Working *Brief*

SEAF-K

Photo credit by: https://cega.berkeley.edu/

ASSESSMENT OF LAST MILE CONNECTIVITY PROJECT PHASE I

December 2020

By Wycliffe Amakobe and Tom Randa

Summary of the study

Successful electrification of the last mile communities is key towards social and economic inclusivity if appropriately implemented. Most households in the last mile segment are poor hence any program advancing their access to modern energy stives to empower and address aspects of inequality. This study focused on phase I of the last mile connectivity project in Kenya which is implemented in four phases. The study assessed stakeholder roles and extent to which financing model(s) used promoted poor households to get connected to the grid and the extent to which envisaged results were achieved. This involved assessment of households and businesses connected network extension and transformer maximization between 2015 and 2020. The study further highlights two case studies of other countries that had or have similar rural grid electrification challenges

Photo credit: https://cega.berkeley.edu/

Key findings:

- Connecting last mile communities requires substantial government commitment as it heavily relies on subsidies
- A systems approach is key towards making last mile connectivity projects economical and sustainable
- Implementation of LMCP though under progress, has encountered delays contributed by various internal and external factors thereby delaying achievement of envisaged results
- LMCP had a strong vision towards stimulating demand for electricity but along the way this objective was dropped
- Connections were mainly single phase, highly unreliable
- Project design and implementation was largely within KPLC instead of multi-agency
- LMCP did not explore joint approach with private sector to offer credit towards connectivity or adoption of modern lighting, cooking, and productive appliances to steer demand
- Even though peak demand has increased since 2015, percentage of total energy purchased yet not sold due to low demand against supply has increased by over 6 percent since 2015.

Last mile energy landscape

Powering households and businesses among the rural and peri-urban poor is a key step towards universal energy access. Last mile communities are often left out of electricity connectivity processes due to various socio-cultural and economic challenges. There is little demand for energy among the most marginalized customers (Ken et. al, 2015). Thus, their willingness to pay for connectivity is exceptionally low. To realize any increase in their willingness to pay, these potential beneficiaries should be facilitated to access energy first, after which they will be motivated upon continued use. According to IEA (2017), 97 percent of people who have gained access to electricity in the millennium have done so through grid electrification which from a system perspective offers the lowest-cost path to household electrification for areas with sufficient density of electricity demand. However, this turns out to be less favorable compared to decentralized provisions under circumstances of complex terrain, low population density, regulatory and institutional hurdles, or high investment and maintenance costs that may not be recoverable by utilities. High population density reduces overall cost per household thus enabling wider access based on economies of scale in distribution (Jonathan et al, 2020).

Overview of the LMCP in Kenya

The last mile connectivity project (LMCP) came into existence in 2015 with the goal of ensuring increased access to electricity prioritizing low-income households in rural and peri-urban areas. According to AfDB (2014), the project was expected to maximize the use of KPLC's 35,000 distribution transformers spread across the 47 counties. The strategy was designed around extension of low voltage network to reach around 1.2 million people located in the vicinity of these transformers. It purposed to achieve these through construction of distribution network, the installation of equipment for connecting a minimum of 284,200 residential and minimum 30,000 commercial customers in phase I. Implementation was split into four phases financed by several entities as listed in table1, including the Government of Kenya. The Ministry of Energy is the executing agency, Kenya Power and Lighting Company (KPLC) as implementing agency while The National Treasury is the borrower of the loan. The project was launched in 2015 and is expected to end in 2021 since the various phases are implemented concurrently.

This study assessed implementation of phase I with the goal of seeking to understand how various stakeholders were engaged, financing models used, results achieved as of October 2020 and implication of the project within the overall country connectivity endeavors with two case studies. Data used in the assessment was mainly from desk review and key informant sources.

