UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

GLOBAL ENVIRONMENT FACILITY
INVESTING IN OUR PLANET

DECENTRALIZED SUSTAINABLE ENERGY PLANNING MANUAL

Sustainable Energy Solutions for Development and Productive Use at County Level in Kenya

Contents

Foreword

Kenya has restructured its governance system which enabled the devolution of power to the 47 counties in the country. These counties have their own budgetary allocation for planning and undertaking projects in their respective counties in tune with the national plans.

This Manual is the result of capacity building activities undertaken by UNIDO under the framework of the Global Environmental Facility (GEF)-5 funded project entitled "Sustainable Conversion of Waste to Clean Energy for Greenhouse Gas (GHG) Emissions Reduction in Kenya".
A two-stage training programme was developed and organized for Sustainable Energy Solutions Planning at the County level in 2016. The aim of the training was to enhance the capacity of energy planners of the 47 counties in Kenya. This manual for Sustainable Energy Solutions Planning will be a reference material for the trainees and to anyone interested in decentralized sustainable energy planning for achieving Sustainable Development Goals (SDG) 7 targets. The purpose of this manual is to strengthen the energy personnel at the county level with skills and knowledge on energy planning. Also, to enable the energy planners to identify and assess renewable energy resources in their respective counties as well as to develop sustainable energy projects/programmes for productive uses.

Even though the manual is developed based on a training programme for energy planners at county level in Kenya, it can also be applied to other countries with comparable administrative structures. To emphasize the aforementioned, this manual provides relevant background information of energy in the global context and in the developing world. Additionally, the present manual introduces different sustainable energy technologies, including brief summaries and their key characteristics. This is followed by the centrepiece of the manual, the planning of rural sustainable energy projects, divided into three chapters to provide a clear structured approach, starting with the analysis of the county specific information and energy profile in step one, the analysis of available sustainable energy resources and appropriate technology and investment options in step two, and finally, the project scoping ranking and implementation in step three.

The energy planner utilizing this manual will understand the of rural sustainable energy planning and find different tables for information gathering as well as checklists and critical success factors. We hope that this manual serves its purpose by being a useful tool in strengthening the energy planners at the local level.

List of abbreviations

CNG	Compressed Natural Gas
CFLs	Compact Fluorescent Lamps
CH4	Methane (natural gas)
GHG	Greenhouse gas
CO2	Carbon dioxide
CSP	Concentrated Solar Power
GEF	Global Environmental Facility
GHG	Greenhouse Gases
ISID	Inclusive and Sustainable Industrial Development
Ktoe	Kilo Tons of Oil Equivalent
kW	Kilowatts
Mtoe	Million Tons of Oil Equivalent
MW	Megawatts
PV	Photovoltaics
SDG	Sustainable Development Goals
SMEs	Small and Medium Enterprises
UNIDO	United Nations Industrial Development Organization
WTE	Waste-to-Energy

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Acknowledgements

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1

Introduction

Energy can be described as the “golden thread that connects economic growth, increased social equity, and a sustainable environment that allows the world to thrive”. Energy is essential for inclusive and sustainable industrial development (ISID), is a critical component for economic growth and a prerequisite for human beings to meet their basic needs. According to Conserve Energy Future, sustainable energy is a form of energy that meets our today’s demand of energy without putting them in danger of getting expired or depleted and can be used over and over again. Sustainable energy solution is about finding clean, renewable sources of energy that renew themselves, do not cause any harm to the environment and is available widely free of cost to meet our energy demand. As such, choosing the right type of energy source helps to contribute to the realization of the Agenda 2030 and the Sustainable Development Goals (SDGs).

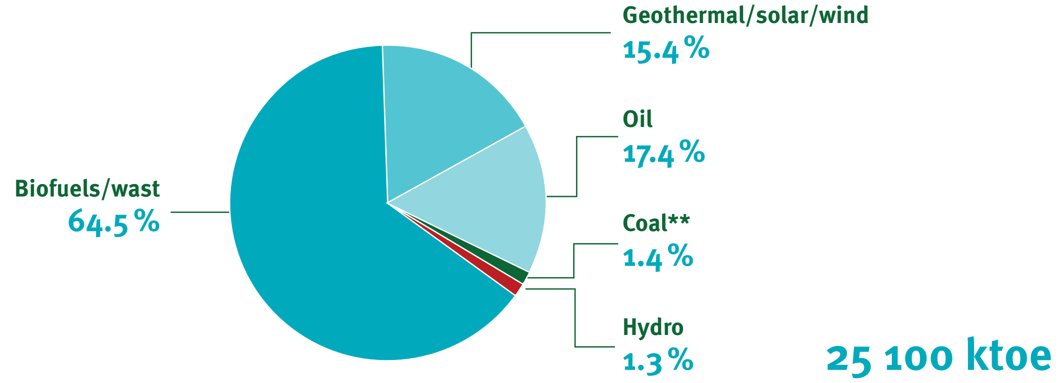
What is Sustainable Energy?

The provision of energy such that it meets the needs of the future without compromising the ability of future generations to meet their own needs. Sustainable Energy has two key components; renewable energy and energy efficiency.

REEEP/Sustainable Energy Regulation Network, 2010

Kenya’s energy sector is dependent on four predominant energy sources, hydro, geothermal, fossil fuels and traditional biomass which provides the basic energy needs of the rural communities, urban poor, and the informal sector. In the year 2014, the total primary energy supplied was around 23,630 kilo tons of oil equivalent (ktoe). An analysis of this supply shows high dependency on biofuels and waste which account for 66.8% of the supply, followed by oil at 15.8 %, coal at 1.4%, hydro at 1.5% and other renewable sources at 14.8%. Figure 1 depicts the energy balance of Kenya.

FIGURE 1 | **Energy balance of Kenya: share of total primary energy supply* in 2015**



* Share of TPES excludes electricity trade.
** In this graph, peat and oil shale are aggregated with coal, when relevant.

Note: For presentational purposes, shares of under 0.1% are not included and consequently the total may not add up to 100%.

For more detailed data, please consult our on-line data service at http://data.iea.org.

Source: © OECD/IEA 2017

The Government of Kenya has initiated a program "Vision 2030" to transform Kenya into a "newly industrializing, middle-income" country. However, Kenya has 2,333 MW of generation capacity to serve its population of over 44 million as of May 2017, which constrains economic growth since energy is essential for ISID. The energy sector is pivotal to Kenya's vision 2030, given its systemic link to almost all other sectors of the economy.

In order to realize its ambition of becoming a middle-income country, the Government of Kenya has identified a strong ISID serviced by a clean and modern energy sector. Kenya has an electrification rate of 60 per cent and an ambitious target to increase current electrification rate to at least 100 per cent by the year 2020. Electricity demand in Kenya is increasing rapidly due to the accelerated productive investment and increasing population. Poor investments in electricity sector have widened the gap between electricity demand and supply. The demand is projected to grow to about 15,000 MW by 2030. To meet this demand, Kenya's installed capacity should increase gradually to around 19,200 MW by 2030[1]. The current situation of limited access to electricity hampers further development of rural industrialization, including agro-industries as well as the improvement of living standards of the rural communities.

United Nations Industrial Development Organization (UNIDO), in cooperation with the Ministry of Energy and Petroleum, Ministry of Industry Investment and Trade, the Ministry of Environment and Natural Resources and Jomo Kenyatta University of Agriculture and Technology, developed a training programme for sustainable energy planning at the lowest administrative units. This was under the framework of the Global Environmental Facility (GEF)-5 project "Sustainable Conversion of Waste to Clean Energy for Greenhouse Gas (GHG) Emissions Reduction in Kenya". This manual is an outcome of the training which is intended to help officials responsible for energy planning to introduce sustainable energy solutions and concepts to all the 47 counties in Kenya. In enhancing the capacity to develop sustainable energy plans for counties, this manual aims to have a positive effect on raising the business competiveness of small medium enterprises (SMEs) at a local level. This is by lowering the energy costs, improving universal access to modern sustainable energy services at the household level and contributing to environmental benefits in reducing the carbon footprint and lowering deforestation.

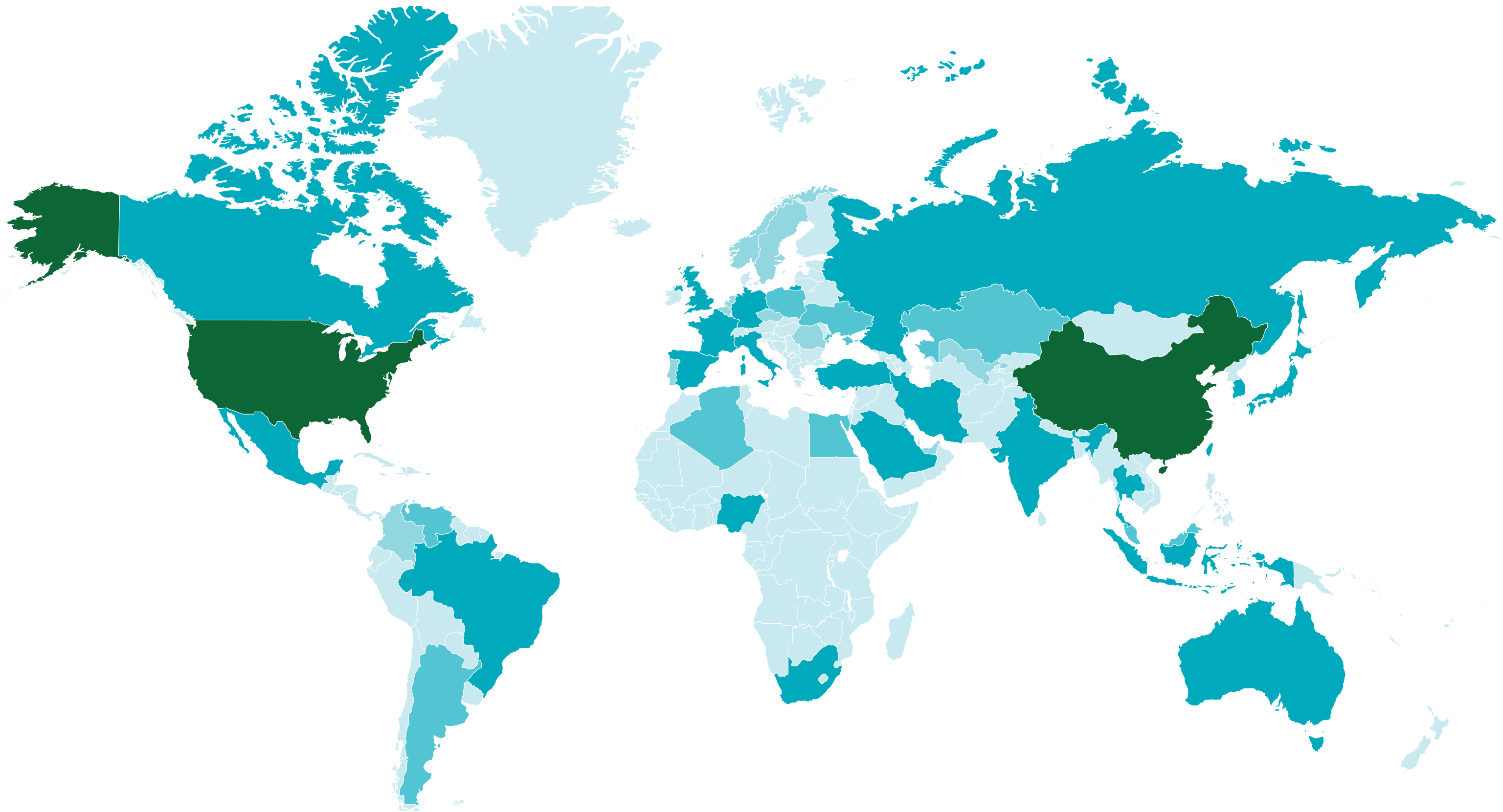
1 http://www.kplc.co.ke/img/full/bWXFzkYGyS97_National_Energy_Policy_-_Third_Draft_-_May_11_2012.pdf

1.1. Energy in the Global Context

The amount of energy consumed in different parts of the world varies significantly. One way to understand this matter is to consider the energy consumed per capita (per person) in different countries and some of the differences are shown below:

FIGURE 2 | **World: Total Energy Consumption, 2015**

Unit: Mtoe **Above 2000** **500 to 2000** **100 to 500** **50 to 100** **Below 50**



Source: Enerdata, 2015

While some of these large energy consumption disparities relate to local climatic conditions, the main reasons are profound differences in quality of living, mobility and economic activity. When the energy consumption patterns are related to demographics, it becomes even clearer that most developing countries have minimal energy consumption per capita.

