calculated based on system size. E.g for a 350kW solar PV system, estimated cost = 350W*1000*$2.75 PER watt: $962,500	The total installed costs for grid connected solar PV minigrid is between USD 2.5/W and USD 3/W (IRENA 2016)[1] . An average of USD 2.75/W is applied [41]
Puree Evaporator	• Complete set inclusive of installations. • Product specifications not provided.	USD 300,751.88	On-site data collection.
Grading shade nets	Shades nets available for 30% shade, 55%, 75% and 90%	Shade % cost per acre: • 30% - USD 2,219.55 • 55% - USD 2,651.13 • 75% - USD 3,082.71 • 90% -USD 5,240.60	https://grekkon.co.ke/product/shade-nets/

[41] Solar PV in Africa: Costs and Markets (irena.org)

Surface Solar water pump	• Flow rate: 3000 litres/h • Voltage of 24v • Power of 200w • Outlet size of up to 1.25″	USD 488.72	https://www.waterpumps.co.ke/solar-water-pumps-prices-in-kenya.html
Submersible solar water pump	• GRUNDFOS 3KW 3PH MS4000	USD 960	Quotation from supplier (Trans Africa Water)
Container Cold room (Vendor: Tree Sea Mals)	• AC/DC: DC coupled with AC output. • Voltage range: 240Vac, single phase. Production cost: USD 33,000 • Storage capacity: 4 tonnes of meat. • Operating temperature: 0°C - 5°C • Power (energy consumption): 3.5kW • Product dimensions: 6*2*2m (24 cubic metres) • Capacity of PV modules required: 4.7kW • PAYG integration capabilities: Available. • Additional assumption: ✓Cooling requirements for meat is the same as that for FFV. ✓All walk-in and containerized cold rooms of the same capacity cost $38,000.	Selling price: USD 38,000	https://sun-connect.org/wpcont/uploads/Assessment-of-the-Cold-Chain-Market-in-Kenya.pdf
Solar powered incubators	• Power =1000W; Cost of incubator alone is USD 451, • For power: Assuming 1000W*2.75 USD • Estimate storage battery costs separately.	USD 3,201	528 chicken eggs automatic incubator - 0727087285 (ecochickspoultry.com)

Milk Chiller Boxes	• 100% solar powered. • Food-grade material . • Hygrometer for humidity display. • Temperature control. • Power backup available. • 100 litre capacity.	USD 977	Cost based on supplier catalogue (Savanna Circuit Technologies)
e-motorbikes	• Singular battery • Battery capacity: 3.24kW • 75km range	USD 1500	https://scepturempire.com/electric-bikes-in-kenya/#:~:text=Cost%20%E2%80%93%20The%20price%20of%20electric,to%20KES300%2C000%20for%20motorcycles.
Refrigerated milk transport	• Savanna Circuits MaziwaPlus Chiller-Pro as an example. • 100% solar powered. • A temperature drop of 4°C in 35mins in 20°C ambiance. • Customizations available on request.	500L from USD 4,721 (cooler only)	Cost based on supplier catalogue (Savanna Circuit Technologies).
Diesel tuktuk	• Load Capacity: 500kgs • Low fuel consumption 36km per litre of diesel. • Low cost of service.	USD 4,510	Buy ApeXtra Pick Up Diesel - Best Deals Available Now (cargen.com)
e-TuK Tuk	 • Top Speed: 45 km/h • Typical Driving Range (On Road): 90 ± 5 kms • Home Charger: 48V I 3000 W Off-board charger. • Charge Duration: 3 hours, 45 mins.	USD 9,744	https://cargen.com/product/ape-e-xtra-fx

Multipurpose feeds processing machines.	Multipurpose feed processing machine handle poultry and animal feed but it needs different formula, and different moulds (boiler and shipping and excise duty not included).	USD 51,774 for 500kg/h fish feed line. Power=2.75usd/w *95000 = $ 261250	Supplier quotation (Tonde).

Annex 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:

- 5% of farmers' incomes within each project is used as debt repayments towards the respective project capital expenditure (CapEX) required. Where a project involves solarization, the monthly electricity and fuel-related costs incurred are assumed to be redirected towards debt repayments to cover the project CapEX.
- The Cost of capital is assumed to be 10%.
- Project duration is assumed not to exceed 10 years (120months).
- Monthly repayments must exceed the interest component at the assumed cost of capital. If not, a suitable blending ratio of grant: equity: debt is calculated iteratively. Equity is assumed not to exceed 50% in any of the given scenarios.

OFFICE OF THE GOVERNOR
DIRECTORATE OF STRATEGIC PARTNERSHIPS AND INTERGOVERNMENTAL RELATIONS
P.O. BOX 78 - 90300, MAKUENI
EMAIL: liason@makueni.go.ke; governor.makueni@gmail.com
WEB: www.makueni.go.ke