KITUI COUNTY ENERGY PLAN

Summary version




EDM ENERGY DELIVERY MODELS

iied

CAFOD Catholic Agency for Overseas Development

THE COUNTY GOVERNMENT OF KITUI
Rasilimali Zetu, Maisha Bora

Caritas KITUI

July, 2021

Foreword

In meeting our county mission of providing effective services and an enabling environment for inclusive and sustainable socio-economic development and improved livelihoods for all, energy is set to play an important role in achieving our county development blue print namely, Health and Sanitation, Food and water security, Women and Youth empowerment and wealth creation. The County Government of Kitui has fully taken the mandate for planning and developing energy initiatives as stipulated in the 4th Schedule of the Constitution of Kenya 2010.

As a county government, we aim to provide affordable and sustainable energy alternatives to all households. It is our goal to provide an enabling environment for all residents so that everyone is accorded similar opportunities to economic growth and environmental sustainability.

Our energy plan is in line with the county's policies, Kenya Vision 2030 framework, Constitution of Kenya, the Energy Act 2019 and the National Energy Policy 2018. Once implemented, the plans will go a long way in meeting the UN sustainable Development Goals and Contribute to the National agenda on Sustainable Energy for All.

This County Energy Plan provides a picture of the current county energy gaps and recommends solutions, both energy and non-energy components in the following sector; Household lighting, Water, Health, Agriculture, Livestock, SMSEs, and clean cooking.

It further provides for recommendations for priority investments based on the solutions developed, explains the rationale for the prioritisation and suggests criteria for finalize the list of priority investments.

Lastly it highlights steps to move from planning to demonstration and implementation of the solutions and priority investments.

We aim to work with all stakeholders in order to promote equitable access to reliable and affordable energy within the County while promoting environmental sustainability and bettering the livelihood of its residents.

Hon. Meshack Kyalo Muthusi
Ag. County Executive Committee Member
Ministry of Environment, Tourism and Natural Resources
KITUI

Acknowledgements

The Kitui County Energy Plan (CEP) was developed as a collaboration between the Ministry of Environment, Natural Resources (MENR), CARITAS Kitui, the Catholic Agency for Overseas Development (CAFOD), and the International Institute for Environment and Development (IIED).

The CEP and the detailed solutions developed to meet the priority development needs of citizens in Kitui County are a result of intensive research and analysis, and the project partners are grateful to all stakeholders who gave inputs to the planning process, including community members involved in the needs assessment process. We are grateful to the Ministries of the County Government, the REACH programme, KPLC and by other key stakeholders such as GROOTS Kenya, Kitui Development Centre (KDC) for sharing data used in the solutions development.

The CEP was written by Dr Sarah Wykes and Emmanuel Ngeywo (CAFOD), and Ben Garside, Nipunika Perera and Kevin Johnstone (IIED). Additional research for the sections on renewable energy resource mapping, least cost electrification planning and energy efficiency was provided by Dmitrios Mentis and Benson Kibiti, World Resources Institute (WRI). Further data gathering and analysis for solutions development was provided by staff from CARITAS Kitui, led by Martin Mwendwa, Surabhi Rajagopal, Gustavus Mwambui Muli, the Sahelian Solutions Foundation (SASOL), Linda Wamune, EED Advisory and East Africa Market Development Associates (EAMDA).

The full version of the CEP can be found at: https://kitui.go.ke/countygovt/ministries/ministry-of-environment-and-natural-resources

County Government of Kitui: Fredrick Kimwilu, Director, Enviroment & climate change (fkimwilu@yahoo.co.uk), Benjamin Musili, Director Energy Department (bmmusili@yahoo.com) & Rachel Mwangangi, Assistant Director, Energy Department (kalumuhm@gmail.com) Titus Muvea, Electrical Engineer (kyalotitus@gmail.com), Nicodemus Mwanzia, Electrical Engineer(nimwabe@gmail.com), Faith Moki ,Renewable energy officer (fakamo.jo@gmail.com)

CARITAS Kitui: Florence Ndeti, Director, (fndeti@caritaskitui.org or florendetti@gmail.com) & Martin Mwendwa, Project officer (mwinzimartin@gmail.com)

CAFOD: Dr Sarah Wykes (s.wykes@lboro.ac.uk) & Emmanuel Ngeywo (encyoy@gmail.com)

IIED: Ben Garside (ben.garside@iied.org), Nipunika Perera (nipunika.perera@iied.org) & Kevin Johnstone (kevin.johnstone@iied.org)

Introduction

The Kitui County Energy Plan (CEP) analyses the context for energy planning in Kitui County and proposes financially, socially and environmentally sustainable solutions, including both energy and non-energy supporting interventions, to meet the priority development needs identified by Kitui County citizens and the County Government's development objectives. This summary outlines the main points of the CEP but does not include the full analysis contained in the master CEP, including the detailed components and costs for proposed solutions. Readers interested in the full contextual analysis, planning methodology and the detailed solutions should refer to the master CEP.

This summary outlines the policy context for county energy planning and progress towards SDG7 in Kenya, along with the development context for energy planning in Kitui County. The methodology used to develop the County Energy Plan, the Energy Delivery Models (EDM) approach is explained and presents the holistic solutions developed to meet the seven priority needs identified through the planning process, which include energy and non-energy supporting services to ensure sustainability and maximize development impact, along with options for least cost electrification. Recommendations for next steps and priority investments to move to implementation are presented for each set of sectoral solutions.

The policy context for county energy planning

The governance of energy planning at national and county level is articulated in four key frameworks: the Kenyan Constitution (Republic of Kenya, 2010), which outlines the roles of the national and county governments in energy planning; the County Government Act 2012 (Republic of Kenya, 2012) which provides for county government powers, functions and responsibilities to deliver services; the National Energy Policy 2018 (Republic of Kenya, 2018b), which outlines policies and strategies for energy sector; and, finally, the Energy Act 2019 (Republic of Kenya, 2019b). This mandates the 47 County Governments to develop County Energy Plans (CEPs) as inputs to development of an integrated national energy plan.

The Government of Kenya (GoK) has identified energy as one of the key enablers of the economic pillar of its Vision 2030 development blueprint. Policies and strategies guiding the energy sector in Kenya are set out under the National Energy Policy of 2018 (Republic of Kenya, 2018b), whose overall aim is to provide "affordable quality energy for all Kenyans".