1.2. Energy and the Developing World

According to the World Energy Outlook 2016, 1.2 billion people lack access to electricity, while 2.7 billion people still use traditional biomass for cooking, which is associated with approximately 3.5 million deaths annually from indoor air pollution. Analysis shows that sub-Saharan Africa and developing Asia are the most deprived regions in the world for electricity and modern cooking fuels, accounting to more than 3.7 billion people[2]. There is a proven link between access to reliable and affordable electricity and socio-economic development. Indeed, where the electricity network grid ends, so does the modern economic and social development too. The key causes of this global trend are rapid population growth, unreliability of national grids, transmission and distribution capacity and losses, etc. While the World Energy Outlook 2016 analysis of existing and planned government policies predicts the rapid growth of the region and significant improvements in power generation capacity with an increase of nearly 60 per cent from renewables by 2040, and universal access to modern energy services by 2030. But, despite increased efforts, more than half a billion people, increasingly concentrated in rural areas of sub-Saharan Africa, would still lack access to electricity by 2040 (down from 1.2 billion worldwide today)[3].

1.2.1. The scale of the problem

World energy outlook has projected that 30 per cent of the increase in energy demand will be from developing countries by 2040. Therefore, effective management of emerging energy transitions in the developing world becomes very important.

Increasing electricity supply alone is not the solution- thermal energy needs must also be addressed on a massive scale with clean, safe, efficient and affordable energy.

In Africa, there are over 700 million people but the continent consumes only around 3 per cent of world's energy produced. The World Energy Council reported that 20 per cent of the world's population uses 80 per cent of the world's energy production, with most of the remaining population relying on traditional energy sources such as wood. The eradication of energy poverty in developing countries is often simplistically viewed as being solvable by the provision of some limited electricity supply. While this helps to a certain extent, this alone is not the solution. Despite the predicted growth, economic development and income growth, it does not automatically lead to the adoption of clean cooking facilities, meaning that specific government policies have an important role to play in giving equal attention to clean cooking solutions and access to electricity3

2 http://www.worldenergyoutlook.org/resources/energydevelopment/

3 http://www.worldenergyoutlook.org/media/publications/weo/WEO2016Factsheet.pdf

1.3. Addressing Global Energy Poverty

Lack of energy is often mentioned as an obstacle to development, especially economic development. Is this true or is the reality rather the opposite in that it is economic development that creates a demand for energy? While both views are valid depending on the specific circumstances involved there is a need for more research into the practical linkages between modern energy provision in rural areas and economic development, especially successful case studies and practical ways of deploying energy for this purpose.

To overcome energy poverty, greater innovation, appropriate funding mechanisms and viable designs under strict adherence to different cultural and climatic conditions are needed.

All too often, innovative and technically proficient rural energy projects stop short and fail to integrate with broader development strategies such as micro and small enterprise development. It appears often that the provision of minimal electricity alone does not spur development. However, increased energy access alone will have minimal developmental spin offs unless it is actively deployed with complimentary initiatives of small business investment, skills development and entrepreneurial leadership with local citizens. Only in this way can energy provision play a contributory role in helping to create sustainable economic development in remote areas. Modern energy used in combination with other necessary rural development initiatives is therefore, a fundamental resource for enabling economic development and growth.

1.4. Integrated Energy Solutions

It is clear that two further elements are of critical importance to have any chance of long term success of providing access to modern energy to poor communities. The first is a new approach to designing and implementing energy supply schemes in rural and poor communities. There needs to be an in depth situational research and diligent consultations with local residents conducted at every step in a detailed preparatory stage. What will be suitable and will work in one locality, culture or climatic region may not be suitable for other locations. Every location will have its unique characteristics that will impact the energy use. There will also be at every location different indigenous sources of energy. These will include sunlight, wind, biomass, hydro and waste. Where ever possible, local energy sources should be deployed and this should be done with an eclectic approach.

This then raises the second essential element for such schemes. The aim must always be to design an integrated household and micro business energy supply package that will include some electricity and a range of thermal energy needs such as heating and cooling. Technology must then be deployed to provide the range of energy services that are required.

1.5. Benefits of Utilizing Renewable Energy Technologies in Developing Countries

Renewable energy can be particularly suitable in rural and remote areas of developing countries. Connecting these areas can be difficult and expensive, sustainable energy solutions can offer a viable alternative. Technological advances are opening up a huge new market for renewable energy technologies due to the dramatic price reduction of these technologies.

Sustainable energy projects in many developing countries have demonstrated that renewable energy and energy efficiency measures can directly contribute to poverty reduction by providing the energy needed for creating businesses and employment.

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2

Overview of Renewable Energy Technologies

Energy in its many forms is the stored up ability to do work--from the energy in a flowing river that turns the turbine, to the energy that is released when a piece of fire wood/charcoal or coal is burnt, the electrical energy within a charged battery or the solar energy when one walks out in the sun. When energy is utilized, it is converted into some action, outcome or work, such as the burning fuels to provide heat, driving motors to create movement or energising chemical processes to create light from a screen.

Renewable energy is generally defined as energy that comes from sources which are continually replenished on a daily basis such as sunlight, wind, rain, tides, waves and geothermal heat. Most forms of renewable energy come either directly or indirectly from the sun. For example, heat from the sun causes the wind to blow, contributes to the growth of trees and other plants that are used for biomass energy, and plays an essential role in the cycle of evaporation and precipitation that makes hydropower possible. This chapter provides an overview and brief description including fundamentals of the different renewable energy technologies.

2.1. Wind power

PICTURE 1 | **Windmill**

Airflows can be used to turn wind turbines. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms. Typical capacity factors are 30 per cent to 40 per cent. Modern utility-scale wind turbines range from around 600 kW to 5 MW of rated power, although turbines with rated output of 1.5MW–3 MW have become the most common for commercial use.

FIGURE 3 | **Wind Energy: An Overview**

WIND ENERGY

OVERVIEW

Wind turbines are designed to capture wind energy through the spinning of the turbine blades.

The shaft energy in turn is used to generate electricity for other applications.

AVAILABILITY

Varies across the world; a wind atlas needs to be consulted.

Sufficient wind speeds for practical use can be as little as 25% of the time.

ECONOMICS

Currently the economics of wind only work when sold into a national electricity grid

Or for private use in remote setting such as farms and holiday homes.

ADVANTAGES

Capital costs up front and no operational costs except for some maintenance.

Independence from the grid and lower carbon emissions. Wind turbines suppliers have increased, efficiency of turbines has improved

CHALLENGES

Irregular wind speeds, so alternate back up is needed such as a diesel generator.

Alternatively a significant battery back-up is needed Noise and possible danger to wild life.

2.2. Hydropower

Energy in water can be harnessed and used. Since water is about 800 times denser than air, even a slow flowing stream of water, or moderate sea swell, can yield considerable amounts of energy. Hydropower is produced in 150 countries, with the Asia-Pacific region generating 32 per cent of global hydropower in 2010.

PICTURE 2 | **Small hydropower**

FIGURE 4 | **Hydro Energy: an overview**

HYDRO ENERGY

OVERVIEW

Hydroelectric installations harness flowing water through a turbine that in turn drives the electricity generator

Varying size (power) and the turbine nature – a combination of the flow rate and the head or pressure of the water utilised. Basic calculation Power in kW=7 x Head x Flow [mx m3/s]

Four classifications:
- Large Hydro > 50MW
- Small Hydro 1-50 MW
- Mini 100 kW - 1 MW
- Micro 5 kW - 100 kW

AVAILABILITY

All across Africa, especially to farmers with access to perennial running water sources and are able to invest in suitable installations.

ECONOMICS

Economics of mini or micro hydro is becoming very promising when compared to the escalating costs of extending the national grid to remote areas.

Basic costs can be as low as USD 500/ kW installed

ADVANTAGES

- Capital costs up front and no operational cost
- Limited maintenance
- Potential for multi-purpose hydropower usages (usage for energy production and irrigation technologies)
- Independence from the grid and lower carbon emissions,
- possibility to link the hydropower plant to mini-grids
- Operation and energy production 24h each day/night
- Installations more easily available

CHALLENGES

Risks associated with such a venture.

Sessional water availability can vary in some countries Impact on the flow of rivers/ streams through adding weirs and pipelines

2.3. Solar Energy

PICTURE 3 | **Solar energy plant**

©123rf/hxdyl

Solar energy, the radiant light and heat from the sun, is harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaics, solar thermal electricity, solar architecture and artificial photosynthesis.

Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the sun, selecting materials with favourable thermal mass or light dispersing properties, and designing buildings that allow a lot of sunlight to penetrate the building.

FIGURE 5 | **Solar Photovoltaic Energy: An Overview**

SOLAR PHOTOVOLTAIC ENERGY

OVERVIEW

Solar photovoltaic (PV) panels generate electricity directly from the sun's rays in silicon wafers, generating a voltage through the photon effect.

[Natural] DC (Direct Current) which needs to be inverted to AC (Alternating Current). There are only low maintenance costs, mostly limited to cleaning.

The electricity output is limited to the solar hours

Varying size--from single 40W panels through to larger commercial installations of 20-100kW up to large scale solar farms supply a utility with more than 1 MW.

AVAILABILITY

Solar intensity varies a little across the world.

In Kenya the useful hours are limited to 6-7 hours each day.

Lower rate in winter in terms of intensity and hours.

ECONOMICS

Currently, the pay back is a number of years over normal grid electricity, resulting in predominant use in remote areas.

Solar PV and a small battery for a size of 5 kW equals USD 89,45 /kW, whereas for a size of more than 10kW the costs will go down to USD 67,08/kW

ADVANTAGES

no operational costs

Independence from the grid

The use of PV lowers the carbon emissions, when diesel generators are replaced

PV panels have become more easily available

Water pumping solutions with PV, having the advantage of its corresponding to the drinking times

CHALLENGES

Output is limited to the solar hours

Affected by cloudy weather.

High capital costs and associated small volumes of electricity generated.

FIGURE 6 | **Solar Thermal Energy: An Overview**

SOLAR THERMAL ENERGY

OVERVIEW

Solar thermal applications capture the heat of the sun and convert it directly into an application

The most common being the heating of low temperature water in Solar Water Heaters. Other applications include hot houses, food drying panels and very large thermal solar collectors for the generation of electricity.

The applications of Solar thermal are primary for water heating within the residential and commercial sector (e.g. Hotels, Gyms, Swimming pools), or for industrial processes, such as preheating, washing.

AVAILABILITY

Solar intensity varies little across the country, but more importantly the useful hours each day. Lower in winter in terms of intensity and hours.

ECONOMICS

Currently the pay back is generally a number of years over electric water heating

TSh 60,000/unit

ADVANTAGES

Capital costs up front and no operational costs. Independence from the electricity grid and lower carbon emissions.

Solar water heaters have become more easily available.

CHALLENGES

Lower gains in winter, plus effected by cloudy weather. Continuing inability to store large quantities of electricity cost effectively.

Frequent need for back-up of electrical or hydrocarbon energy supply systems. When renewable energy plant is off-line, when the wind does not blow or the sun does not shine.