Motivation behind the LMCP

KPLC estimated that at least 472,002 households were within reach of distribution transformers (KPLC,2014). This meant minimized resources would be needed in terms of setting up completely new infrastructure required to serve this population otherwise considered as under the grid. While justifying the business case and projected social impact, KPLC projected a possible connection of approximately 1.2million customers, across the four phases

Stakeholder engagement

Given that LMCP was expected to cover all the 47 counties, project team leveraged on the environmental impact assessments (EIA) that were on-going for upgrading of existing substations and establishment of new ones across the country in 2014/2015 financial year. Consultations were thus narrowed to stakeholders within counties where these EIAs were being undertaken and used as representative sample. According to KPLC (2014) stakeholders consulted included local and central government entities and key ministries at the County level and this was delivered through interviews with key informants. Community views were sought during environmental and social screening phase in January 2014 conducted by KPLC's Department of Safety Health and Environment, whereas further consultations were undertaken by field engineers during project site identification and mapping. They sought views of sector players through the two processes of which most of the issues were reported to have entailed connectivity charges, which were presumed to be high by stakeholders as well as safety issues. The project implementation team constituted mainly from KPLC comprised of a coordinator, site supervision engineers, a procurement expert and a socio economist, an environmental expert and accountant. However, it did not outline the desired composition in terms of multi-stakeholder inclusion although as presented it met optimal multi-disciplinary desire. The second and subsequent phases which involved extension of the power lines and new transformers required wider stakeholder consultations especially in terms of way leaves acquisition procedures. Chiefs played critical role in mapping households, awareness creation through local barazas and enforcing registration for personal identification numbers. Members of Parliament supported the projects largely through community awareness creation and support of material delivery is areas with poor terrain alongside Members of County Assembly.

Stakeholder analysis

Table1 below shows the stakeholders involved in the LMCP.

Segment	Stakeholder	Role
Financiers	African Development Bank	Financing of loan package for phase 1 and phase 2 both totaling to Ksh. 30 billion
	World Bank	Financing to the tune of Ksh. 15 billion across phases
	European Investment Bank	Financing phase 4 jointly to the tune of Ksh. 20 billion
	Agence Française de Développement (AFD)	
	European Union	
Government institutions	KPLC	Implementing Entity of the LMCP
	Ministry of Energy	Executing Entity of the LMCP
	The National Treasury	Borrower of the loan
	NEMA	Review and approval of Environmental Impact Assessment/Audit
	Members of National County Assembly	Mobilizing communities and mapping of vulnerable households
	Chiefs	Local community coordination and wayleaves oversighting
Beneficiaries	Rural households	Expected users to benefit from the connections for household use
	Rural businesses	Expected users to benefit from the connections for businesses

Source: adopted from (AfDB,2014, KPLC 2019, and AfDB,2016)

Approach used

A cost-effective approach was devised whereby options were considered including reduction in the cost burden on KPLC as well as the amount paid by the customer to connect to the grid. According to AfDB (2016) the strategy proposed was to extend the distribution network to as near the customer as possible by dropping cables for those near roads and in proximity to the transformer during phase 1. At least 5320 distribution transformers were considered using principle of equitable distribution formular used by constituency development Fund system in various constituencies. Phase 2 involved extending the low voltage network on existing and other upcoming distribution transformers to reach households lying within the transformer protection distance. Alternative solution of installing solar home systems was found to be expensive. In addition, several other options were considered, such as rural electrification with expansion of the high voltage transmission system and construction of distribution systems. However, these options were rejected mainly because of their extensive investment requirements compared to maximization option.

Results

(i) Connection of domestic consumers

Figure 1: Status of LMCP single phase customers
Data adopted from KPLC (2016) and KPLC (2019)

A total of 201,269 domestic customers were connected to the grid against the target of 235,296 thereby signifying 86 percent achievement in the phase. The remaining portion is underway implementation and was delayed by contractor malperformance in second and fourth lot out of a total of ten lots. The first three bars show variation as final targets approved for implementation were affected by field characteristics and increase in price of materials and equipment

(ii)Annual connections between 2016 and 2020

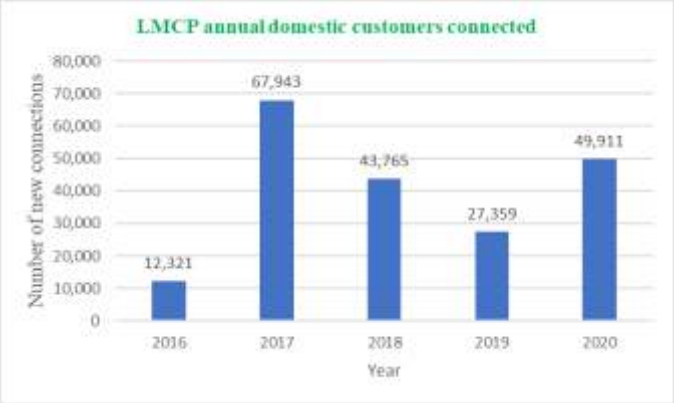


Figure 2: Connection status as of November 2020

Source: Key informant, KPLC

Figure 3 illustrates implementation status across the five years of phase 1, under domestic customers connection target. Procurement procedures delayed implementation in year 1 together with exemption procedures. Some lots experienced challenges due to terrain, regulatory procedures such as way leaves and social dynamics at household level

