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

List of Figures, Tables, and Pictures

FIGURES

TABLES

PICTURES

Acknowledgements

This training manual was prepared by Paul Harris, Energy Planning Trainer, as reference material for the Decentralized Energy Planning training as an activity of the GEF project in Kenya under the guidance and substantive inputs of Jossy Thomas, Industrial Development Officer, UNIDO. Special thanks to Jayaraj Manepalli for Editing the manuscript, Kolade Esan and Chidi Aghaizu for ensuring the quality of the manual.

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).

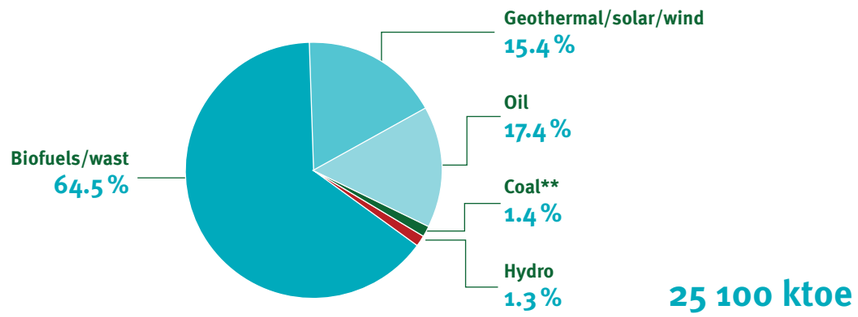
What is Sustainable Energy?

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.

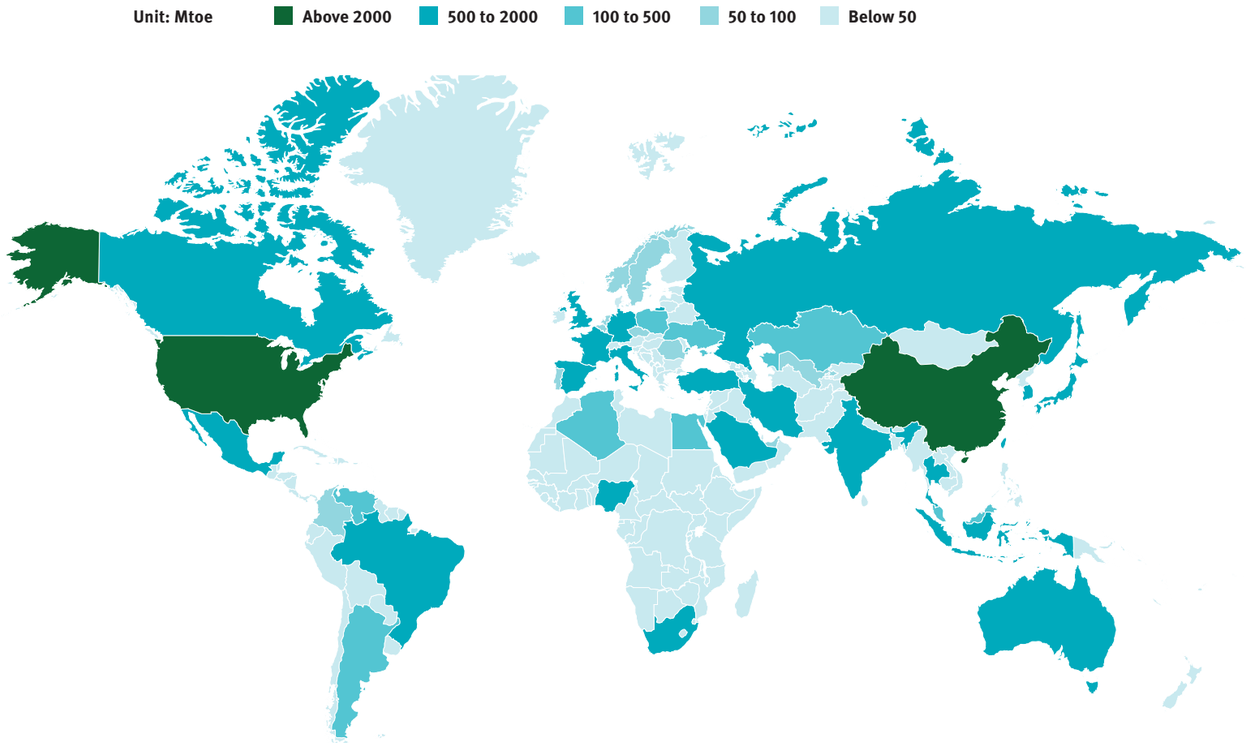
United Nations Industrial Development Organization (UNIDO), in cooperation with the Ministry of Energy and Petroleum, Ministry of Industry Investment and Trade, the Ministry of Environment and Natural Resources and Jomo Kenyatta University of Agriculture and Technology, developed a training programme 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**



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.

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. These technologies can also make indirect contributions to alleviating poverty by providing energy for productive uses.