2.4. Biomass/Gas/Fuel

PICTURE 4 | **Bio power plant**

©123rf/Andrei Merkulov

Biomass/gas/ fuel can be classified as waste based renewable energy sources also known as Waste-to-Energy (WTE). WTE is a form of energy recovery from the primary treatment of waste. Most WTE processes produce electricity and/or heat directly through combustion, or produce a combustible fuel commodity, such as methane through anaerobic digestion, methanol, ethanol or synthetic fuels through fermentation.

FIGURE 7 | **Bio thermal and Ethanol energy: An Overview**

BIOTHERMAL AND ETHANOL ENERGY

OVERVIEW

Biomass, in the form of agricultural and other wastes are superb sources of renewable energy.

They include Rice and other husks, saw mill residue, sugar cane residue, animal husbandry residue, collected firewood.

Each feedstock contains different specific calorific value and different seasonal availability.

The potential energy component of the biomass can be utilised in a number of ways, from straight burning in pellets, to production of biogas in digesters and even ethanol through fermentation and distillation.

AVAILABILITY

The availability of feedstock varies across the country, and has to be assessed site specific.

Various available bio wastes can be utilised; cow manure, sisal waste, saw dust, sewerage through to molasses.

ECONOMICS

Currently the economics of bio fuel based electricity still does not compete with grid electricity. However good economics if used as thermal fuel or off grid electrical solution.

ADVANTAGES

If waste based, greater GHG reduction through avoidance of methane production.

Independence from the grid and lower carbon emissions. Self-sustainability by communities.

CHALLENGES

Intermittent waste supply Capital cost of some machinery and the on-going operational and maintenance costs

Risk associated with such a venture.

2.4.1. Biomass

Biomass is biological material derived from living, or recently living organisms and most often refers to plants or plant-derived materials. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel. Conversion of biomass to biofuel can be achieved by different methods which are broadly classified into: thermal, chemical, and biochemical methods. Wood remains the largest biomass energy source today; examples include forest residues (such as dead trees, branches and tree stumps), yard clippings, wood chips and even municipal solid waste. In the second sense, biomass includes plant or animal matter that can be converted into fibres or other industrial chemicals, including biofuels.

2.4.2. Biogas

Biogas is gas produced by the breakdown of organic matter in the absence of oxygen. It is produced by anaerobic digestion of biodegradable material such as plants and crops, manure, sewage and municipal waste. It is primarily methane (CH_4) and carbon dioxide (CO_2). Biogas can be used as a fuel in a gas engine to produce electricity and heat and for thermal purposes such as cooking and drying. It can also be compressed in the same way that natural gas is compressed to form compressed natural gas (CNG) and used to power motor vehicles.

2.4.3. Biofuel

Waste to energy technology includes fermentation, which can take biomass and create ethanol, using waste cellulosic or organic material. In the fermentation process, the sugar in the waste is changed to carbon dioxide and alcohol, in the same general process that is used to make wine. Normally fermentation occurs with no air present. Esterification can also be done using waste to energy technologies, and the result of this process is biodiesel. The cost effectiveness of esterification will depend on the feedstock being used, and other relevant factors such as transportation distance, amount of oil present in the feedstock, and others. Gasification and pyrolysis by now can reach gross thermal conversion efficiencies (fuel to gas) up to 75%, however a complete combustion is superior in terms of fuel conversion efficiency. Some pyrolysis processes need an outside heat source which may be supplied by the gasification process, making the combined process self-sustaining.

Biofuels may be classified broadly into two major categories.

a) First-generation biofuels are derived from sources such as sugarcane and corn starch. Sugars present in this biomass are fermented to produce bioethanol, an alcohol fuel which can be used directly in a fuel cell to produce electricity or serve as an additive to gasoline. However, utilizing food-based resources for fuel production only aggravates the food shortage problem.
b) Second-generation biofuels, on the other hand, utilize non-food-based biomass sources such as agriculture and municipal waste. These biofuels mostly consist of lignocellulosic biomass, which is not edible and is a low-value waste for many industries.

2.5. Geothermal Energy

PICTURE 5 | **Geothermal power station**

©123rf/nmint

Geothermal energy is produced from the thermal energy stored inside the Earth's core. The Earth's geothermal energy originates from the original formation of the planet (20 per cent) and from the radioactive decay of minerals (80 per cent). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. The heat that is used for geothermal energy can be from deep within the Earth, all the way down to Earth's core – 6,400 km down. At the core, temperatures may reach over 5,000 °C. Heat conducts from the core to surrounding rock. Extremely high temperature and pressure causes some rocks to melt, which is commonly known as magma. Magma convects upward, since it is lighter than the solid rock. This magma then heats rock and water in the crust, sometimes up to 371 °C. Water from the surface that seeps down through fissures in strata is heated by these high temperature rocks and rises to the surface. Conventional geothermal facilities consisted of wells drilled anything between 3000 and 12000 feet into permeable rock to release the very hot water and steam at the surface. This energy is then deployed for a range of thermal applications including to drive generators for the production of electricity.

FIGURE 8 | **Geothermal energy: an overview**

GEO THERMAL ENERGY

OVERVIEW

Geothermal power plant technology converts hydrothermal fluids into electricity. The heat is used to produce steam, which powers a turbine that generates electricity.

There are various types of conversion; dry steam, flash steam and binary cycle. The type of conversion used (selected in development) depends on the state of the fluid (steam or water) and its temperature.

Use of the heat for thermal applications is also possible. Plant size from 1-900MW.

AVAILABILITY

Best suited for places located on the edge of tectonic plates, such as the Rift Valley in Kenya.

ECONOMICS

Currently the economics of geothermal electricity production is working in Kenya given the number of plants planned and being built.

ADVANTAGES

Continuity of supply as there is no break in heat production

Completely renewable and minimal carbon emissions

CHALLENGES

Thermal efficiency of geothermal electric plants is low, around 10–23%

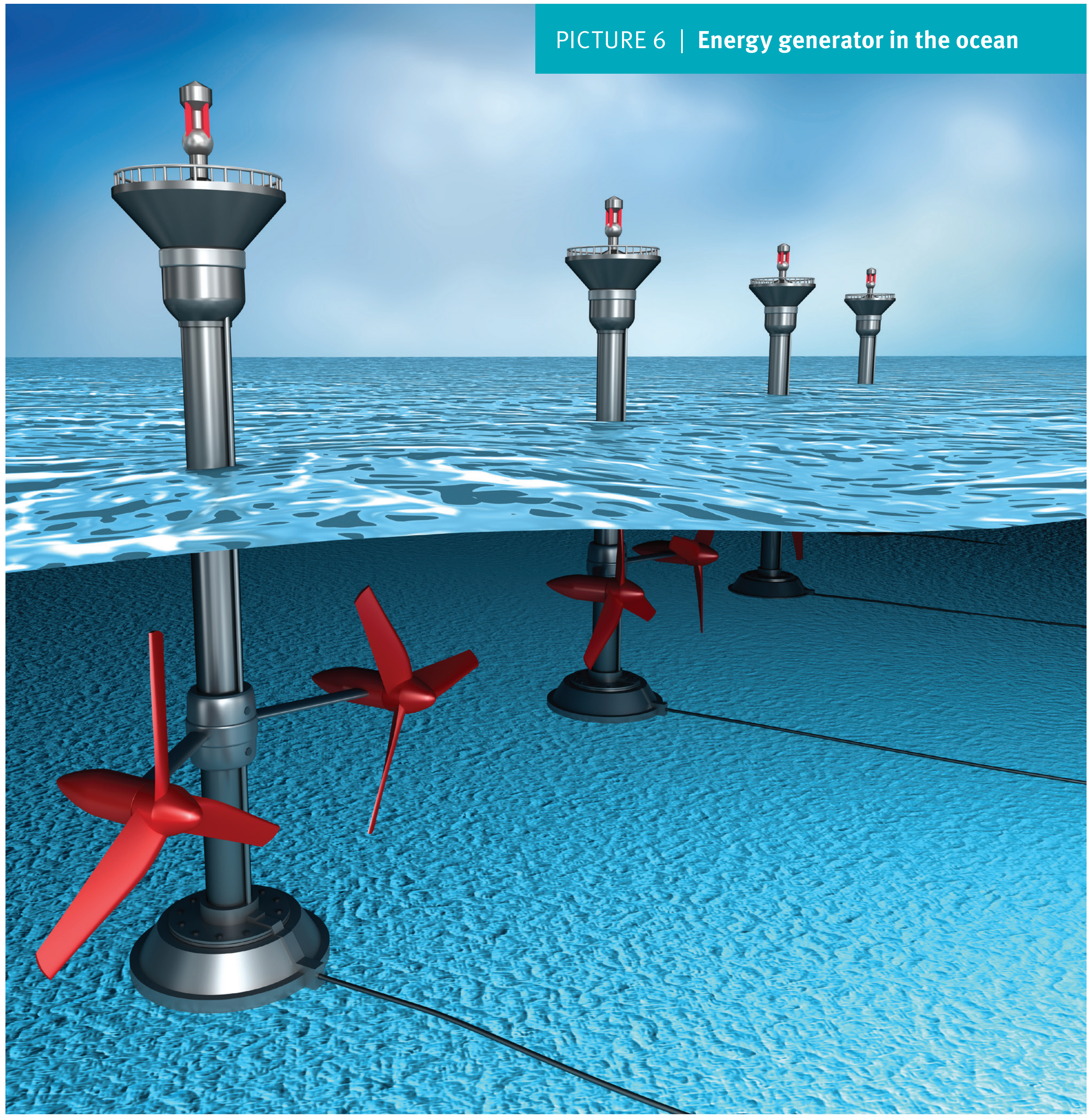
Risk associated with such a venture.

Normally grid feed only due to the scale and costs.

2.6. Marine Energy

Marine energy (also known as ocean energy) refers to the energy carried by ocean waves, tides, salinity, and ocean temperature differences. The movement of water in the world's oceans creates a vast store of kinetic energy, or energy in motion. This energy can be harnessed to generate electricity to power homes, transport and industries.

The oceans have a tremendous amount of energy and are close to many, if not most, concentrated populations. Ocean energy has the potential of providing a substantial amount of new renewable energy around the world.



PICTURE 6 | **Energy generator in the ocean**

©123rf/alexmit

3

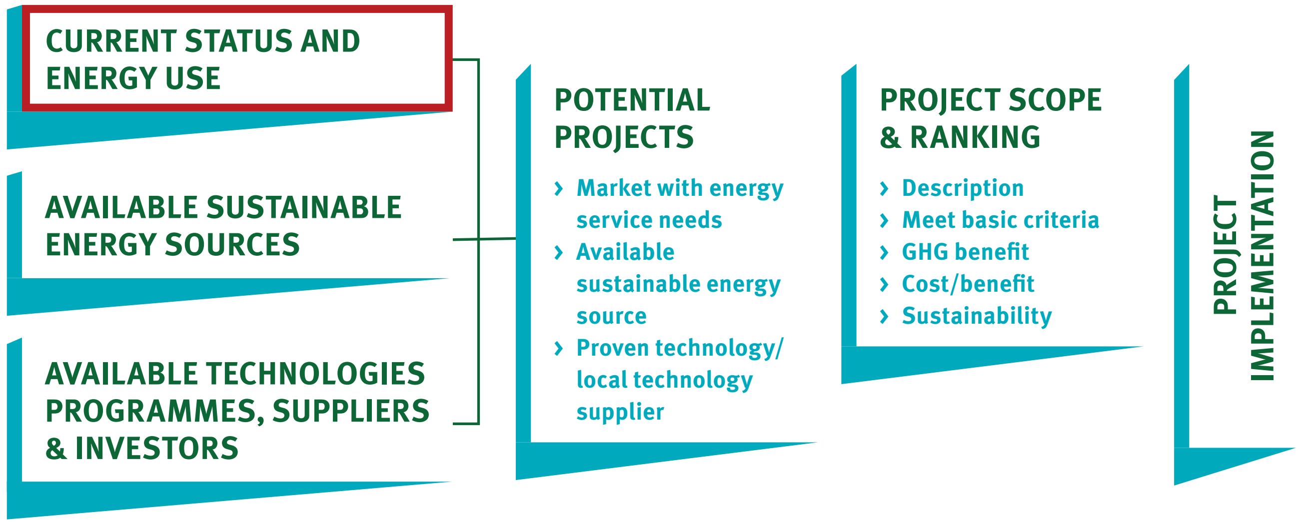
Planning Rural Sustainable Energy Projects:

For successful planning and implementation of rural sustainable energy projects, this chapter provides a clear, structured approach, organized in three steps. The first step is dealing with the analysis of the County specific information and energy profile. At this stage, a comprehensive research is needed to define the current status of the energy use and the county market segment. In the second step, the available sustainable energy resources and technology and investment options, as well as the context to the County will be investigated. Finally, the third step provides relevant information on how to scope and rank the potential projects, as well as important information for the implementation stage. The identification of potential projects, within the planning phase I and II could be called the real heart of the sustainable energy Plan. A planner simply needs to look for the intersection of the current status of energy use in the county, the available sustainable energy resources and technologies, plus taking the role of the County into account. This is a real thinking activity, as it is complex to integrate these different sets of data. Nevertheless, it is the precondition for all further actions in Project scoping, ranking and implementation.