(iii)Extension of low voltage network

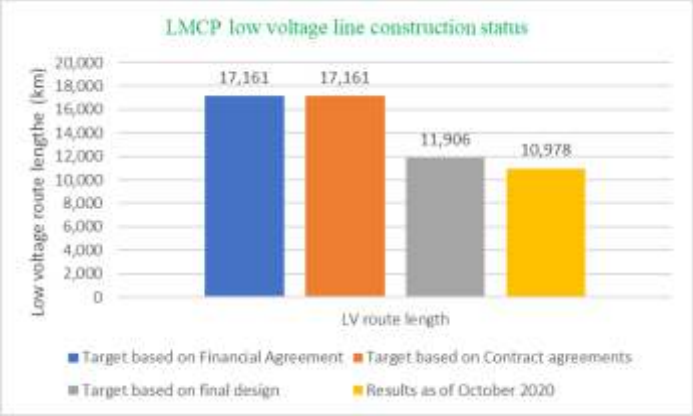


Figure 3: Status of LMCP low voltage network extension

Data adopted from KPLC (2016) and KPLC (2019)

Following contract revision, the new target for low voltage network extension was set at 11,906 which as of October 2020 approximately 92 percent of network length had been extended

(iv) Transformer maximization

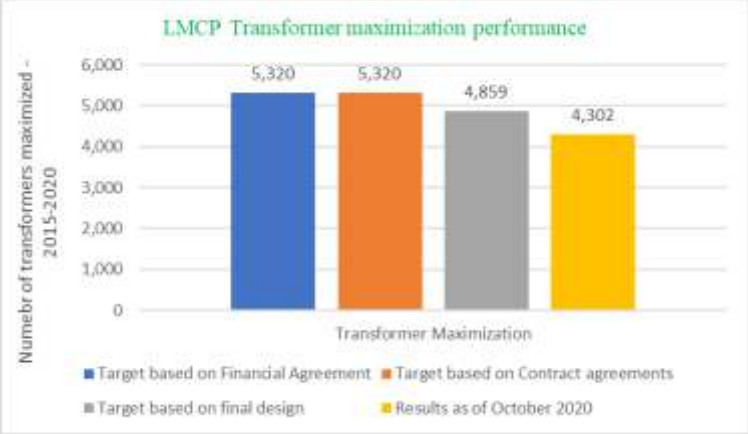


Figure 4: Status of LMCP transformer maximization

Data adopted from KPLC (2016) and KPLC (2019)

Approximately 89 percent of transformer maximization had been achieved by the end of October 2020.

(v) Connection of commercial customers

As of October 2020, three-phase connectivity targeting commercial customers had not been implemented. The decision was dropped, and businesses were anticipated to undertake ordinary commercial approach for connectivity outside LMCP delivery

Figure 5: Status of LMCP commercial customers connectivity

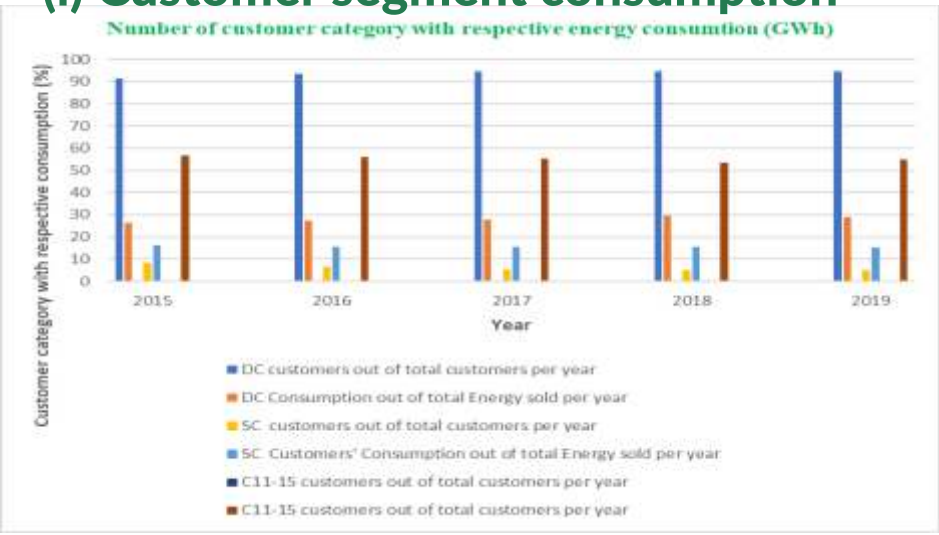
(Data adopted from KPLC (2016) and KPLC (2019))