Kenya was an early adopter of the precursor Sustainable Energy for All (SEforALL) initiative and has three ambitious national targets for meeting Sustainable Development Goal (SDG) 7 on ensuring access to reliable, affordable, sustainable, and modern energy for all by 2030. The targets are universal access to electricity by 2022,[1] and to clean cooking fuels and technologies by 2028;[2] improving the annual energy intensity rate by -2.785% by 2030; and increasing the share of renewable energy (RE) in the national energy mix to 80% by 2030.

Kenya's National Electrification Strategy (KNES) (Republic of Kenya, 2018d) acknowledges the key role of distributed renewable (DRE) solutions (such as mini grids, and stand-alone solar home systems) along with centralised grid extension and densification in delivering universal electricity access. The GoK has also put in place enabling reforms to promote energy efficiency and conservation measures.

[1] The baseline year for access to electricity for Kenya is 2012.
[2] The baseline year for access to clean cooking solution is 2013

Progress on reaching SDG 7

According to the *Tracking SDG7: Energy progress report (*IEA et al., 2020), Kenya has made significant progress towards achievement of its SDG 7 targets but there remain around 13 million people without electricity access.

The GoK, including working in collaboration with other international energy actors, have targeted energy access through various initiatives, mostly aimed at electricity access. For a full list, see SEforALL et al. (2020). This includes the Kenya Off-grid Solar Access Project (KOSAP) initiative aimed at providing access to modern energy (electricity and clean cooking) to 14 marginalized and underserved counties.[3]

However, end user uptake and the sustainability of RE interventions in Kenya's counties remain low. One reason for this is that promoters of new energy technologies tend to focus on the supply side and there is little attention paid to demand-side issues such as the affordability of products and services by last-mile consumers The market challenges are compounded by weak institutional and policy frameworks and the approaches taken towards energy access planning.

Recent research has highlighted several specific policy gaps in terms of ensuring that planning and delivery of energy services are appropriate to meet the country's ambitious energy access targets (SEforALL et al., 2020).

Kitui County: the development context for energy planning

Kitui is the sixth largest county in Kenya and is divided into eight sub-counties (KNBS, 2019). The population is just over one million according to KNBS (2019), with 48% in employment, just above the national average. Although the county is not classified as having high levels of extreme poverty, it has concentrations of extreme poor populations (KNBS, 2019). It has an arid and semi-arid climate (SEAF-K, 2017). The main economic activities include agriculture (crop and livestock farming), tourism, and trade and industries like cotton ginnery, fruit processing and maize milling.

The County's development objectives are captured in the County Integrated Development Plan (CIDP) of 2018-22 (County Government of Kitui, 2018a). Critical gaps to meeting the goals identified in the CIDP include: "[t]he low resource base, harsh climatic conditions, infrastructure gaps, high levels of poverty, and low access to social economic services such as education, health, water and sanitation, and energy" (p. 58).

The Ministry of Environment and Natural Resources ((MENR) has the responsibility for energy provision in the county. Its mission is 'to improve the livelihoods of Kitui people through the provision of varied and reliable sources of affordable energy and increased levels of minerals investments in a sustainably managed environment'. The CIDP also recognises that energy access is an enabler of progress in many development sectors (County Government of Kitui, 2018a). The solutions developed through the CEP process are aligned with delivering the County Government's energy and sectoral development priorities (County Government of Kitui, 2018a, pp. 83-158).

[3] See: https://projects.worldbank.org/en/projects-operations/project-detail/P160009.

Current energy usage in Kitui County

According to the 2019 Kenya Population and Housing Census (KNBS, 2019), almost half (44%) of households in the county employ solar powered technologies as their primary source of lighting, followed by paraffin-based solutions (23.7%). Less than a fifth (17.1%) use grid electricity. For cooking, the vast majority (81.3%) of households reported using firewood as their main fuel type for cooking, followed by around ten percent of households using charcoal. Only a very small proportion of households (use clean cooking fuels and technologies. There is a lack of disaggregated data on household energy consumption and its drivers.

Given that 90% of Kitui households use firewood and charcoal for cooking purposes, the biomass energy supply potential for Kitui County versus the demand for firewood and charcoal exerts considerable pressure on forest and vegetation stocks and accelerates the processes of land degradation and desertification. In 2018, Kitui County Government effected a ban on charcoal production and transport within county borders, aimed at addressing the degradation of forests in Kitui (County Government of Kitui, 2018b).

Energy resource potential

According to County Government of Kitui (2018a), solar energy has the highest potential in Kitui (p. 53). According to the Global Solar Atlas, the solar potential in Kitui is significant, particularly in the north of the county. Geospatial analysis also shows that 33% of the land area in Kitui has the potential for wind power generation.

Kitui County has coal deposits in the Mui basin estimated to be more than 400 million tonnes of reserves for which several licenses have been awarded (Oguge, 2017). Coal mining is associated with serious negative environmental and social impacts and research has highlighted the potential consequences of developing the Mui Basin resource (Oguge, 2017). The 2018-2022 CIDP recognises the need for greater community sensitization and participation in mining sector projects and for development of a county policy on mining/ compensation and resettlement (County Government of Kitui, 2018a, p. 52).

Energy efficiency

There are many potential barriers and constraints to improving energy efficiency (EE) in the county including lack of disaggregated data or poor quality of existing data on energy consumption in different sectors, a lack of awareness/information and technical knowledge on energy efficiency among staff in different line ministries, public institutions and the general public, and the lack of availability/affordability of energy efficient appliances and equipment.

One priority action would be for the County Government to undertake an 'energy efficiency policy audit' to identify any gaps in the current enabling policies for improving energy efficiency/conservation across public and private sectors in the County.

There are also clear opportunities to promote energy efficiency in most of the sectoral solutions developed to meet the priority development needs in this CEP. For instance, appropriate consideration should be given to the most energy efficient solutions for electricity systems and lighting equipment at the level of both individual households and public health facilities. In the business sector, there is the opportunity to link MSMEs to existing initiatives to access more efficient appliances and to enhance linkages with efficient appliance suppliers.

The CEP planning methodology

The CEP was developed using an inclusive and integrated planning methodology called the *Energy Delivery Models* (EDM) approach (Garside & Wykes, 2017). The rationale for using the EDM approach is that current energy planning approaches are mostly top-down, energy infrastructure-focussed and pay little attention to identifying the wider development needs that energy services should enable and their potential impacts on end users' lives and livelihoods. Understanding local context, including socio-cultural factors, and how these might enable or impede service delivery is also central to the methodology. Lack of consideration of end-user demand and the local context for service delivery has often resulted in failed or sub-optimal service performance (Brown et al., 2015).