FIGURE 9 | **Three-stage planning of rural sustainable energy projects**

3.1. **Planning I:** Current status and energy use

FIGURE 10 | **Planning rural energy projects stage 1.**



3.1.1. The plan context and the energy market analysis:

County general information
Prepare a description of the County, its people and economic activities related to the current and future use of energy. Current and future as changes in energy use going forward is always evident due to factors such as population growth, technology shifts, income increases and extraneous factors such as electrification.

Cryptic summaries are needed of any substantive data published in official County Government documents, plans, speeches, etc. However, it is important to focus on real hard descriptive data not excessive general and aspirational matters, such as County specific geographic position, access roads/air, and general economic matters. The information can be structured in the following way:

- Description of topography, mountainous, flat, desert versus tropical
- Names of major towns, features such as institutions, population, universities, etc.
- Rural population versus urban and the share of each
- Map of major roads and transport infrastructure
- General overview of population groupings by cultural type, language, gender/age, income groupings and educational levels
- Any tribal, linguistic and cultural factors impacting energy supply and use, such as cooking preferences
- What socio economic level is the County, rich vs poor
- Economic growth rates such as GDP projections
- Main economic activities, what types, size, ownership
- Entrepreneurial skills and overview of small and medium business
- Business skills development initiatives taking place in country, if any
- General availability of water, how is it managed

County Plans and national policy goal:
Upfront, the planner needs to deal with the context of such a County sustainable energy plan. This covers specifically national policy that needs to be embraced and taken cognisance together with any prescribed matters. Also, any relevant energy or other inputs from County government officials. Through an iterative process with County leadership, realistically achievable goals need to be set and fully supported. County government's agendas need to be reflected here, they are beyond energy and sustainable energy to include socioeconomic goals as well.

Energy Market Analysis:
First area of real data gathering and analysis covers the present use of energy within the County, as most renewable energy opportunities require one to replace current fossil usage. A special case is the residential market that experiences rapid changes when electrification is delivered.
When gathering and processing the required data, a distinction needs to be made between two specific types of data--qualitative and quantitative.

Quantitative data are the numbers, such as number of households, number of electrified households, number of businesses by type of business, volume of energy used and penetration of appliances or equipment.

Qualitative, on the other hand is a written description, the types of houses (e.g. brick construction or wooden, single storeyed etc.) found in the County. Also, the households in terms of family structure, aspirations and socioeconomic level. Or a description of each major commercial business type, the nature of farming, whether there is irrigation, the seasonality and markets.

These two sets of data together will provide the County with the ability to both describe and separate the usage of energy into fairly homogenous blocks or groups that use the same level of energy for the same type of energy service. What is absolutely imperative is that while preparing the plan, one lists:

- All major planning assumptions that have been made, so readers can validate them
- Where the information was sourced from should be noted in the text
- Any serious limitations to the data that would create risk to the projects
- Basic overview of current fuels and energy sources--Kenya power, coal, petroleum etc.
- What energy/fuels sources are used within the state and what volumes are utilised
- Current level of electrification
- Any existing studies that have been completed on waste or renewable options
- What major conventional energy schemes are planned such as natural gas pipelines, power stations, mining activities etc.
- What trading takes place in country and what is level of transport energies used
- Who are the main traders in energy, how is the fuel sold, what are the prices

3.1.2. Residential household analysis:

Basic demographics:

- Number of households, population and number/house
- Maps showing rural versus urban numbers distribution
- Any form of household demographic segmentation would be beneficial, such as on income, rural versus urban, education levels etc.
- An overview of family structure, particularly related to household decision making
- Common occupations and types of work (types of employment), sources of household income, seasonality and employment/unemployment levels
- What are mortality rates by gender and age group, reasons such as indoor air pollution
- Residential energy usage analysis:
- The residential energy usage analysis should identify the status quo of the current used energy sources and services and also provide an outlook for upcoming trends within the next years.
- What are the electrification levels in the County, rural versus urban, what percentage of the population have local power lines but not connections, what electrification plans are there for grid expansion?
- The 5 year figures should show the anticipated growth and changes between the various categories as shown in Tables below.
- Set out a residential household segmentation matrix with numbers e.g.

TABLE 1 | **Siaya County Residential Electrification Data**

Electrification		Current			5 years		
Residential segment	Number	% elec	# elec	# no elec	% elec	# elec	# no ele
Rural upper income	7,602	80%	6,082	1,520	95%	7222.1	380
Rural middle income	53,215	40%	21,286	31,929	60%	31929	21,286
Rural lower income	91,226	5%	4,561	86,665	25%	22806	68,419
Urban upper income	869	100%	869	–	100%	868.83	0
Urban middle income	2,172	65%	1,412	760	75%	1629.1	543
Urban lower income	5,648	25%	1,412	4,236	40%	2259	3,389
Total	**160,732**		**35,621**	**125,110**		**66,715**	**94,017**

For each segment, what are the current sources of energy and what are the associated energy services (e.g. lighting, cooking), plus what are the current appliances used for each service

TABLE 2 | **Kakamega County Residential Services**

Services		Lighting				Cooking		
Residential segment	Number	Elec	candles	paraffin	solar	Wood	charcoal	other
Rural upper income	30,000	24,000	0	4,500	1,500	25,500	3,000	1,500
Rural middle income	150,000	60,000	0	82,500	7,500	135,000	7,500	7,500
Rural lower income	60,000	6,000	6,000	48,000	0	57,000	2,400	600
Urban upper income	6,000	6,000	0	0	0	0	600	5,400
Urban middle income	18,000	16,200	0	1,080	720	0	3,600	14,400
Urban lower income	36,000	21,600	3,600	10,800	0	3,600	18,000	14,400
Total	**300,000**	**133,800**	**9,600**	**146,880**	**9,720**	**221,100**	**35,100**	**43,800**

General comments related to the use of health harming fuels--wood, paraffin charcoal etc. Perhaps the local health authorities will have information about the incidence of upper respiratory illness, particularly in young children and women, also burns from household accidents caused by fires, number of still-births, etc. These statistics and health problems are surrogate intelligence for the lack of modern, clean and efficient energy.

Concluding paragraph should contain data on the current usage of energy in the residential sector, the types of appliances the trends, and what it will look like in five years. It is important to note that this data may only be readily available at a very superficial level initially, but on-going refinements and improvements should be incorporated annually as the County sustainable energy plan is updated via every annual planning cycle. Importantly a list of references and data sources should be listed for future reference and the guidance of readers.

3.1.3. Commerce/Institutional analysis

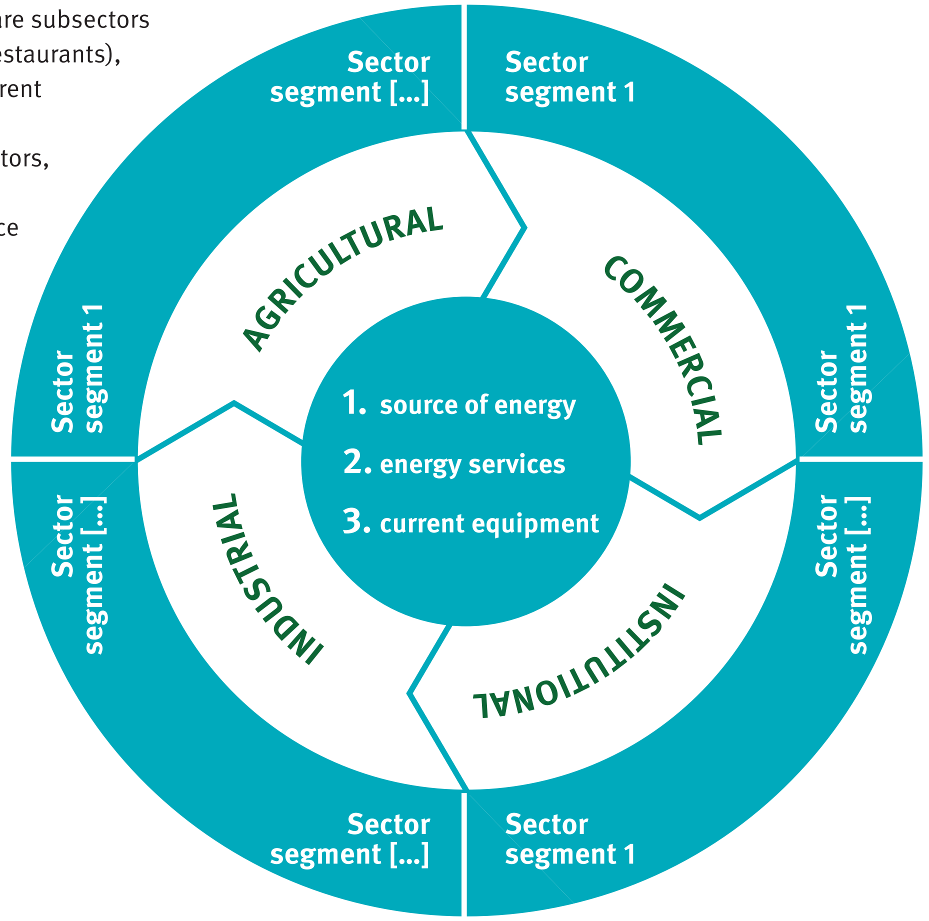
The situation analysis should to be done for each existing sector in the county. The analysis should start with a general description of the economic area in the County, divided by different sectors, followed by the description of the sector specific activities, and the numbers of organisations and their size.

The different sectors can be divided into Agricultural, commercial, industrial and institutional sectors, as indicated in the following table. For each sector, there are subsectors (e.g. Commercial (e.g. shops, hotels, restaurants), it should be identified what are the current sources of energy (1) and what are the associated energy services (2) (e.g. motors, refrigeration), plus what is the current equipment used and what energy source is used for each energy service (3).