Financing

Beneficiaries under LMCP were mainly rural and peri-urban dwellers. Since majority are poor, affording upfront connectivity charges would deprive them the chance to get connected. According to Ken et al (2015) poor households are very sensitive to economic shocks and frequently have to adjust consumption patterns to survive while majority working primarily in the informal sector, may have inconsistent and unreliable incomes, making it difficult to commit to a flat rate monthly energy payment. The financing model adopted in the LMCP was based on lessons drawn from a pilot programme implemented two years prior to LMCP kickoff whereby through Stima loan, KPLC advanced households 70% of the connection cost, which would later be refunded to KPLC by the consumer over a period of 2 years (FDA, 2014). Under the LMCP, one of the strategies employed in addressing the burden of high upfront costs was to lower connection fee from Ksh. 35,000 to Ksh. 15,000 (KPLC,2014). This was a subsidized rate since the government offset the rest of the costs. Households unable to pay the Ksh. 15,000 connection fees enjoyed the service on condition that they would service the amount every month approximately Ksh. 417 per month spread over three years in addition to the monthly power consumption expenditure. Key informant from the project reiterated that the loan was recoverable on a 50-50 basis whenever a customer purchased token.

Why is the issue of productive use in rural areas critical?

(i) Customer segment consumption



Since LMCP phase I was implemented through a loan to the government by AfDB, sustainability of connections for poor houses struggling to meet basic daily needs is likely to be under threat. However, establishment of large commercials and industries in rural areas has potential to boost consumption likely to cater for part of the costs incurred by these households under appropriate tariffs and lifeline threshold determination. Figures 8 demonstrate the case for supporting commercial activities alongside any targeted domestic electrification.

Figure 6: Comparison of total customer pool per segment versus annual consumption

Data adopted from KPLC (2016) and KPLC (2019)

(ii) Variation in supply

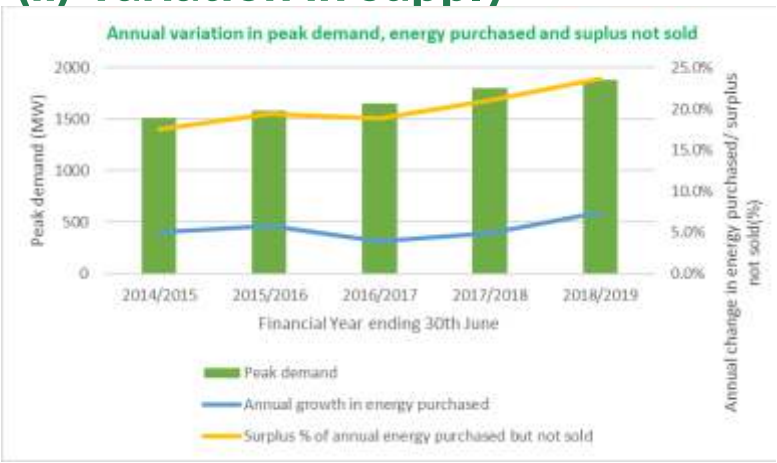


Figure 7: Trend in peak demand, annual growth in supply and surplus not sold by off taker
Data adopted from KPLC (2014) and KPLC (2019)

From figure 7, there was observable increase in the peak demand over the last six years giving a positive indication of increasing utility. However, future electrification strategies need to make the business perspective sustainable for investors pursuant to Energy Act. 2019 that unlocks space for multiple off-takers.