Approaching energy as an enabler of wider development needs and including end users and stakeholders in service planning can result in more appropriate and acceptable solutions. Scalability can be achieved through aggregation or clustering solutions or components. Several tools, including geospatial mapping tools, have been used to quantify this. In turn, effective needs-based energy planning requires cross-sectoral awareness of energy as an enabler and coordination of planning across development sectors.

To date, only a small number of CEPs have been developed in Kenya, the majority with minimal cross-sectoral and end user/stakeholder participation.[4] In most CEPs, energy services are not approached as enablers of county government development objectives and county planners exhibit a range of technical capacity gaps. Addressing these gaps requires ongoing institutional capacity building, together with horizontal and vertical, peer-to-peer learning and knowledge sharing.

The Energy Delivery Models (EDM) approach

CAFOD and IIED began developing the Energy Delivery Models (EDM) approach in 2013. It was tested at the community level in Indonesia and has since been used in designing and reviewing solutions in several countries in Africa and Asia.

EDM starts by target group or end-users identifying their priority development needs and the energy and non-energy "gaps" or barriers to meeting these, including lack of supporting services (eg access to finance), the enabling environment (policies, regulations and so on) but also socio-cultural factors (gender/power relationships or specific behaviours and practices).

Initial solutions or delivery models are developed and then optimised through further, iterative analysis, with risks identified and mitigated. The final products are financially, socially and environmentally sustainable solutions that can be moved quickly to implementation. Scalability can be achieved by identifying synergies between solutions or solution components and mapping delivery and co-financing partners.

The EDM Toolkit (Garside and Wykes, 2017) summarises the experience of piloting the EDM into a six-step inclusive planning process with supporting tools, including the *Delivery Model Map* and *Delivery Model Canvas* adapted from the Osterwalder Business Canvas (Osterwalder & Pigneur, 2010). This approach has been further adapted for use at the more macro-level of Kitui County, which has more than one million inhabitants, while retaining its main features.

[4] Project team internal review of CEPs, 2019-21.

Application of the EDM approach to county level planning

The application of the EDM to county planning involves a two-stage approach (for more detail see Garside and Perera, 2020).

Stage One takes place at the **government and sectoral level**. Energy services and non-energy supporting interventions are designed to produce holistic solutions within and across development sectors at the county-level, based on an extensive, county-wide needs assessment process targeted a sample of community members and other stakeholders (see Table 1 below for the seven priority needs identified for Kitui County). Further extensive research and analysis to understand the needs and develop solutions was undertaken, including value-chain analysis, market mapping, developing business models and mapping linkages to potential delivery partners, existing initiatives and co-financing opportunities.

Priority needs- findings from the ground		
Ranking	Need	Wards
1	Improved farmer income from rain-fed crops	7/8
2	Access to clean water in closer proximity for drinking and washing	6/8
3	Better access to health services in remote areas	4/8
4	Improved productivity and income from livestock (poultry, goat keeping, cattle and dairy farming)	3/8
4	Better quality lighting for cooking and working at night (W), general purpose, learning, security	3/8
4	More reliable electricity & supporting services for existing SMEs	3/8
4	Cleaner, cheaper & faster cooking fuels & methods to reduce health impacts, costs, time and drudgery, and allow more time for relaxations	3/8

Table 1: Ranking of priority development needs in Kitui County

These solutions are presented in the County Energy Plan to support evidence-based investment decisions by the County Government.

Stage two takes place at the **initiative and project level**. Priority investments identified in the CEP are mapped onto specific groups of end users and locations and optimised for those locations, working with potential delivery partners, to move solutions to demonstration and implementation.

Figure One summarises the EDM Steps included in the two-stage county planning process in Kitui.

