RAEL
Renewable & Appropriate Energy Lab

Empowering Informal Settlements: Renewable Energy and Employment

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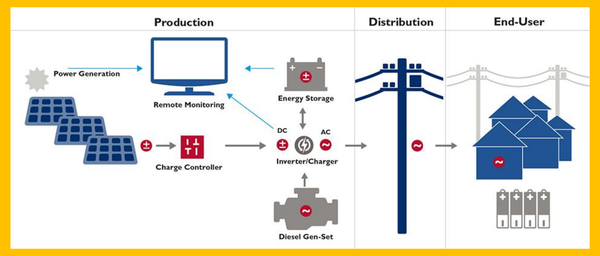
Problem: What combination of decentralized renewable energy sources supplies the best electricity to support livelihoods in low-income, underserved communities?

Back to Basics Corner



What are the technical components of a mini-grid?

Introduction

This study examines the potential for renewable energy to meet energy demands of critical, community-scale energy needs that support education, clean water and sanitation services, and livelihoods in Kibera, an informal settlement in Nairobi, Kenya. The first installation of the 35 kW solar-battery system on the Kibera Town Centre trained 10 people on solar installation.

KTC artistic rendition.

The Kibera Town Centre (KTC) is a two story community center serving the basic washing, shower, and toilet needs of ~700 women and children each day. KTC also offers internet access, programming and smart phone applications training, a green products store, and offers classes in solar installation, digital media, adult education, and business.

Methods

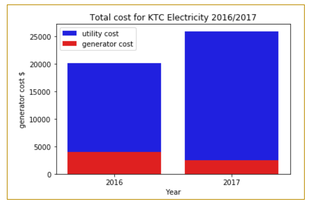
First, a techno-economic analysis using **HOMER Pro (Hybrid Optimization of Multiple Electric Renewables)** results of the Kibera Town Centre electricity demand was conducted. The **Kibera Town Centre (KTC)** is a central hub in Kibera that sells clean water, laundry services, food services, and adult classes at affordable rates. Having reliable, high quality electricity directly relates to their quality of service and business.

In Kibera, electricity demand was measured at KTC. Energy audits were conducted at the neighboring schools with over 4,000 students as well as interviews with the principals. A community engagement team at KTC surveyed 50 surrounding shops and collected data about their appliances and electricity services.

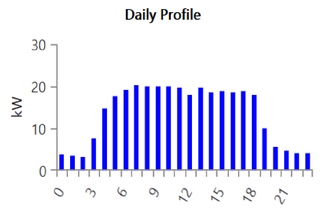
KTC installed a **35kW solar-battery system** in October 2018, and current and voltage sensor data of all the different components from **November 2018 – January 2019** is used to calculate HOMER daily load profile inputs, continually build the case for expanding this system, and compare to load satisfied by solar energy.

Results

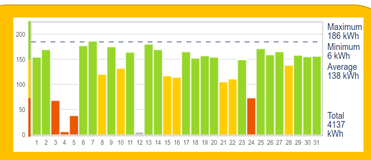
Below is the cost breakdown and daily load profile of the Kibera Town Centre before the solar installation. Their primary demand came from a borehole 3 phase pump and the washing and drying machines.



Total Cost for Kibera Town Centre Electricity *BEFORE installing 35 kW of solar. In 2016, energy demand of 71,264 kWh and 401,508 Ksh in generator fuel cost (24.9%). In 2017, energy demand was 91545 kWh and 241,538 Ksh in generator fuel cost (10.3%).*

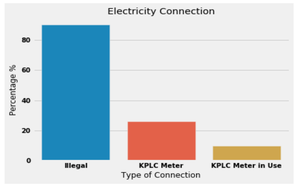


Kibera Town Centre daily load profile *generated from 06/20-27/2018 and 11-12/2018 electricity sensor readings. Daily recordings ranged from* ***190 - 340 kWh/day,*** *with the highest peak draw of* ***37.3 kW.***



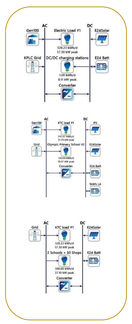
Solar Production at KTC

The 35 kWp system installed on the roof of KTC produced an average of 138 kWh per day in January 2019, which is ***approximately 40% of the daily load demanded.***



90% of the shops *surveyed reported having an illegal connection to the utility, 26% had a Kenya Power & Lighting Co. meter, but only 10% of the entire sample use meters.*

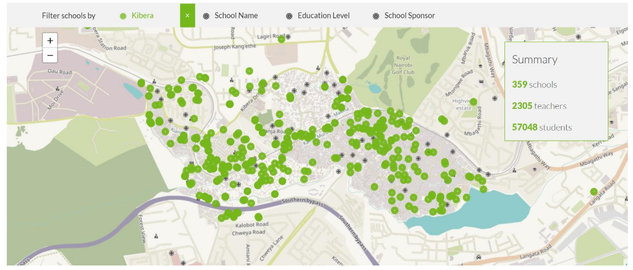
The table below is the alternate scenarios for satisfying KTC demand (330 kWh/day) then expanding the system to serve Olympic Primary & Secondary School Demand (200 kWh/day), and 50 shops (2 kWh/day each). Expanding the system results in lower capacity shortage and more solar production and less utility demand.



Scenario	Solar Capacity	Levelized Cost of Solar Energy	Utility Demand	Renewable Output Percentage of Total Generation	Solar Production	Capacity Shortage
Satisfying KTC Demand with Grid-tied system	35 kW	$0.0358/kWh	31,330 kWh/year	68%	57,428 kWh/year	50%
Satisfying KTC & Olympic Primary School Demand	104 kW	$0.0135/kWh	0	100%	179,549 kWh/year	40%
Satisfying Olympic Neighborhood Demand	336 kW	$0.0413/kWh	-22,520 kWh/year	100%	477,277 kWh/year	20%

Conclusions

Above is 69 kWp of solar panels rated at 320 W each, overlayed on the rooftop of the Olympic Primary School on Buildings 1, 2, 3, and 7. There are 17 buildings, with over 2500 m^2 of roof space available.



Above is a map of all schools in Kibera from the Mapping the Marginalized initiative. Estimates show that the 14 government schools demand 100 kWh/day and have cumulative roof space to install 1 MW of solar generation.

In conclusion, scalable solar generation is a technically and economically viable and preferred pathway to integrate sustainable, modern electric renewable energy in low-income, vulnerable communities.

Acknowledgements

We would like to thank the Human Needs Project, and employees of the Kibera Town Centre for piloting renewable energy in their community and sharing their experiences.

KTC
Kibera Town Centre