Discussion

There is observable increase in the number of overall connections through 2016-2020 in figure 2 with noticeable decline in 2019. Figure 7 illustrates increase in peak demand from the green bars throughout the period. However, there was a gap in matching supply against demand indicating surplus production across the years. It can be deduced from the line graphs that the annual surplus (yellow line) of purchased energy has been increasing over time, a trend implying saturation.

Together with figure 6, the graph in figure 7 depicts that it is essential to invest in commercial services to keep the consumption higher as illustrated by the reciprocal relationship where domestic customer group (DC) represents over 90 percent of customers connected but comes after large commercial in terms of consumption. The small commercials (SC) too present a case for supporting business activity development in areas where last mile connectivity project is implemented. Availability and reliability of supply of power is critical to stimulation and maintenance of growth and expansion. This is essential especially in manufacturing and agricultural sectors in rural areas alongside health and education. Data presented in figure 6 further supports this whereby large commercial and small commercial represented over 60 percent of total consumption between 2015 and 2019 even though domestic consumers accounted for 95 percent of total number of connected customers.

Figure 8: KPLC staff during one of the technical operations in a city in Rift Valley

High consumption by large commercials industries is essential in tariff design. In 2018 for instance, when Energy and Petroleum Regulatory Authority (EPRA) reviewed domestic customer category tariff by increasing the lifeline threshold from 10kWh to 100kWh in addition to reduction in the charge rates from Ksh. 12/kWh to Ksh. 10/kWh, over 5.7 million customers benefited (ERC,2018). Peak demand during that year was recorded in November, a month during which the reviews took effect. Further, 67 percent of small commercial category witnessed at least 31 present decrease in power bills in 2018/2019 financial year as a result of the adjustments made in November 2018 (EPRA, 2019). This implies that households and small businesses had a chance to expand their businesses through increased hours of operation, additional investment in more machinery due to power bills savings not forgetting household savings that otherwise facilitated access to other basic needs.

Considering the targets set by the Last Mile Connectivity Project for small businesses, the last two bars of figure 5 indicate that these were not achieved as envisaged during planning phase. Through key informant from the project, the government decided to drop the targets which comprised connecting 30,000 small businesses during contract signing. Furthermore, inception packages never demonstrated sufficiently how locals would be facilitated to acquire these given that it is a 3-phase connectivity. Further, capacity building reports seemed to lean more on household connectivity and safety aspects leaving out business development information which would have informed the design phase.

Case studies

Photo courtesy: Yelantsevv/Freepik.com

Tunisia

This case study focuses on Rural electrification in Tunisia between phase (vi)-(ix) undertaken between 1987 to 2000 raising overall rural electrification from 28 percent in 1987 to 88 percent. Coordination between the busines oriented utility operation with regional governments together with substantial state financing and explicit support for rural electrification resulted in key development synergies. Phases (vi) and (ix) were similar to Kenya's LMCP since this is the moment the government of Tunisia decided to seek external financing from AfDB, Kuwait Fund, and French Development Agency (Cecelski et.al ,2005). Strong political will towards electrification saw 21 percent of regional development allocated towards rural electrification. This, together with external financing supported approximately 376,000 rural residents making up to 61.7 percent of the 609,000 rural households connected over this period. Subsidies towards powering agricultural services were availed to enhance maximization of the utility. This includes water pumps and other agricultural productivity commodities (Jonathan et al ,2020). The financing arrangements were such that the beneficiary household contributed US$ 176, Tunisian Electricity and Gas Company US$(176-353) while the State contributed US$1,588 out of which total government financing per connection was approximately eighty-five percent (Cecelski et.al , 2005). However, this payment arrangement turned out to be unaffordable for many rural customers. The project team resolved to spreading the amount through forty months instead of the initial ten months. This was paid in 20 bi-monthly instalments. However, it was later extended to 72 months in 36 bi-monthly payments which was reported to have worked sufficiently reducing arrears. One key lesson learnt from the case study was the decision by the State to integrate rural electrification into rural development programs of the Economic and Social Development Five-year Plans. This allowed for local participation in decision making and understanding of electrification benefits especially on productive opportunities.