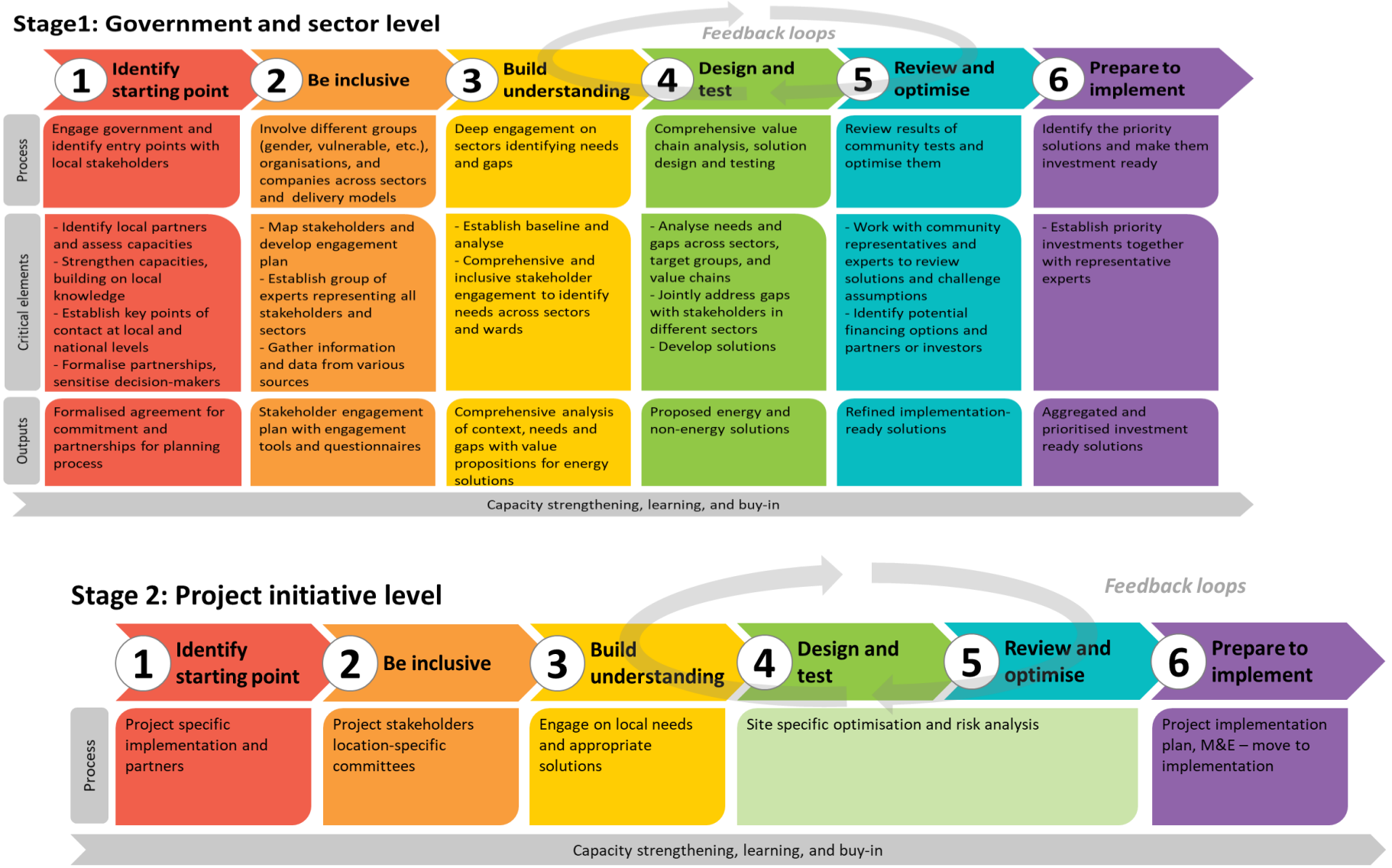

Figure 1: The EDM steps applied to county energy planning

Source: Garside & Perera (2021), adapted from Garside & Wykes (2017)

Solutions developed by the CEP process

Seven sets of solutions were developed, along with least cost electrification (LCE) options, to meet the priority needs of Kitui's citizens as identified during the needs assessment process:

1. **Lighting:** better quality, reliable household lighting for general purpose use
2. **Health:** improved provision of health services through level two (dispensary) and level three (health centres) facilities for communities in remote and poorly served areas
3. **Water:** improved access to clean, affordable, and reliable water for drinking and general-purpose needs in households
4. **Agriculture**: improved income for smallholder farmers from irrigated and rainfed crops
5. **Livestock:** improved yield and productivity of small-scale livestock (poultry and dairy) farmers across Kitui County
6. **Micro, Small and Medium Enterprises (MSMEs)**: improved business capacities to deliver quality products and services for communities in remote and poorly served areas, and increased revenue of existing MSMEs
7. **Cooking**: improved access to cleaner, faster, reliable, and more affordable fuels and technologies for cooking for households in Kitui.

The solutions aim to meet the needs in different locations in the county. Least cost electrification (LCE) modelling was also undertaken and should be considered in conjunction with the solutions in making final, priority investment decisions. In all the solutions, consideration was given to potential delivery partners and co-financiers and types of financing support available. Further mapping of these partners will be required before moving to the solutions demonstration and implementation phases (see below).

Further capacity building is also recommended so that planners can implement effective and transparent planning and investment decision-making. Having clear, transparent, and evidence-based investment decision-making criteria and approaches should make it more likely that Kitui County can access financing through national or international financing mechanisms and programmes.

Least cost electrification (LCE) options for Kitui County

The LCE solution aims to provide power to deliver universal electricity access in Kitui and meet the priority need of better-quality lighting for households for general purposes. The modelling was carried out using the GIS-based electrification tool OnSSET, combining geospatial data, socio-economic parameters (eg population, HH size), and techno-economic inputs related to the cost of off-grid technologies and of grid operation and extension to develop the optimal LCE mix. Given the lack of recent data on grid-based electricity access, the percentage of households that use electricity as their main type of fuel (KNBS, 2019) was used for the modelling.

The LCE options are aimed to deliver a *range of access scenarios* in Kitui County, building on the emerging consensus that to be meaningful any definition of energy access must capture its multi-dimensional characteristics and impacts (e.g. affordability, reliability, safety etc.). For this reason, the LCE modelling uses the different tiers of household electricity access developed under the Multi-Tier Framework for Measuring Energy Access (MTF) (Bhatia & Angelou, 2015). This identifies key characteristics or factors affecting the end user's

experience of energy services to define tiers of access ranging from Tier 0 (no access) to Tier 5 (full access).

LCE options for Kitui county to reach Kenya's national target of universal electricity access by 2022 were calculated for six scenarios delivering different levels of access: for urban areas, this was aimed at Tier four. For rural settlements, tiers one to three of access were explored, with two potential solar home systems (SHSs) identified corresponding to the lower and upper end of each tier (system 1 & system 2). The two systems provide an indication of the spread of cost and energy service variations available in the SHS market in Kenya.

Figure two summarises the analysis, which shows that standalone SHSs are the dominant least cost option for new connections in the county. As the consumption levels increase (ie from Tier 1 to Tier 3 SHSs in rural areas), SHSs increase their share further. This is due to the much lower capital costs (USD/kW) compared to the per kW costs for a grid connection or a mini grid.

To reach full electrification in Kitui County, investment costs range between approximately 200 million USD for the lowest access scenario (Tier 1- System 1) and 400 million USD for the highest scenario (Tier 3: System 2). This includes the capital costs for generation, transmission, and distribution infrastructure, as well as for all off-grid systems (SHSs and mini grid technologies).

The LCE modelling identifies several scenarios to help with investment planning by identifying which type of technology is most suitable for the location. The modelling, however, does not select the scenario or locations prioritised: this is a political decision, requiring clear and transparent decision-making criteria. However, given that mini grids are a potential solution for five of the six scenarios presented, MENR and KPLC should conduct pre-feasibility studies to identify potential sites for mini grids. This should consider high energy consumers such as (MSMEs), institutional consumers such as health facilities and populations living within proximity. These feasibility studies should also determine end-user affordability and set appropriate tariffs.