An example could be – Dairies – 4 in the County

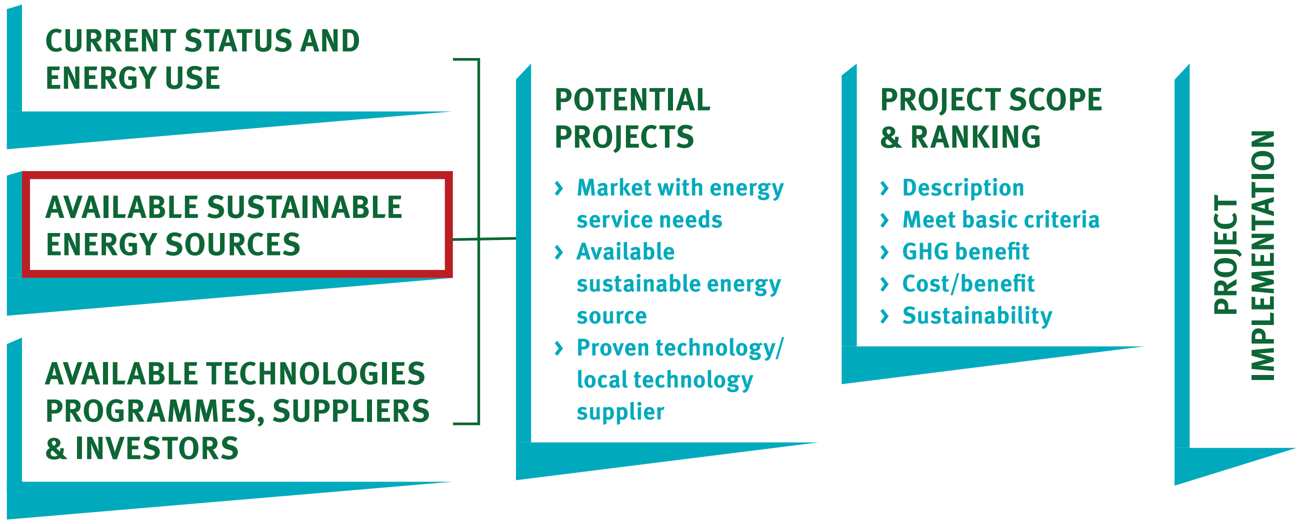
- Pumps for the movement of diary milk and products around. Stirrers for the various vats and the bottling machines
- Steam boiler based on fuel oil for heat in the pasteurisation process and washing water
- Electric driven chiller/cooling plant for the cooling of milk products and holding rooms
- Office & laboratory equipment and general electric lighting

FIGURE 11 | **Sectors and sub-sectors for situation analysis**



3.2. **Planning II:** Sustainable Energy Resources, Technology and Investment

FIGURE 12 | **Planning Rural energy projects stage 2**



3.2.1. Available Sustainable Energy Sources

Identifying sources
Before all the potential projects can be identified, a County planner needs to complete an inventory of the available renewable energy sources and potential energy efficiency options. In this first sustainable plan not all sources are likely to be identified and fully categorised, but during the next year more details can be obtained. Sources of data include:

1) An analysis of the agricultural activities in the County for waste. Contact with a sample of farms is needed to confirm the details
2) Similarly, major industries can be approached to check on waste. Again, contact is needed with the industries to check on the waste availability and characteristics.
3) Wind & solar maps
4) Hydrological assessments for hydro potential
5) Geothermal assessments
6) Energy efficiency options

The results of this inventory can be summarised in the associated example of Nairobi County below.

TABLE 3 | **Nairobi County Prospective Renewable Energy Sources**

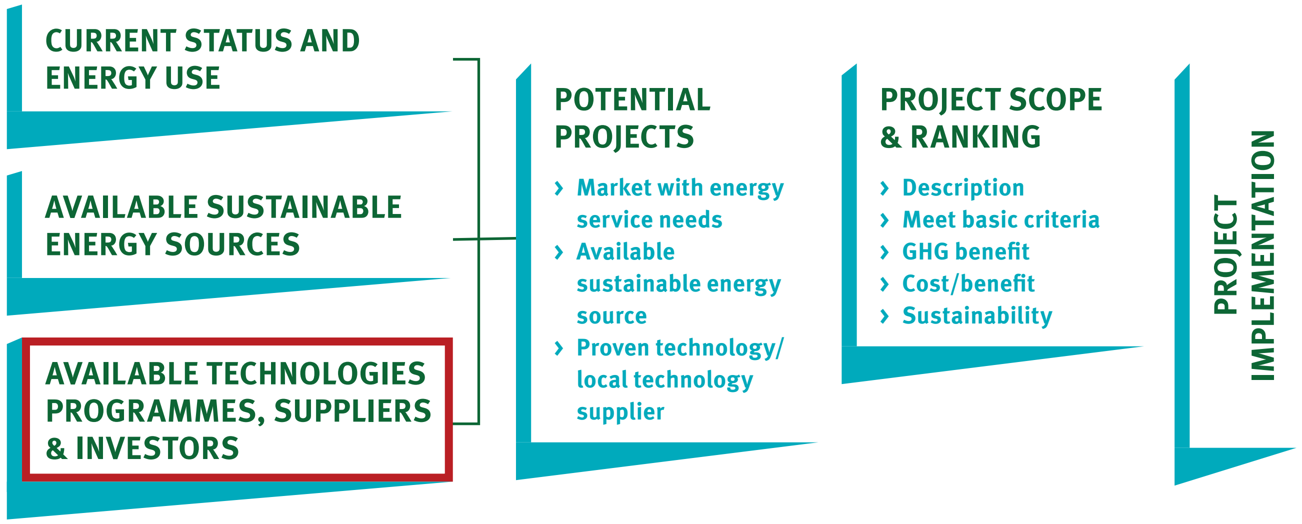
Sector	Source categorisation				
	General description	Volume	Seasonal	Location	Other
WASTE					
Cattle manure - Diary	The dairy farmers practice urban animal husbandry.		No	Across the county	Goat, rabbit, poultry and beef farming
Cattle manure - Feedlot	the animals are fed on free range system with some animals being reared in paddocks		No	Across the county	nappier grass, hay
Rice husks					
Corn residue	corn processing is done at commercial level		no	one in industrial area	potatoes, soybeans, groundnuts, sesame, millet, sorghum
Cotton waste					
Sugar cane waste					
Bagasse/Barley	barley and sorghum is used in beer production and processing of beer		no	Across the county	Biogas, solar
Market waste	available in the major markets within the county		no	Across the county	Biogas, solar
Landfill sites	there is a site at Dandora with potential to generate energy from the waste		no	in the dumpsites	
Sewerage waste	sewerage waste is available in the whole county with potential for hydro power generated from the Rural sewerage treatment plant		no	in rural sewerage treatment works	abattoirs waste, non-biodegradable waste
SOLAR					
Solar radiation by area	there is potential in this sector for the solar radiation to be harnessed across the county		no	Across the county	wind, hydro,
WIND					
Wind potential by area	it is a potential source of energy that can also be harnessed for use by small wind turbines for lighting		no	Across the county	hydro, solar
HYDRO POWER					
Opportunity A	There is potential to harness this source from the available rivers and streams crossing the county		no	Some parts of the country	Small and Mini hydro power potential
Opportunity B	N/A	N/A	N/A	N/A	N/A
GEOTHERMAL					
Opportunity A	N/A	N/A	N/A	N/A	N/A
Opportunity B	N/A	N/A	N/A	N/A	N/A
Etc.					
PURCHASED RENEWABLE ENERGY					
Bioethanol					Biogas, solar
Green electricity	there is enough potential for it to be purchased from the national grid		no	All parts of the county	Biogas, solar
Renewable waste					

Furthermore, examples of existing use of renewable energy sources in the County could be identified in order to assess the potential for up-scaling.

3.2.2. Available technologies, programmes, supplier & investors

In addition to the simple renewable energy source, what is also important for County planners is the identification of all the other ingredients that make a project possible. A description of these is provided below.

FIGURE 13. **Planning rural energy projects: stage 3**



Technologies/suppliers
For any County driven or promoted projects there will be a need for conversion technology to be proven in a national context, there need to be local equipment suppliers and a reassurance that the technology will be effectively maintained over the life cycle of the renewable energy production project. It is therefore recommended to make a list of all renewable energy suppliers such as PV panels suppliers, wind generator suppliers, micro hydro installation designers and suppliers, biogas plant designers and suppliers and bioethanol production plant suppliers and others.

The key issues here are what is being already utilised locally and what actually works effectively in a country specific context. Only technologies and suppliers that already have working installations and a demonstrable track record should be included. In contrast, County Energy Planners must always look for energy project options that demonstrate: capability, economics and sustainability.
There also a need for Counties to share information on what projects have been successful to build up a series of case studies on the technologies and suppliers for reference during continuing annual planning cycles.

National & NGO programmes
County planners need to identify and endeavour to embrace as many National and NGO funded programmes as possible that will have a local benefit. Such national and NGO programmes could also help to build the capacity in a county to manage sustainable energy projects, via trainings on project implementation and maintenance. Moreover, regular contact is needed with the Ministry of Energy, or Rural Electrification Authorities etc. for further inputs on national and NGO programmes. The following key points can be identified for each national or NGO programme.

- Programme name and focus
- Local applicability and impact of the programme
- Time frame of the programme
- Scope in terms of possible investment value or number of entities impacted e.g. number of household PV systems

What needs to be done to obtain County inclusion in the programme

Investors/project developers
Finally, for the large projects investors and funders will be the key. Governors and other senior County staff will need to assist them with their identification. Examples include:
1. Sustainable energy project investors
2. Development banks with a renewable investment portfolio

Records of possibilities
This list will change regularly as more programmes and suppliers emerge. Thus, during each year, a running list should be kept for inclusion in the next annual energy plan.
Again, the results of this inventory can be summarised in the spread-sheet table below.

TABLE 4 | **Kakamega County available technologies, programmes, suppliers & investors**

Technologies/ suppliers	General description	Equipment range	Case Study	Contact
PV supplier A	Solar standalone	Solar panels, batteries, cables & controls	Makhokho Sec School; Borehole water pump	
PV supplier B	Solar standalone	Solar panels, batteries, cables & controls	Khwisero Health centre; Borehole water pump	
PV supplier C	Solar standalone	Solar panels, batteries, cables & controls	Mautuma coffee factory; Borehole water pump	
PV supplier D	Solar Mini-grid	Solar panels, batteries, cables, controls, metering & distribution	Nyabondo solar Electricity generation site-Kisii County	Powerhive EA Ltd
Wind generator supplier A				
Mini/micro Hydro supplier A	VSCF micro hydro	Rotor, alternator, Power Inverter, metering, distribution & controls		
Biogas design/ supplier A	Dairy farm biogas plant	Tanks, digestors, Collector, gas pipework	Bukura (BAC)	Principal Bukura (BAC)
Biogas design/ supplier B	Kakamega Slaughterhouse biogas plant	Tanks, digestors, Collector, gas pipework	Dagoretti Slaughter	Manager-Dagoretti Slaughter house

Technologies/ suppliers	General description	Equipment range	Case Study	Contact
Biogas design/ supplier C	Mumias Slaughterhouse biogas plant	Tanks, digestors, Collector, gas pipework	Dagoretti Slaughter	Manager-Dagoretti Slaughter house
Ethanol plan supplier A				
Clean cook stove supplier A	Improved, energy saving cookstove	Cookstove	Ekero Market Vendor's Premises	Isak & Mohammed
Waste pelletiser supplier A				
Gasifier/generator supplier A				
National & NGO programmes	**General description**	**Time frames**	**Scope**	**Process**
Programme A	Powerhive EA Ltd	4 years	Sustainable solar RE	County, sponsors & stakeholders
Programme B	Malava Solar Energy Sites	To be set	500 Households	County, sponsors & stakeholders
Programme C	Practical Action	2 years	Sustainable Energy policy, plan & Projects	County, sponsors & stakeholders
Programme D	Nextreme	1 year	Unit cost reduction	County, sponsors & stakeholders
Investors/project developers	**General description**	**Type**	**Scale**	**Process**
Option A	County & NGO	Buy-into Programmes		
Option B	County & NGO	Internal Promotion		
Option D	County & NGO	County Investment		
Option E	County & NGO	Independent Investors		

3.2.3. The Role of a County in developing sustainable energy projects

What is necessary to comprehend is the broad range and structure of sustainable energy projects that could be adopted by Counties. To widen the delegate's understanding and appreciation for what projects are possible, a framework of project types is presented, together with a matrix of factors governing each. The main factors governing or differentiating projects include, what role the County will play in delivery, whether other players are involved, would the renewable energy source or processed sourced (electricity, biofuel) be used in the County or exported, where will the money come from for the equipment. All projects need to be driven or facilitated by the County. However, there are varying types of activities and levels of involvement. There are 5 basic levels:

1) Buy into - National or NGO support programmes for the local role out of a sustainable energy solution. With getting a share of the support programme the County can facilitate the local delivery. For Example, DIFD sponsored solar panel based home system for remote rural households in Kenya.
2) Internal promotion – of renewable based alternatives with local commerce. In this case, the role of the County is simply awareness raising and encouraging local investments by business.
3) An example would be the installation of grid tied PV panels by retailers to simply lower their Kenyan Power purchases and costs. Here the County's role is to promote the opportunity, perhaps run workshops with the equipment suppliers and target businesses.
4) County sponsored programmes – allocation of County funds to deal directly with urgent or high-level needs of the County's population.
5) An example could be the payment of subsidies on low emission/high efficiency fuel based wood stoves for use in rural households using firewood for cooking. This will directly improve health through lowering indoor air pollution and if locally made also increases jobs.
6) County role in this case would be full project development and implementation using suitable consultants or knowledgeable support persons to augment local staff capacities.
7) County investment – opportunities exist for Counties to harness renewable resources under their ownership with the resultant profits accruing to the County. County governments would need to drive the project, whilst incorporating others such as project developers, development financers, funding agencies, etc.
8) An example could be the installation of a hydroelectric plant on a County owned river site, with the power either utilised by the County e.g. for pumping loads or sold to Kenyan Power and exported.
9) Independent investors – private players are able to participate in the national energy economy and may invest in sustainable energy opportunities situated in a County.
10) An example would be the setup of solar or wind farms directly supplying to the national Power utility or the manufacture of bioethanol for sale. Here, the role of the County government is simply to assist and make the investment environment attractive, including possibly the promotion of renewable energy sources, help with land acquisition, local labour arrangements, community liaison and so forth.
11) Involvement of other players –In addition to the County government, key players that will be involved in projects who will effectively change the nature of any sustainable energy project include:
    a) Externally supported or driven programmes will mean the project will be driven by the National government or the funding NGO
    b) Project developers who independently run projects
    c) Projects with the need for significant external involvement through consultants, and suppliers

Internal use or export
Another project dimension that needs to be appreciated is whether the useable energy obtained from the renewable source is utilised internally or exported out of the County. Some sustainable energy projects will be completely for local consumption such as the clean fuel efficient stoves for rural households, others might be fully exported, as in the case of a Kenyan wind farm with 100 per cent sale to Kenya power. Others may be a mixture, perhaps bioethanol production from waste that may be partially sold in the County and the rest exported.

Sources of investment
Lastly, projects can be categorized from the perspective of where the funding is coming from, including:

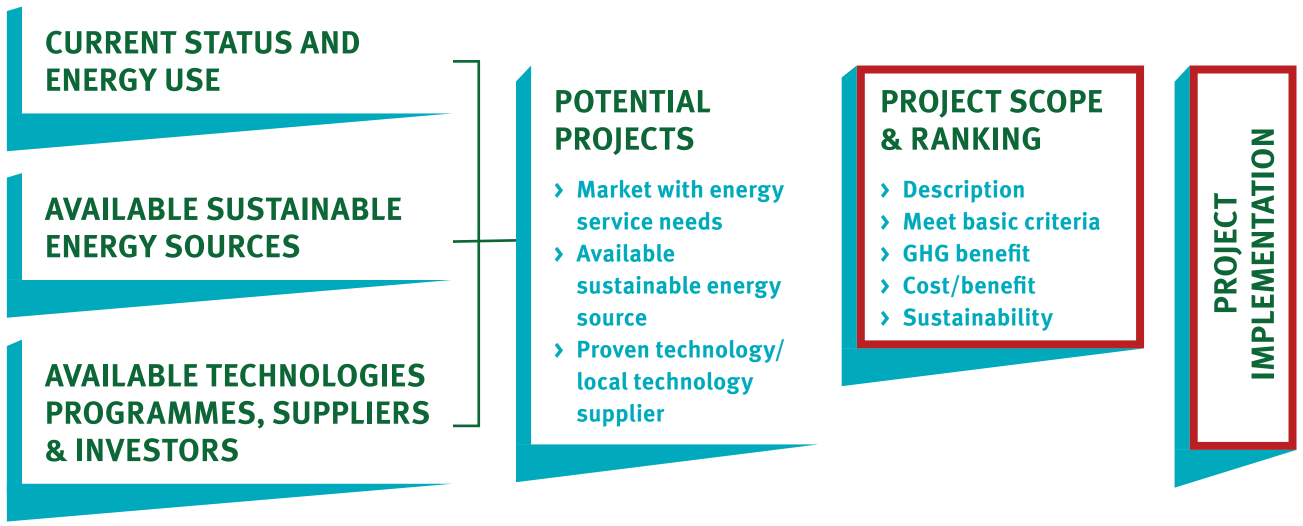
1) County internally funded projects (possibly through loans on major infrastructure)
2) Renewable energy and energy efficiency programmes funded by national programmes or NGOs
3) Funded projects by the County as businesses for its own use
4) Investment funded projects in the case of large scale generation projects

3.3. **Planning III:** Project scoping and ranking & Implementation

3.3.1. Project scoping and ranking

While a whole list of potential or possible projects will have been identified, it is now important that the projects are interrogated, scoped more fully and then ranked for decision making purposes. County Government can then make a final decision on which projects to pursue, before they are then fully developed and implemented.

FIGURE 14 | **Project Scoping**



Only projects that can show acceptable convergence of the following aspects are likely to become successful viable projects. Therefore, the scoping process requires the detailed analysis of the following aspects:

General description

- A detailed narrative needs to be written that describes the proposed project, background, what source of energy, conversion technology, funder, programme etc.
- What parties will be involved in which status of the project, etc.

Market size, acceptance and competitive position

- A description of the target market in detail, characteristics and size e.g. number of poor rural households, current energy source and equipment, etc. This description needs to clearly show who and what is being targeted.As these projects are centrally planned, it is imperative during this stage to make contact with the receivers to ensure acceptability of the project. This will vary from remote community leadership to the local business persons. This section must demonstrate such acceptance.
- What is the compelling reason why the target market will take up the planned sustainable energy offer or make the required investment? Possibilities include, lower running costs pay for investment, and aspirational value compared to current equipment, for instance a subsidy makes it attractive or there is long term investment potential. Indicate that the new renewable technology will supply a service as good as or better, at a lower cost than the existing.

Project sizing, time frames and costing

- Based on the programme parameters, or the market scope, an estimate needs to be made of how many will be delivered or implemented under the programme in what time. An example could be 10,000 solar PV home systems supplied in 2 years with a cooker or 3 ethanol production plants in 3 years.
- An indication is needed of what the project will cost to deliver. The spread-sheet contains a range of project costing data.

Investment options

- How will the project be paid for, who will be supplying the money, how will the project be promoted by the sponsors, etc.
- If external funding, what process is involved, when is the return of investment expected, etc.

Implementation strategy including County role

- Based on the different County involvement options (see chapter *3.2.3. The Role of a County in* developing *sustainable* energy *projects*), a listing of what is needed by the County needs to be written.
- Needs to include manpower, investment and facilitation type support

For this and the ranking information a spread-sheet page/project is needed, in the following an example of the project scoping for Kakamega County is provided.

TABLE 5 | **Kakamega County Standalone Solar PV in Malava Sub-county**

A more detailed narrative needs to be written that describes the proposed project, background, what source of energy, conversion technology, funder, programme etc. What parties will be involved, where it will be etc.
Market size, acceptance and competitive position
A description of the target market in detail, characteristics and size e.g. number of poor rural households, current energy source and equipment etc. Needs to clearly show who and what is being targeted
As these projects are centrally planned, it is imperative during this stage to make contact with the receivers to ensure acceptability of the project. This will vary from remote community leadership through to local business persons. This section must demonstrate such acceptance
What is the compelling reason why the target market will take up the planned renewable energy offer or make the required investment? Possibilities include, lower running costs pay for investment, and aspirational value compared to current equipment, a subsidy makes it attractive or long-term investment potential. Indicate that the new renewable technology will supply a service as good as or better, at lower cost than current.

Project sizing, time frames and costing			
Basic delivery item	Standalone solar PV home system		
Number to be delivered	500	e.g. 1 Hydro system or 10,000 solar systems	
Expected start date	1-Jun-17		
Project duration	2 years		
Total project delivery costs	100.00	Ksh million	
Total project Annual GHG savings	85.8	tons CO_2/annum	
Investment options			
County funds	e.g. general promotional activities		
End user payments			
Private investor			
Support programme funding	Subsidised support programme funding		
Development bank			
Other			
Implementation strategy including County role			
What role will the County play ... promoter and facilitator			
County staff - Person years	30		
Who will lead the project	Malava Sub-county Administrator		

Lastly, the listing of projects that have been scoped need to be ranked. A ranking matrix has been prepared for County planners, which is based on the 4 County benefits from sustainable energy projects plus a cost and scale factor. These measures are weighted to provide an overall project score.

1. Universal access to electricity and modern energy:
   - Score 0-10 dependent on household number impact.
   - If the project will bring essential electricity to households faster than grid connections, then score based on the project number as a ratio of those that need to be supplied e.g. if 50,000 out of 200,000 remaining without power then score 2.5 or if 100,000 score 5.
   - If the project supplies modern cooking negating injurious health effects of indoor air pollution and lowering the impact of deforestation score similarly score based on the project number as a ratio of those that need to be supplied e.g. if 50,000 out of 200,000 remaining without power then score 2.5 or if 100,000 score 5.

2. Business competiveness through lowering energy costs and sales opportunities:
   - Score 0-10 dependent on financial impact
   - Self-generation – ratio of electrical bill reduction – average of 20 per cent reduction then, score 2
   - For export energy, out of each County through grid sales or the supply of biofuels – ratio to County electricity spent

3. Improved County income
   - Score 0-10 dependent on financial impact
   - County receiving dividends or electricity in kind from project, then a ratio of income to County income

4. Environmental benefits accruing to the County
   - Real tons CO_2 reduction per year. Calculation included in spread-sheet, including methane avoidance
   - Projects scored as a ratio of biggest to smallest savings

5. Overall project investment cost
   - Simply the expected investment cost to complete the project.
   - Projects scored as a ratio of biggest to smallest

TABLE 6 | **Project scoping and ranking Table 6. Project scoping and ranking**

#	Project name	Household electricity impacted #	Household cooking impacted #	Commerce Electrical bill reduction %	Export value KSh pa	County income KSh pa	GHG CO_2 reduction tons pa	Project investment cost KSh	County Cost KSh	Overall County Score
1	Magoya Kojira SHP	450	0	20	0	500,000	10,000,000	4m	100,000	13%
2	Amburr SHP	300	0	60	0	350,000	7,500,000	4m	150,000	7%
3	Ndanu Falls	600	0	40	0	500,000	20,000,000	10m	0	2%
4	Magoya Solar	450	100	15	0	400,000	10,000,000	2 m	50,000	16%
5	Nyamninia solar Site	500	150	25	0	300,000	25,000,000	20m	200,000	10%
6	Barr Anyali Solar Site	300	100	15	0	250,000	15,000,000	20m	200,000	9%
7	Katonde Solar Site	325	75	15	0	200,000	12,500,000	20m	200,000	14%
8	Nambo Beach Wind Site	250	0	0	0	200,000	7,500,000	25m	150,000	9%
9	Wanya Beach Wind Site	250	0	0	0	200,000	7,500,000	25m	150,000	8%
10	Uwembo Jaggery Co-Generation Plant	600	75	5	0	750,000	6,000,000	4m	25,000	5%
11	Sidindi Market Biogas Plant	150	100	10	0	50,000	1,000,000	2.3m	2,300,000	3%
12	Ugunja Market Biogas Plant	150	100	10	0	75,000	4,500,000	1.6m	1,600,000	4%
13										**100%**

3.3.2. Decision making, funding & Implementation

Once completed the project scope and overall ranking matrix as described in the previous chapter, the ranking needs to be presented to the County Governments for decision making on which projects to pursue going forward.