Brazil

Brazil has implemented several electrification projects since 1970s. However, the Light for All, 'Luz para Todos' (LpT) program, launched by the Brazilian government in November 2003 with the goal of extending access to electricity to all rural communities in the country was unique, given its focus on rural areas. According to ANEEL (2005) ninety-seven percent of urban population had access to electricity, whereas less than 50 percent of rural population had been electrified by the time LpT came into place. The programme was coordinated by the Ministry of Mines and Energy (MME) through six phases between 2004 – 2018 (Borges et al ,2016). The first phase 2004-2008 under the first social oriented electricity access policy did not require any financial contribution from the beneficiaries. Over 15.6 million people in rural areas had been reached in 2016 with an overall investment of US$ 7 billion (Paula et. al, 2017). LpT agents played a critical role of identifying electricity demand by informing communities about program objectives and benefits while working closely with local leaders. Interesting in the approach was ability of LpT agents to work with communities to identify context specific productive uses of electricity and complementary actions of social inclusion. Gómez and Silveira (2010) affirm that through this approach communities were partially involved in the program's decision-making process, whereas utility companies conducted educational and awareness campaigns about appropriate, efficient, and secure use of electricity. Empirical assessments of the programme conducted by Paula et. al (2017) established that electrification projects are apparently more successful in regions with higher human development indices insinuating that electricity access is more effective when accompanied by, or in addition to, other development relevant policies and measures. Financing arrangements were such that 50 percent of the total costs was met by the federal government, 10 percent by the administration within States, and fifteen percent by distribution companies. The remaining twenty-five percent was financed by soft credit lines (Carlos, 2016). Despite the achievements, there are people still lacking access to electricity. This is partly due to terrain with hard to access areas due to presence of large rivers and dense forests. Part of the population living in those areas are sparse, therefore, supplying electricity to these isolated communities is a challenge for the program.

Challenges encountered by LMCP

- Delayed acceptance by some households who do not consider electricity as a priority
- The requirement for customers to obtain KRA pin certificates delayed the processes as majority of rural population lack this
- Emergence of new homes in the proximity of the network who had not been included in the survey
- In most cases such customers were asked to pay extra amount and ended up feeling segregated
- Poor terrain in rural areas makes navigation difficult leading to increase in network costs
- Poor terrain was also associated with delayed execution
- Adverse weather such as flooding destroyed some of the newly established networks
- Election period slowed down activities especially given that 2017 was characterized by uniqueness electoral characterization
- Low consumption implies longer periods of loan recovery
- It was not possible to witness significant value of the loan revolving fund due to low consumption
- Some customer s are nomadic hence the system stay idle for several months before consumption resumes
- Prices of some electrical equipment and materials doubled during implementation given that it took 3 years for majority of the lots to procure products and services since inception.
- Initial Government policy on logging which affected supply of wooden poles. Low capacity of local supply of wooden poles.
- Delay in exemptions certificate and clearance certificate.
- Customer's lack of required documents for contracting such as wiring certificates which is a statutory requirement.
- Delays in execution of works as way leaves clearances were being sought especially where a customer is already on supply.
- Non-performance of contractors due to lack of adequate cash flow and poor project planning.
- Delays due to emergence of COVID-19 pandemic that led to nationwide travel and local movement restrictions.

Recommendations

- Strong leadership including national and county governments should be established with a vision of social welfare and economic development with energy access as a catalytic enabler.
- This has the potential to provide affordable rates to poor households and sufficient income for the service provider as well as funding for the investment subsidy
- Electrification projects should adopt a value chain approach which can spur local economic opportunities both directly through those employed in enterprises and indirectly through increased activity for suppliers and markets, and greatly increase energy consumption
- Electrification projects should include social - economic and environmental parameters in planning and design including gender considerations, education level of targeted households and income.
- Political aspects in electricity expansion should include County government leadership in decision making and financing for electrification programmes in the country
- Counties can play a critical role in leveraging state subsidies by offering loan guarantees and concessions for productive utilities at domestic and commercial levels
- County governments can play an essential role in subsidizing household wiring costs or providing guarantee in cases where connections stall due to unpreparedness of households who fail to carryout wiring by certified electricians due to costs related thereto. Although KPLCs' intervention to enhance connectivity in such cases through single board unit have proved useful, this has remained limited to only one lighting bulb in the entire house. This means additional rooms such as kitchen have been left to use kerosine and other unsustainable fuels.
- Electrification project coordinators should engage local actors such as civil society organizations and private sector in sensitization activities since most of them interact with communities on regular basis
- Awareness creation entailing sensitization on benefits of electricity can stimulate demand among unconnected customers who feel electricity is a tertiary need
- Capacity building that targets key decision makers at County government level should be prioritized to prioritize household support in areas where national government is implementing electrification projects