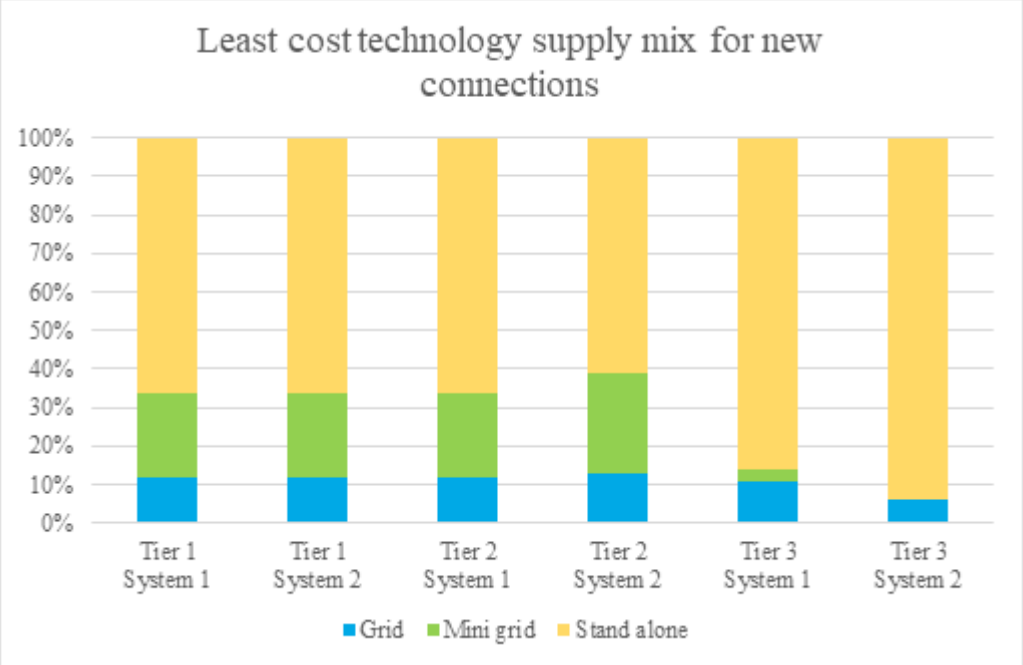

Figure 2: Least-cost technology supply mix for new connections in Kitui County

Summary of Solutions to meet Kitui's priority needs

Solution 1: Household Lighting - better quality, reliable lighting for households

Gaps or barriers identified

- Lack of grid in remote areas; unaffordability of connection and wiring costs in grid areas
- Low reliability of the grid due to infrastructure breakdown and power rationing
- Little access to off-grid SHSs and poor operation due to limited availability of local suppliers, technicians and supporting services
- Unaffordability of off-grid solar systems, generators, and fuel as well as for maintenance
- Lack of enabling policies and financing options for off-grid systems and more efficient appliances
- Low knowledge/awareness of off-grid lighting options and benefits in terms of quality

Energy components

- **Reliable access to better quality, affordable electricity and strong maintenance provisions through a combination of grid and off-grid (mini grid & SHSs) solutions:**
    1. **Option 1**: Grid connection for households not connected to the grid living within 600m from a grid transformer[5]
    2. **Option 2**: Mini grids (solar): For remote households without access to the grid, living in areas that are unlikely to have the grid extended by 2022.
    3. **Option 3**: Solar Home Systems (SHSs) for remote households without access to the grid in areas unlikely to get grid extension by 2022 or not economically and technically feasible for mini grids. Also, an option for households currently facing significant reliability issues. For SHSs, the solution includes different options based on tier of service (Tiers 1, 2 and 3 of TTF)

Non-energy components

1. **Access to affordable finance options** for all household energy options, including connection costs and off-grid systems through (a) MFIs and SACCOs (b) Existing PAYG enterprises (c) Govt subsidized financing options through low interest loan programmes
2. **Community awareness programmes** on energy solutions, supplier options, quality, and costs.

5 Based on criteria used for the last mile connectivity project

Solution 2: Water - improved access to clean, affordable, and reliable water for drinking and general-purpose needs in households

Gaps or barriers identified

- Reliability: lack of reliable and affordable electricity for water pumping
- Functionality: high number of non/partially functioning water points (due to poor design and/or maintenance, of repair services)
- Management: weak governance and operation of Water Management Committees (WMCs)
- Data issues: lack of data on community water demand, and ground and surface water availability
- Water quality: impurities in water supply due to increasing salinity, low surface and ground water levels and lack of treatment facilities
- Awareness: lack of community and wider stakeholder awareness on sustainable use of water points and availability of water resources

Energy components

1. **Replacing non/ partially functional diesel/petrol generators and manually driven water points**: either with SHS or grid-based with solar back-up pumping systems
2. **Repair of non/partially functioning** solar or electric water pumps
3. **Building new water points with solar or electric with solar back-up**: for areas with water supply gaps
4. **Establishing effective maintenance and repair function** for electricity systems, including increasing local technical capacity, remote monitoring functions and technology standardisation.

Non-energy components

1. **Exploring options for water purification: i**mproving county-wide water treatment and reducing water salinity
2. **Improving governance and effectiveness of Water Management Committees (WMCs)**
3. **Increasing awareness** within communities, public and government agencies on need for sustainable water use and management
4. **Improving county level capacity for data collection and analysis** on water demand, climate risks and water availability to develop sustainable water resource management strategies and investment plans.

Solution 3: Health - Improved provision of health services through level 2 (dispensary) and level 3 (health centres) facilities for communities in remote and poorly served areas

Gaps and barriers identified

- Electricity: lack of reliable electricity service and mandated appliances in facilities
- Supporting services: lack of access to medical equipment and supplies; lack of access to clean water; lack of skilled staff required for effective delivery of priority basic health services

Energy components

1. **Provision of reliable electricity service including back-up systems** for meeting electricity needs to deliver health services required of Level 2 and 3 health facilities. Based on the health facility level, the distance from and reliability of grid, there are four solution options (specified and costed based on the assumptions and description below). Further analysis will be needed to identify how many of each solution and overall costs:

    a) **Grid connection:** for all facilities within 600m of the grid.
    b) **Solar or battery back-up for grid connected facilities:** for all facilities currently grid-connected or where Option 1 is implemented and reliability is poor.
    c) **SHS or battery powered back up for facilities with unreliable grid access (minimum of 95% availability):** this is to ensure continuity of health services and essential 24-hour appliances such as vaccine refrigerators. Over the long term, this is a more cost-effective and environmentally sustainable than using diesel-powered systems as a back-up.
    d) **Standalone SHS for Level Two health facilities:** for facilities beyond 600m from the grid. The system capacity is calculated at 4kW peak demand and 5kWh daily energy demand
    a. **Standalone SHS for Level Three health facilities:** for facilities beyond 600m from the grid. This is calculated at 4kW peak demand and 10kWh daily energy demand

2. **Maintenance and repair service for all electricity systems** installed plus support to build wider technical capacity for ongoing operation and maintenance of electricity systems ensuring long-term sustainability
3. **Provision of appropriate electric appliances** to deliver health services required of Level 2 and 3 health facilities

Non-energy supporting services

1. **Improved access to clean water**
2. **Improved provision of medical equipment and supplies** (including medicines and vaccines)
3. **Increased staff retention** through access to training and improved welfare and conditions

Solution 4: Agriculture - Improved income for smallholder farmers from irrigated and rain fed crops