Matters that need to be addressed during such meetings include:
- Ensure that representatives fully understand what is being proposed, the benefits and impact on the County
- Clarity about the funding and resource requirements for each project option
- Take the decision and minute which projects will be implemented
- Clearly mandate who will be responsible for driving each project

Based on the decision of the County, a detailed business case for the project should be developed. The following chapter provided all necessary information on how to structure such a business case.

3.3.3. Business Case & Funding

The business case needs to present an overview of the entire project, from the community overview to technical, financial, marketing, competitive and other business aspects, before making compelling financial and other arguments for the raising of development and/or loan funds.

Overriding focus of the business case for a sustainable energy project and venture will be:

- To provide evidence and justification to attract third parties to invest in the venture
- To satisfy the project prerequisites to proceed to give the project full support to move to set up phase
- To bring confidence and accountability into play to obtain all the necessary relevant approvals, licensing and other consents from stakeholder bodies

A business case to achieve the above objectives must contain the following information:

Executive summary
- Recommendations: This will consist of a brief statement with a description of the sustainable energy supply venture with a statement on financing requirements, planned revenue and profit volumes and next steps
- Key business facts particularly about the business opportunity, competitive advantages, mitigation of risks and intended outcomes
- Decision to be taken: Amount of funding and other resources required and timelines for take up
-

Overview matters
- A description of the business drivers: Lack of affordable clean energy or electricity, growing local population and productive enterprise, ability to pay, consumer desire for services that modern energy can provide, and so forth.
- Scope: What the project and energy supply business will focus on with clear delineation of what energies, services and to which customers the business will operate. This section also to include indications of assumed growth of the business with timeline and future revenue forecasts.

Analysis
- Assumptions used in all analysis and planning activities
- A marketing plan showing the products, margins, sales approaches and take up rates
- Financial dimensions of the venture: Essentially the cost structure of the business from a capital and operational nature, sales prices, revenue, margins and volumes. Also, a summary of customer types, income versus affordability levels, diversity of customer types and proportion of productive/commercial customers.
- Cash Flow Statements, reflecting growth and any loan repayments
- Costs versus benefits from both the venture and a customer perspective
- Risks: A full risk analysis with descriptions of measures to mitigate identified risks to the venture

Conclusions with Recommendations and implementation plans

Supporting Annexures (such as financial spread sheet data, customer data etc.)

The business case must be suitable to be submitted to a commercial bank for the raising of loan capital for the sustainable energy project. Ownership, key management and operational personnel must also be identified and fully described in the business plan document. Investors look not only at the market potential, the technical and financial numbers but more particularly at the quality of the people who will be involved to make the venture a commercial success.

3.4. Implementation

Moving to the next stage

Before embarking on the actual project agreements and fund raising, there is a need by all major implementation stakeholders, especially the community and local entrepreneurs to sign off on the business plan and commit to mutual responsibilities for implementation and on-going operation. Possibly political and technical approvals if required, such as licences to operate may need to be obtained before funders will take decisions. In this case, approvals and sign offs should be obtained from the relevant authorising body such as the local energy regulator, any technical approvals for equipment to be used as being according to local technical standards authorities, and so forth. Once funding bodies have approved the business case and other necessary approvals are obtained the project can progress to the next stage in its formation. However before obtaining all the necessary approvals to move to the implementation stage, there will probably be a number of iterations, negotiations, amendments and refinements to the terms and conditions to be applied to funding. Appropriate documentation, legally binding letters of obligation, financial accounts and other customary commercial arrangements will need to be put in place.

3.4.1. Performance Management Checklist

Sustainable Energy Project Checklist – is everything in place?

The following checklist presents the critical matters to be verified and confirmed to qualify for a sustainable energy project 'go' decision and the receipt of necessary financial investment by stakeholders. It is intended that County Government complete such due diligence on potential projects so that the risks of county sustainable energy project failures will be greatly reduced.

TABLE 7 | **Sustainable energy planning: Checklist**

	Point	Description
1.	Socioeconomic development and size	Socioeconomic impact scores and project size. Clearly projects that will have a substantive impact from a socioeconomic perspective need to be selected.
2.	Correct sources of commercial funding	A minimum level of entrepreneurial or local community commercial funding for capital requirements for the proposed renewable project. Agreement with all stakeholders that the venture will be established and operated on commercial terms and operating conditions
3.	Clarity of vision and goals	Ensure clarity of vision and goals. These to include matters such as renewable energy venture ownership, achieving specified implementation timelines and costs, proper staff training and employment terms and conditions, plant maintenance service agreements with suppliers, trained technical support staff, customer service levels, revenue collection standards and the systematic achievement of realistic performance targets.
4.	Credible Energy venture entrepreneur or champion	Credible Energy venture entrepreneur or champion. In almost all ventures success or failure depends largely on the person who initiates, develops and then leads the business. Passion, relevant skills, integrity and legitimacy with all stakeholders are typical pre-requisites that define such individuals.
5.	Competitive tenders & guarantees	All procurement performed with open competitive tenders against defined specifications, levels of equipment and manpower performance and guarantees.
6.	Stakeholders sign off	Stakeholders, actors, roles, obligations and benefits must be fully identified and specified.
7.	Substantive commercial market proven	Substantive commercial market demand identified and demonstrated. Such energy demand from productive commercial activities in local communities must always provide the bedrock on which to build commercially sustainable off-grid energy ventures. In this way, their future success is greater while also driving to meet the other primary objective of creating new economic activities and livelihoods.
8.	Ability to pay and affordability checked	Ability to pay and affordability of energy venture products and services for the designated customer categories. It is vital that details are described and validated as to how payment for energy and other services provided by the energy venture will be made by customers.
9.	Tariffs & revenue collection	There must be an acceptable tariff structure and revenue collection system including metering where appropriate.
10.	Supply evaluated and accepted	All choices of energy sources, energy production and supply technologies must be properly evaluated and assessed in terms of costs, technical durability, operational reliability and suitability for purpose and the environment where they will be operating.
11.	Fuel source availability	Renewable energy resources must be known to be available, quantified and where necessary, supply contracted. All sources of energy such as sun light hours, seasonal wind sources, biomass materials, local river flows for mini hydro and all other sources such as vegetable oils must be thoroughly researched and where necessary annual supply contracts put in place.
12.	Availability and potential to contract suppliers	Appropriate suppliers must be sourced and specified. Only quality contractors and suppliers should be employed. References, appropriate accreditations and their track record must be validated. Formal legal supply agreements with all the strategic suppliers (i.e. those on which the energy venture depends to continue the business properly) must be negotiated with appropriate performance guarantees and redress for failure to deliver or perform.
13.	Commercially robust contracts Plant guarantees and compliance	Appropriate contractual arrangements especially with plant and equipment suppliers to ensure that maintenance and spare parts commitments are fully honoured. Appropriate standards for equipment, training and other resources provided to the off-grid energy venture. These also to include proper guarantees and full compliance with local and International Standards and Safety Rules.
14.	Marketing plan prepared	Marketing, business and revenue acquisition plan. Identify the market gaps, introduce products and services in a manner that customers would want them and establish the demand. Product and services must meet expressed needs of the local consumers. All necessary provisions must be planned and made to market, sell, grow the local market, charge affordable tariffs, collect revenue and provide excellent customer service. Any customer financial or other incentives must also be specified and the costs included in the financial business plan.
15.	Financial plan prepared	A detailed financial plan plus adequate revenue measurement, supplier payment and audit systems must be established. Part of this plan must also embrace provisions for the repayment of any loans or funding used to establish the energy venture. Capital and ownership arrangements must also need to be described.
16.	Growth built into the plans	Cater to changes that particularly demand growth. The demand for energy will grow and change over time so provision must be made to accommodate these changes. There may also be external factors impacting the energy venture that must also be provided for. An important possible external development may be the arrival of grid power and the best ways to integrate the energy venture with this.
17.	Completed business case	Business case (and operational plan and blueprint). The business case is the first major initiative necessary for the creation of a sustainable energy venture. It must contain all the financial, technical, market, manpower, entrepreneur and management team critical information and energy venture business model to enable an investor to assess the potential viability and commercial success of the venture. It is used to raise the necessary funding and capital to set up the energy venture. Acceptable economics must be demonstrated to all stakeholders and customers.
18.	Operational plan prepared	Operational plan and blueprint. The operational plan must contain as subsets, a range of firm specifications including the marketing, revenue collection, customer service, staffing, technical, maintenance, staff training and development, performance management methods and the management team with all key roles and responsibilities specified. This plan must cater to the necessary reinvestment, technical maintenance and provide a number of goals and targets to be achieved within stipulated timescales such as a year, five years and ten years.
19.	Legislative checks completed	Favourable political, regulatory and political framework. It is vital that relevant legislation and regulations that may apply to the energy venture are fully understood and adhered to.
20.	Sustainable management review system agreed	Adequate management systems must be specified and enacted. There is a need for progress reviews, performance against benchmarks, proper record and feedback mechanisms. Systems must be in place and carried out that enable swift responses to the day to day operational requirements of the sustainable energy venture.

3.4.2 Performance management & monitoring /verification

Having a plan is one thing, implementation is everything! Here the County Government need to ensure the signed off County sustainable energy plan is being implemented successfully. In this regard, it is recommended that a progress matrix be maintained and regularly presented to the management.

Important mile stones that need to be manged include:

1) Project name and responsible person
2) A measure of development completion, all the activities prior to first household delivery or beginning of construction work in the case of say, a hydro plant.
3) An indication that all major contracts are signed, funders, suppliers, receivers etc.
4) Expected project launch date – always a time for media and celebration
5) Implementation completion – the progress of implementation as a percent
6) Expected project completion date – when everything is expected to be signed off
7) Once operational a tacking of the GHG Co2 savings
8) Reporting perhaps on the other benefits from the project, hectares of trees saved, and additional income to the County etc.

TABLE 8 | **Siaya County Project Ranking Matrix**

#	Project name	Responsible person	Project development % complete	Contracts signed Y/N	Launch date	% completion	Expected completion date	GHG CO2 tons pa	Other benefits
1	Magoya Kojira SHP	C.O.-Energy	90%	Yes	Unknown	40%	Unknown	10,000,000	NB
2	Amburr SHP	C.O.-Energy	25%	No	Unknown	0%	Unknown	7,500,000	NB
3	Ndanu Falls	C.O.-Energy	60%	Yes	Unknown	5%	Unknown	20,000,000	NB
4	Magoya Solar	C.O.-Energy	40%	No	Unknown	0%	Unknown	10,000,000	NB
5	Nyamninia solar Site	C.O.-Energy	25%	No	Unknown	0%	Unknown	25,000,000	NB
6	Barr Anyali Solar Site	C.O.-Energy	25%	No	Unknown	0%	Unknown	15,000,000	NB
7	Katonde Solar Site	C.O.-Energy	40%	No	Unknown	0.50%	Unknown	12,500,000	NB
8	Nambo Beach Wind Site	C.O.-Energy	15%	No	Unknown	0%	Unknown	7,500,000	NB
9	Wanya Beach Wind Site	C.O.-Energy	15%	No	Unknown	0%	Unknown	7,500,000	NB
10	Uwembo Jaggery Co-Generation Plant	C.O.-Energy	15%	No	Unknown	0%	Unknown	6,000,000	NB

The following section contains more details on how to manage a specific project which is important for projects that the County implements themselves.

3.4.2. Sustainable Energy Projects Management

It is important to have a suitable performance management system established throughout the sustainable energy project from day one. Every person working on the project must have clear terms of engagement and work outputs fully defined. When the renewable energy production and supply entity is established, all employees should have a letter of employment, terms of employment and a clear and understandable set of responsibilities and deliverables. These administrative arrangements will form the backbone of any performance management system that can then be arranged on a hierarchical basis up through the organization structure from ordinary staff member, supervisor and then manager and ultimately coordinated at the management team and CEO level.