Reference

- AfDB (2014). Last mile connectivity project appraisal report. Abijan. Cote de Vour. https://www.afdb.org/sites/all/libraries/pdf.js/web/viewer.html?file=https%3A%2F%2Fwww.afdb.org%2Fsites%2Fdefault%2Ffiles%2Fdocuments%2Fprojects-and-operations%2Fkenya_last_mile_connectivity_project_-_project_appraisal_report.pdf#page=1&zoom=auto,-14,849

- AfDB (2016). Last mile connectivity project II appraisal report. Abijan. Cote de Vour. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/Kenya__AR-_Last_Mile_Connectivity_Project_II.PDF

- ANEEL. (2005). Atlas de Energia Elétrica 2nd edn (Brasilia: Agência Nacional de Energia Elétrica)EMM. Brazil.
  Borges, P., Portugal-Pereira, J., Koberle, A., Lucena, P., Szklo, A. & Schaeffer, R. (2016). Policy case study: evaluation of the Brazilian electrification program: Luz para Todos (Light for All Program). Brazil.
  Callos, S. (2016). Brazil Energy Sector, Light for All. EMM. Brazil
  .https://www.unece.org/fileadmin/DAM/ceci/documents/2016/PPP/Forum_PPP-SDGs/Presentations/Case_17_Brazil__Energy_Sector__Carlos_Salle.pdf

- Cecelski, E., Ounalli, M,. & Dunkerley, J. (2005). Rural Electrification in Tunisia: National Commitment, Efficient Implementation and Sound Finances. Washington, DC: World Bank.
  EPRA (2019). Energy and Petroleum Statistics Report 2019. Nairobi. Kenya.
  https://www.epra.go.ke/wp-content/uploads/2020/09/Energy-and-Petroleum-Statistics-Report-2019-1.pdf

- ERC. (2018). Press statement on the reviewed electricity tariffs for the 2018-2019 tariff control period. Nairobi. Kenya.
  https://www.epra.go.ke/press-statement-on-the-reviewed-electricity-tariffs-for-the-2018-2019-tariff-control-period/

- Gómez, F. & Silveira S. (2010). Rural electrification of the Brazilian Amazon—achievements and lessons Energy Policy 38 6251–60. Brazil.
  IEA (2017). Energy Access Outlook 2017: From Poverty to Prosperity, Paris. France.
  https://doi.org/10.1787/9789264285569-en.

- Jonathan, P., Victoria, P. & Seth, Y. (2020). Lessons for Modernizing Energy Access Finance, Part 1: What the Electrification Experiences of Seven Countries Tell Us about the Future of Connection Costs, Subsidies, and Integrated Planning. Durham, NC: Duke University.
  https://nicholasinstitute.duke.edu/publications/lessons-modernizing-energy-access-finance-part-1

- Ken Lee, Edward Miguel, and Catherine Wolfram (2015). Economics of last mile electrification. University of California, Berkeley.
  http://cega.berkeley.edu/assets/miscellaneous_files/CEGA_Energy_REPP June2015.pdf

- KPLC (2014). https://kplc.co.ke/content/item/77/stima-loan

- KPLC (2016). Annual report and financial statements for the year ended 30 June 2016. Nairobi
  https://www.kplc.co.ke/AR2016/KPLC%202016%20Annual%20Report%20Upload.pdf

- KPLC (2017). Annual report and financial statements for the year ended 30 June 2017. Nairobi
  https://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf

- KPLC (2019). Annual report and financial statements for the year ended 30 June 2019. Nairobi
  https://kplc.co.ke/AR2019/Audited%20Accounts%20for%20Year%20Ended%2030.6.2019.pdf

- Paula B., Camila C., Aline R., André L., Joana P., Alexandre K., Alexandre S., & Roberto S. (2017) . The power of light: socio-economic and environmental implications of a rural electrification program in Brazil. Environ. Res. Lett Brazil.
  https://iopscience.iop.org/article/10.1088/1748-9326/aa7bdd/pdf