Two options are proposed: one for irrigated (4a) and one for rain-fed agriculture (4b). Only 4a has energy components. The non-energy components are similar for 4a and 4b. It is assumed that some of the farmers who practice irrigation agriculture also do rain fed farming

Solution 4a: Improved income of smallholder farmers from high-value crops on farms with reliable access to water through improved irrigation and better market linkages

Gaps and barriers identified:

- Electricity: lack of access to affordable and reliable electricity to run irrigation equipment
- Equipment: lack of access to and knowledge of reliable irrigation equipment.
- Finance: lack of finance for irrigation equipment and agricultural inputs
- Good Agricultural Practices (GAP): lack of knowledge of irrigation farming techniques, especially for new crops & preference for flood irrigation, even where water is scarce
- Socio-cultural: reluctance to work together for collective marketing (aggregation), to continue to carry out GAP (after training), and to share equipment at farm level.
- Security issues for equipment left on the farm
- Market linkages: lack of access to market information and inability to link with more reliable buyers

Energy components

1. **Provision of reliable electricity and appliances for irrigation systems:** including adapting to site specific conditions and adequate equipment security measures. Four options are proposed:
    a. **Standalone solar powered system for drip irrigation**: for many farms where grid connectivity will not be possible in the near future or where only occasional mobility of equipment is needed. The most environmentally friendly option.
    b. **Standalone petrol generator system for drip irrigation**: Higher carbon footprint. Lower entry capital expenditure cost but higher operating costs
    c. **Standalone petrol generator system for furrow-based irrigation**: the cheapest option with a portable pump for ease of moving between locations. However, it has significantly higher water consumption. Pump operating costs are higher but overall opex is lower than other options.
    d. Grid connected system for drip-based irrigation: for locations with grid access and suitability for fixed location pumping is fine. Opex costs lower than (b) but higher than (c) when considering overall maintenance of system.

2. **Maintenance and repair service for irrigation systems** combined with support for wider technical capacity building for ongoing operation and maintenance of systems.

Non-energy components

1. **Improved access to recommended agricultural inputs** (seeds, fertiliser and pesticides)
2. **Good Agricultural Practice (GAP)** for farmers: irrigation techniques for a variety of horticultural crops; addressing socio-cultural barriers in farmer practices & preferences.
3. **Improving knowledge on markets** and supporting farmer linkages.
4. **Improving farmer knowledge and access to inclusive financing options** for maintaining and expanding business.

Solution 5: Livestock - Improved yield and productivity of small-scale livestock (poultry and dairy) farmers

Gaps and barriers identified

- Electricity: lack of affordable and reliable power for operating appliances with potential to increase livestock production
- Appliances: lack of access to good quality appliances to improve livestock management, increase yield and diversify produce/products
- Inputs: lack of access to affordable inputs (eg water, drugs, vaccines, feed, nutrients etc.)
- Veterinary care: lack of access to timely veterinary care services for disease control and vaccination; high costs of drugs and vaccines
- Extension services: Lack of livestock extension officers for training and supporting farmers
- Market links: Lack of access to market information and links to reliable buyers

Energy components

1. **Provision of reliable electricity, including back-up systems for incubators**: the target group is small-scale poultry (indigenous chicken) farmers, and hatcheries (formed as farmers' groups registered as cooperatives). Primary appliances and energy needs for lighting (daylight mimicry), electric egg incubation and heat for brooding. Farmers need customised solutions f depending on the flock size, but the following four solutions are proposed for independent farmers, cooperatives/ SMEs or more commercial hatcheries:

    a. **Stand-alone solar for independent off-grid farmers:** to power an incubator for 100 eggs and manage a flock size of 50 birds.
    b. **Back-up for grid connected independent farmers** facing power shortages for eight hours. Incubator capacity and flock size as in Option (a).
    c. **Stand-alone solar for hatchery for poorer farmers** who cannot afford independent incubators can bring their eggs for a low price. Capacity of 300 eggs.
    d. **Back-up for grid connected poultry cooperatives**: as a hatchery for poorer farmers who cannot afford independent incubators.

2. **Provision of reliable electricity for local feed production**: to power chaffcutters for small-scale dairy and meat farmers (cattle and goats). This solution does not present a specific business model but improving feed processing/preparation through use of chaffcutter to enhance feed consumption can lead to dairy and meal yield improvements.
3. **Maintenance and repair service** for all energy systems and appliances.

Non-energy components

1. **Improved access to clean water** for livestock farmers
2. **Improved veterinary service provision** in local veterinary offices
3. **Improved farmer knowledge and skills** on livestock management strategies, inputs, business skills, and ensuing women and youth participation in such interventions
4. **Improved knowledge on markets** and supporting farmers link with reliable and fair market channels
5. **Improved farmer knowledge and access to inclusive financing options** for maintaining business and expanding business.

Solution 6: Micro, Small and Medium Enterprises (MSMEs) - Improved business capacities to deliver quality products and services for communities in remote and poorly served areas, and increased revenue of existing MSMEs

Gaps and barriers identified

- Electricity: lack of reliable electricity services for both on-grid and off-grid MSMEs and limited access to efficient appliances/equipment
- Skills and knowledge: lack of supporting services including enterprise linkages along value chains, business management and financial skills and enterprise financing.

These solutions aim for more reliable access to electricity then a programme of capacity building for technical and business skills including linkages of different actors along the value chains, followed by mentoring, specifically for MSMEs in rural areas, to maximise their impact and sustainability.

Energy components

1. **Strengthen energy access**: through (a) affordable solutions for targeted MSMEs; (b) lobbying and engaging KPLC on (prioritisation of) MSME needs; (c) extending the distribution channel for quality off-grid energy systems and ultra-high efficiency appliances.

Non-energy supporting services

1. **Comprehensive MSME training programme** for (a) better linkages and networking along the value chains, between businesses, and to customers; (b) basic business skills and finance training and mentorship for real world skills application; (c) 'Champions' network to demonstrate and showcase new skills and equipment

Solution 7: Cooking - Improved access to cleaner, faster, reliable, and more affordable fuels and technologies for cooking for households in Kitui

Gaps and barriers identified

- Lack of access to cleaner fuels and technologies, especially in remote unserved communities.
- Lack of qualified technicians for installation, repair and maintenance services for different cooking technologies in rural areas.
- Deep-rooted cultural cooking practices which impede adoption and usage of alternative cleaner cooking fuels and technologies
- Lack of awareness on negative impacts of continued use of traditional cooking solutions on community health, finances, and the natural environment and on benefits of clean cooking solutions.