There will be two aspects to arrange. Firstly, the performance management system in terms of how things will be measured recorded and reported. Who will do it, how often will it be done and so forth. Will it be done clerically on pieces of paper or will there be a computer system that everyone works with? The second and other aspect is what precisely will be measured, what type of progress will be monitored and how exactly will such measurements be expressed and recorded. Will there be absolute figures such as number of new customers within a defined time period or quantity of electricity supplied to a certain range of customers? Alternatively, it may not be an absolute figure, but a percentage of a target that has been set for a particular activity such as customer satisfaction benchmark measures. Whatever the precise measurements may be, they need to be fit for purpose and not overly complicated. They must also be verifiable and where ever possible open to independent verification.

This Monitoring and Verification (M&V) System will be a matter that most funding bodies will show particular interest in since such a system provides them with the assurance of regular and reliable performance reports. Good financial governance and fiduciary accountabilities of funding bodies usually insist on such robust monitoring and reporting systems.

The purpose of a performance management system is to monitor the whole business on its journey across time for the achievement of previously planned outcomes. It becomes the eyes and ears of the management team so they can see precisely where they are going, which parts of the project or sustainable energy business are operating as intended, where difficulties may be arising and where remedial attention may be required. Without such a system, it is rather similar to attempting to drive a vehicle with one's eyes closed. The result will be a disaster.

Alongside and associated with the performance management system will be the need for a business planning activity performed periodically by the project or sustainable energy venture management team. This activity will look into the future, the next 12 months and over the next five years. Based on previous experience and various well validated assumptions, a range of predictions will be made as to where the business can be (or indeed will need to be to meet expectations of investors) in terms of revenue, cost structures, profit levels and what will need to support these matters such as a growing number and type of customer, the sale of specific tariffs, the control of supply costs and so forth. Once these matters have been clarified it will be possible to set some targets and objectives for the various critical elements of the business. These should be sensibly set and readily attainable thereby providing a motivational goal for staff to aim for.

Shown below, is an example of a typical performance management matrix for an off-grid energy systems venture supply business.

Performance Management system
A performance management system must be simple, readily understood and owned by those involved, directly linked to the critical areas of performance of the business and inexpensive and reliable in operation. There are now available many inexpensive computer software packages to handle small business performance management.

The essential features of such a system are:

1) Defined and shared critical performance indicator's (KPI's) for each of the key business functions or departments. For marketing and sales KPI's might include number of new customers per month and total accumulated customers, whereas for the finance department KPI's will be related to expenditure against budgets, revenue against budget and bad debts.
2) A system of reliable performance and KPI data gathering and a single person mandated and held responsible for regularly (at least every month) reporting the information to management and staff.
3) Monthly concise KPI reports deployed by the CEO, management and staff to ensure that the whole business stays on track to success and aim for the achievement of pre-planned and agreed performance targets and objectives.

Linking performance to remuneration
In some instances, performance management systems and the results reported over 6 and 12 monthly periods whether positive or negative are linked to managers and staff remuneration terms and conditions. At the beginning of each period delivery targets may be negotiated with managers and staff of the various departments. When such targets are exceeded, then additional incentive payments or bonuses may be paid to those responsible. The levels of annual salary increase may also be linked to the performance management results. These aspects of some performance management systems are part of the terms and conditions of employment and will usually be managed by the human resources function. They are not mandatory for core performance management systems, however that should be in place irrespective of staff management and motivational practices.

Variance management
Effective performance management systems will cover the whole business and will enable all managers and staff to regularly monitor and know their performance and contribution to the overall success (or failure) of the business. It is important that managers and staff know what they are aiming at, in terms of level of performance and what needs to be delivered and achieved within defined time periods. For this purpose, previously negotiated and agreed goals and targets need to be set. Deviations (variances) should be identified and enable management and staff to promptly identify where performance problems are occurring and then deploy appropriate remedial measures. This is to ensure that the business remains on course and is successful in achieving its targets together with obligations to customers, investors and staff. So, a good performance management system also acts as an early warning system of problems arising in the business and acts as the 'eyes and ears' of the business management team working with the CEO.

To be effective, all performance management systems must have the full trust and ownership of the management and staff alike. Without an effective performance management system, it is impossible to steer, manage, control, motivate and operate a commercial business in a prudent, safe or successful manner.

In terms of an off-grid energy supply business, there are two particular areas of performance that must be properly monitored and performance managed. They are as follows:

Energy Balance:
An energy balance is a technique for tracking energy flows from what is put into a particular energy system, what happens to it as it flows through the business process and then ending where the energy is either lost through wastage or how it is consumed. For an off-grid energy supply business the electricity put into the business will be recorded at the bulk wholesale supply meter. The business will pay the 'plug in' generation service provider for this bulk electricity. What will be of critical importance to ensure the prudent management of the business will be a monitoring system that will enable all of this energy to be accounted for.

In basic terms the bulk electricity that is fed into a mini network distribution system must tally with three probable areas of use or consumption, namely:

- Combined consumption of all customers and types of customer groups. This will be in all likelihood the total metered electricity supply to all commercial, local institutional (schools, clinics etc.), household and miscellaneous customer groups. The cumulative total of all customers meter and/or prepayment purchase records for a defined period, this consumption should account for an absolute minimum of 90 per cent of the electricity being recorded and billed through the bulk meter.
- Technical losses through the mini electricity distribution network. These should not exceed 4 per cent.
- Incorrect billing or faulty metering equipment. These must be promptly eradicated
- Theft or fraud frequently referred to as non-technical losses.

Non-technical losses
This is a sensitive aspect of any mini grid electricity supply business. Theft of electricity can often account for large volumes of unaccounted for energy 'send out'. Appropriate anti-theft administrative and other routines need to be in place and vigilantly monitored. Sub agents handling pre-paid electricity vending must also be regularly audited to ensure there is no fraud or theft of revenue from within the metering and revenue collection operation.

Non-technical electricity losses can rapidly escalate and over time and could cost any small business highly detrimental financial losses. In view of these possible risk areas involved with non-technical losses it will be important to put in place effective loss performance monitoring and management systems.

3.5. Growing the renewable clean energy business and fiduciary responsibility

Two primary and important responsibilities of most commercial ventures, particularly in the first few years of operation, are to systematically grow the business in terms of presence in the market and number of customers; and, fiduciary responsibility. The management team and the CEO will have a fiduciary responsibility in terms of growing the revenues of the business, controlling costs, prudently managing the financial resources of the business and ensuring that there is legitimate and diligent control of expenditures. Part of the fiduciary responsibilities will be the preparation of a set of transparent and comprehensive annual accounts that have been independently audited by an external professional firm of audit accountants.

Collaboration – Customers, community & stakeholders

In getting a new business venture such as a renewable clean energy supply business properly functional within a community involves time and energy by the management team by collaborating with staff, customers, local community members and forums and the major stakeholders such as funders, major suppliers and socio-economic development agencies. The key need here will be to gradually and systematically harmonize and embed the business in the local area and human community. The staff of the business will need to act as listening ambassadors for the business and the management team must properly gather feedback. The CEO and members of the management team must be actively involved in local chambers of commerce, educational trusts and community forums. Every opportunity will need to be taken to open an on-going dialogue with local people, customers and suppliers and thereby harmonize the business with the needs of customers and stakeholders.

Learning and applying practical lessons

By operating a listening culture from the CEO and management team throughout the whole business and then externally invaluable feedback will arise. The external perceptions of customers and stakeholders of the business and its performance will arise. Any problem areas will promptly emerge and focus areas for the management team to improve and refine the efficiently of the business operation will become apparent for action.

There is a vital adage to be remembered when wishing to succeed in business. A person's perception is his or her reality. So, it will be important to continually learn about everyone's perceptions of the business, the quality of its products, services and staff as it moves forward on its journey. Keeping such perceptions positive is one of the key methods of securing the long term commercial sustainability of the business.

Refining and improving the business operation

Gathering feedback from external players and staff about the day to day operation of the business it will be necessary within the first 18 months of operation for the management team to revisit and focus time on every one of the key operational processes of the business. Such processes will include the bulk metering and purchase of bulk energy, the tariffs, sales process for new customers, connection administration, meter installation, revenue management and so forth. The aims, in simple terms of such an exercise will be to check whether each process is operating as originally designed, and; are there ways in which the process could be improved.

Consistency of the operation

The major watchword for the whole of the new venture in the first few months of operation will be consistency. Energy supply must always be seen as being safe, affordable, consistent and reliable in the hands of competent professional people. Sudden changes in availability, supply interruptions, urgent price rises or other activities or knee jerk management decisions will quickly breed a lack of trust among customers. When considering energy supply, particularly electricity, one of the very important yet rarely defined requirements for successful supply companies is the matter of mutual trust between supplier and customers. Imperil this through mismanagement, lack of proper business planning or poor communication and it will be extremely hard to regain the trust.

TABLE 9 | **Stakeholders and associated business obligations**

Stakeholders	Associated business obligations
Customers	· Safe delivery of modern energy services as per the agreed product offer · Effective usage measurement and fair time billing · Customer service response from information, assistance through to dealing with system faults
Local community	· Socio-economic improvements through the provision of modern and clean energy, especially electricity · Employment of staff from the community · Retention of profits and income within the community · Improved local energy supply infrastructure · Attraction of inward investment for new business creation
Investors	· Repayment of loans on time · Payment of interest and any premiums on loans · Effective stewardship of any grant or other soft funding · Achievement of lenders other reasons for loaning money such as socioeconomic development, political gains in the community, meeting aid body development goals, meeting environmental protection goals, etc.
Staff	· To have a secure and meaningful economic livelihood · To be treated fairly and honourably · Be provided with career building opportunity · Receive appropriate training for the position and opportunities for further studies/accreditations · Suitably rewarded
Local and national government	· Delivery of modern energy, especially electricity to constituents · Socioeconomic improvement associated with the arrival of electricity, especially for productive uses · Political objectives and to retain power · To secure overseas development funding
Regulation institutions	· Adherence to electricity regulation requirements · Meeting all safety regulations · Fiduciary responsibilities such as tax payment and audit accounts
Development agencies	· Socio economic development and the eradication of energy poverty · Use of sustainable energy · Progress towards universal modern energy access and achievement of other development goals such as improved health, education, economic mobility, gender equality etc.

Another way of dealing with business responsibility is to appreciate all the receivers and stakeholders together with what their associated needs or requirements will be.

3.6. Critical success factors

The manual presented different sustainable energy technologies, and planning strategies for rural sustainable energy projects, as described in the previous three planning phases. Different tables for information gathering as well as checklists and critical success factors are also provided in the past chapters.

In order to identify, plan and implement successful sustainable energy projects, some critical success factors are summarized in the following.

FIGURE 15 | **Critical success factors**

1) **Design and Strategy:**
   - Use a proven or reliable design
   - A medium term strategy ought to be in place
   - Site specific factors must be considered
   - Ensure that there is a favourable legislative, political, regulatory framework in place
   - Ensure that there is a system of project review, including provision of feedback and suitable record keeping has been established.

   Mid/Long term Strategy:
   - Ensure that the programme has built into it the ability to cater for future changes in demand (particularly growth and integration with grid electrification).
   - Ensure that there are mechanisms to disseminate and publicize the programme and its results.

2) **Economics and Finance:**
   - Check that the investment has acceptable economics.
   - If an appropriate finance package can be put together.

3) **Market Structure and Development:**
   - Ensure that there is provision for a market support structure.
   - Establish that the target market actually exists.
   - Ensure that a chain exists (i.e. ensure that all the necessary actors from fuel suppliers to financial intermediaries to end user exist).

4) **Customer Relationship and Service:**
   - The focus on customer's needs and that they are fully involved in the product and project design and implementation cannot be over emphasized.
   - That there is a realistic and acceptable tariff structure (i.e. costs can be recovered).
   - Do not give free gifts.

With the necessary knowledge of energy planning at a local level the fundamental re-thinking on energy can start, this will contribute to the aim of helping the poorest and contribute to a sustainable future with human betterment.

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