The solutions need to target different sets of end users and actors in the cooking value chain. Currently there is insufficient and disaggregated data on the drivers of cooking technology and fuel usage among different user groups in Kitui County, particularly the socio-cultural, behavioural factors. The solutions proposed are general, based on the current data and further data gathering and analysis is a critical next step to develop these into detailed solutions targeting specific end user groups.

Energy components

- **Adoption/ongoing use of cook stoves** for households in categories I & II above and are unlikely to change to other cleaner fuels in the foreseeable future
- **Adopt/ongoing use of clean fuels and cooking appliances** for households in category II& III currently purchasing fuels
- **Build technical capacity of local artisans** to manufacture quality cook stoves and provide standardized installation of cooking appliances.
- **Train local artisans/technician** to provide repair and maintenance support services for different cooking appliances (e.g. solar cookers, biogas systems and electric cookers).

Non-energy components

- Raise awareness of the negative impacts of continued use of traditional fuels and appliances and the benefits of using clean cooking solutions
- Build business skills of cookstove artisans/dealers
- Establish effective distribution/supply channels for clean cooking solutions
- Undertake further research to understand the socio-cultural practices preventing/enabling the uptake of clean cooking fuels and technologies in Kitui to inform development of targeted and sustainable solutions

Synergies between solutions

The CEP also presents synergies across solutions or solution components and sectors to facilitate resource allocations by the various sectoral ministries, potential delivery partners and co-financiers to maximize the development impact of the energy services across sectors, enable cost-effective delivery and avoid project duplication. Identifying synergies can also support aggregation of solution components and scaling. Further analysis and discussion with cross-sectoral stakeholders will be required in the demonstration and implementation planning phases for detailed understanding of the synergies between solution components and any potential trade-offs, and for testing.

Examples of synergies identified include:

Across most of the solutions, namely **lighting, water, health, agriculture, MSMEs, livestock and irrigated agriculture**, there is a need for improved operation, repair and maintenance supporting services for energy infrastructure, particularly off-grid systems such as SHSs and stand-alone, customised systems. This requires increased numbers of local technicians with the appropriate skills to install, maintain and repair off-grid energy systems. Training existing KPLC electricians plus technicians and staff at healthcare facilities to carry out basic SHS maintenance could help deliver this supporting service plus eveloping additional, targeted and high-quality training courses at Vocational and Technical Centres (VCTs).

- In terms of the non-energy components of different solutions, there are synergies between the MSME capacity building programme proposed in Solution 6 and the multiple income generation components of most solutions, including in the livestock and agriculture sectors. Farmers require business skills training to build and manage their businesses, and to access finance and markets for their products. This includes synergies with improving the business skills of energy repair and maintenance businesses required for most solutions (one model here is Fundifix[6]), for example through mentoring, basic entrepreneurship training, links to business financing etc.

Priority Investments

The CEP suggests priority investments for the various sectoral solutions based on the priority needs, current solutions developed, the available data, and the stage of planning for each solution. In most solutions, additional data gathering, and analysis is needed to identify the final list of priority investments and develop implementation plans. A critical next step is feedback from the Technical Committee and further discussion with the relevant sectoral ministries and wider stakeholders who will lead solution implementation. Solutions will also need to be reviewed considering any changes in context due to the COVID-19 pandemic.

The following are critical for decision-making on priority investments across all the sectoral solutions.

- Clear linkages between the selected investments and county development objectives and programming – both the current CIDP and planning for the next CIDP (2023-2028)
- Identification of target groups/ locations where the priority investments can maximise development impact and meet community needs while ensuring equitable distribution of interventions and inclusion of marginal and vulnerable groups.
- Identification of potential suppliers, delivery partners and (co)funding for the priority investments
- Identification of co-financiers and cross-sectoral and energy programmes and funds (secured or planned).

Indicative Priority Investments

Household lighting/least cost electrification
Desired impact: better quality, reliable household lighting to ensure cooking, lighting, educational and general-purpose activities can be carried out more safely and effectively.

[6] https://fundifix.co.ke/service/.

Type of investment and rationale

The prioritisation is to target un-electrified households (HH) via different types of infrastructure depending on their proximity to the existing grid infrastructure. Three categories of HH have been identified. The level of access (T1-3) for these groups needs to be determined before the mix of solutions and the costs of investment can be calculated

a. HHs within 600 meters from existing grid transformers not connected to the main grid - grid connection.
b. HHs living in remote areas beyond 15KM from existing grid transformers, no current plans for grid extension before year 2022 - solar mini grid.
c. HH living in remote areas with no access to grid electricity, no plans to extend the grid to these areas and no economic and technical rationale for the installation of a mini grid - SHS.

1. Water sector

   Desired impact: improved access to clean, affordable, and reliable water for drinking and general-purpose needs in households.

Type of investment and rationale

Electrification (SHS and/or grid) and equipping of non-functional and non-hybridised water points with high demand. Data from a water audit conducted under the global REACH programme (Nyaga, 2019) shows that there are around 380 non-functional water points in the County.

2. Health sector

Desired impact: improved provision of health services through level two (dispensaries) and level three (health centres) facilities for communities in remote and poorly served areas.

Type of investment and rationale

Electrification of currently non-electrified facilities. From the available data, only three Level Three and Level Two facilities are un-electrified, with a coverage across all sub-counties. Prioritization should be based on which facilities support the largest number of patients and remoteness from other health facilities. Funding for non-energy supporting services should also be prioritized to optimize the solution's benefits and ensure its sustainability.

3. Agricultural sector

   Desired impact: improved income of smallholder farmers from high-value crops on farms with reliable access to water through improved irrigation and better market linkages.

Type of investment and rationale

Demonstration project for high-value horticulture using powered irrigation targeting a small number of farmers to build their learning and confidence, develop sustainable business models, and create an enabling environment working with government and delivery partners for future scale-up.

Kitui has an existing network of sand dams which capture river water during rainy seasons with potential for irrigation. Analysis shows farmland covering around 61,400 Ha (614 km2 or 152,000 acres) – around 4% of total farmland – is located a reasonable distance for

water pumping (less than 300 metres from a permanent river, major river or a sand dam (Nyaga, 2019).

4. Livestock sector
   Desired impact: improved yield and productivity of small-scale livestock (poultry and dairy) farmers across Kitui County

Type of investment and rationale

Demonstration project involving a group of indigenous poultry farmers from each sub-county to use electric appliances (incubators, brooders and lighting), with non-energy supporting services (training on production and market links) to build understanding of the technology, develop sustainable business models and work with government and other delivery partners for future scale-up.

5. Micro, Small and Medium Enterprises (MSMEs) sector
   Desired impact: improved business capacities to deliver quality products and services for communities in remote and poorly served areas, and increased revenue of existing MSMEs.

Type of investment and rationale

Developing and piloting a comprehensive training programme for MSMEs with key enterprise-focused stakeholders and packaging financial products with reputable energy delivery company systems and appliance companies for MSMEs that fit the programme criteria. The target group is enterprises already using energy for their businesses where improvement in their energy use can be identified and supporting improvements to business delivery.

6. Cooking Priority Investment.
   Desired impact: increased adoption and use of clean cooking solutions for households in Kitui County.

Type of investment and rationale

Additional research into cooking practices in Kitui County. High numbers of households in Kitui use traditional cooking solutions (bio-mass and open fires). There is also a significant data gap for understanding the drivers of cooking technology and fuel use, including socio-cultural preferences and practices as well as affordability, and the barriers/enablers to adoption of clean and improved fuels and technologies. Additional research is required to fill data gaps before sustainable solutions can be developed.

From planning to implementation

The CEP process was overseen by a robust Technical Committee (TC) that draws its membership from representatives of sectoral ministries and other key stakeholders.

The TC, working with the Project Team, can now lead engagement with each sectoral ministry to explore the synergies between the proposed solutions and its current pipeline of programmes and projects. It can also explore integrating (components of) different solutions and priority investments into the planning process for the next CIDP (2023-2028). In addition,

the MENR will lead on socialisation of the CEP with a range of stakeholders across the county, including community members and other stakeholders involved in the initial needs assessment.

Implementation of the solutions will be operationalised through the Annual Development Plans (ADPs) as provided for under the Public Finance Management Act. The ADP is a yearly plan derived from the CIDP, allowing for more detailed planning and for any changes required in response to emerging issues in the county. The ADP is supposed to be presented to the County Assembly by the 1st of September each year. This means different sectoral ministries in Kitui, led by MENR, can present the CEP solutions to members of the County Assembly with a view to allocating commensurate budgets to (components of) the proposed solutions in each of the sectors, as well identifying synergies and opportunities for aggregation of solutions (or solution components).

Alignment with existing or future projects and initiatives being undertaken by the national government, other development partners and the private sector for solution implementation or co-financing should also be explored. The Project Team has undertaken an initial mapping of potential delivery partners/co-implementers; potential sources of co-financing in different sectors (focussed on the energy, health, agriculture and livestock sectors) and a further mapping of off-grid energy suppliers. The findings are listed in Annexes to the full CEP.

In addition, there is potential to develop specific financing mechanisms to support solution delivery, address affordability gaps and ensure social inclusion in target groups (for instance to ensure inclusion of poorer farmers in the agriculture and livestock solutions). One example would be a revolving fund managed by the County Government to provide cross-sectoral financing for the capital costs of energy systems or equipment. Further research and analysis will be needed during the demonstration phase to develop the detailed modalities of such financing and payment models.

Reference List

1. Bhatia, M. & Angelou, N. (2015). *Beyond Connections: Energy Access Redefined. ESMAP Technical Report; 008/15*. The World Bank Group. https://openknowledge.worldbank.org/handle/10986/24368.

2. Brown, E., Cloke, J., & Harrison, J. (2015). "Governance, Decentralization and Energy: A Critical Review of the Key Issues". *Renewable Energy and Decentralization (READ) Working Paper 1*. https://repository.lboro.ac.uk/articles/report/Governance_decentralisation_and_energy_a_critical_review_of_the_key_issues/9486782.

3. County Government of Kitui (2018a). *County Integrated Development Plan (CIDP) 2018-2022, Transforming Kitui for Inclusive and Sustainable Development*.

4. County Government of Kitui (2018b). *Gazette No. 936.* January 2018.

5. Garside, B., & Wykes, S. (2017). *Planning pro-poor energy services for maximum impact: the Energy Delivery Model Toolkit*. https://pubs.iied.org/16638iied.

6. IEA, IRENA, UNSD, WBG & WHO (2020). *Tracking SDG 7: The Energy Progress Report 2020*. World Bank, Washington, DC. https://trackingsdg7.esmap.org/.

7. Kenya National Bureau of Statistics (KNBS) (2019). *Kenya Population and Housing Census*. https://www.knbs.or.ke/?p=5621.

8. Oguge, N. O. (2017). *Community Baseline Report on Social and Environmental Impact Mui Coal Basin Mining, Kitui County, Kenya*. [Unpublished Report]. Centre for Advanced Studies in Environmental Law & policy, University of Nairobi and CAFOD.

9. Osterwalder, A. & Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. John Wiley & Sons, Inc.

10. Republic of Kenya (2010). *Constitution of Kenya 2010.* http://kenyalaw.org:8181/exist/kenyalex/actview.xql?actid=Const2010

11. Republic of Kenya (2012). *County Governments Act No. 17*. http://www.parliament.go.ke/sites/default/files/2017-05/CountyGovernmentsAct_No17of2012_1.pdf

12. Republic of Kenya (2018b). Ministry of Energy. *National Energy Policy.* https://kplc.co.ke/img/full/BL4PdOqKtxFT_National%20Energy%20Policy%20October%20%202018.pdf.

13. Republic of Kenya (2018d). Ministry of Energy. *Kenya National Electrification Strategy; Key Highlights.* http://pubdocs.worldbank.org/en/413001554284496731/Kenya-National-Electrification-Strategy-KNES-Key-Highlights-2018.pdf.

14. Republic of Kenya (2018e). Ministry of Energy. *Welcome to KOSAP / KOSAP Facilities.* https://energy.go.ke/?p=8712.

15. Republic of Kenya (2019a). Ministry of Energy. *The Petroleum Act Number 2 of 2019.* http://kenyalaw.org/kl/fileadmin/pdfdownloads/Acts/2019/PetroleumAct_No._2of2019.pdf

16. Republic of Kenya (2019b). Ministry of Energy. *The Energy Act, 2019*. https://kplc.co.ke/img/full/o8wccHsFPaZ3_ENERGY%20ACT%202019.pdf

17. Sustainable Energy Access Forum Kenya (SEAF-K) (2017). *Kitui County Energy Outlook*.

18. Sustainable Energy for All (SEforALL) CAFOD, EED Advisory & ODI (2020). *Energy Safety Nets: Kenya Case Study*. https://www.seforall.org/publications/esn/kenya.