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MINI GRIDS IN KENYA

A CASE STUDY OF A MARKET AT A TURNING POINT

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The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance program administered by the World Bank. It provides analytical and advisory services to low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, the European Commission, Finland, France, Germany, Iceland, Italy, Japan, Lithuania, Luxemburg, the Netherlands, Norway, The Rockefeller Foundation, Sweden, Switzerland, and the United Kingdom, as well as the World Bank.

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PREAMBLE

The Global Facility on Mini Grids of the Energy Sector Management Assistance Program (ESMAP) hired Castalia to study the regulation of mini grids in six jurisdictions in Sub-Saharan Africa and Asia (Kenya, Tanzania, and Nigeria; and Bangladesh, Cambodia, and the state of Uttar Pradesh in India). The study's objective is to understand what regulatory settings governments may adopt to scale up electrification through private development of mini grids, drawing on the experience of these six jurisdictions; provide technical assistance to four countries that want to further develop their mini grids framework; and disseminate findings and recommendations globally to inform successful mini grids regulation.

The study focuses on mini grids defined as small, privately-owned and operated systems with generation of up to 10 megawatts (MW) capacity and a network that distributes power to several customers. The study includes small mini grids of less than 1 kilowatt (kW) capacity, also known as 'micro' or 'pico' grids.

The six case studies are intended to be combined in one report. The report is to provide a cross-country comparison of these topics: it examines side by side how each of the countries studied have responded to a specific regulatory question, and presents a decision-tree approach to developing regulatory frameworks for mini grids.

This case study is based on in-depth interviews with a number of key stakeholders in Kenya, conducted during and after a research trip in September 2017. We supplemented the insights gained from these interviews with extensive background research. Several experts in the Kenya context and mini grids more broadly reviewed this case study for accuracy and clarity, and we have incorporated their comments while retaining a neutral fact-based position.

Like the other five case studies, this document is structured as follows:

- A brief introduction (Section 1 |),
- A brief description of the context of the state of Uttar Pradesh (Section 2 |),
- An overview of the power sector (Section 3 |),
- Main aspects of the policy setting for mini grids (Section 4 |),
- Technologies and business models used in the mini grids sector (Section 5 |),
- The process to authorize mini grid operators (Section 6 |),
- Technical and service standards for mini grids (Section 7 |),
- Tariff setting, financing, and subsidies (Section 8 |),
- Handling the relationship with the main grid (Section 9 |), and
- A summary of lessons learnt from the experience of the country (Section 10 |).

1 | INTRODUCTION

The Government of Kenya ('the Government') aims to achieve 70% electrification by 2018, and universal access by 2020.[1] In 2017, 50% of the country's population was connected to the grid.[2] Extending the traditional grid is expected to reach up to 90% of the population;[3] mini grids and stand-alone systems will be used to connect the remainder.

The National Rural Electric Cooperative Association (NRECA) is working with the World Bank and the Government to develop a National Electrification Strategy (NES). The NES will set out a plan to meet the Government's goal to provide electricity by expanding the national grid. The NES will also specifically address the needs of people living in underserved areas, as defined by the Commission on Revenue Allocation (CRA).

In 2013, CRA identified 14 counties in the north and northeastern parts of Kenya as underserved areas. To do this, it assessed the socioeconomic profile and lifestyle of the people living there, who are largely cash-poor, nomadic, and pastoralist. These counties make up 70% of Kenya's total land area and 20% of its population.[4]

The Government needs about US$2.5 billion of additional investment to reach its universal electrification targets by 2020. The Kenya Off-Grid Solar Access Project (KOSAP) provides a loan of US$150 million as part of the NES, aiming to increase access to modern energy services in the 14 underserved counties. KOSAP aims to replace kerosene, diesel, dry cell batteries, and other alternative fuels with solar technologies in those counties.[5]

US$40 million of the KOSAP budget will be used to develop mini grids for providing power to the rural population, which currently relies on kerosene, small private diesel generators, and dry cell batteries. The Government plans to establish 120 mini grids under a public-private partnership (PPP) model, jointly implemented by the Rural Electrification Authority (REA) and the national utility, the Kenya Power and Lighting Company Limited (KPLC). Private companies will build the generation and distribution network, and operate and maintain those assets over seven to ten years. The mini grid customers will be charged a regulated tariff, paid to KPLC. The private companies will receive monthly payments from KPLC for services provided under the Power Purchase Agreement (PPA).[6]

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[1] World Bank (2015), 'Kenya – Electricity Modernization Project', Washington, D.C. (http://documents.worldbank.org/curated/en/517661468253781559/Kenya-Electricity-Modernization-Project), accessed 10 September 2017.
[2] KPLC (2017), '2016-2017 Full Annual Report for the Year Ended 30 June 2017' (http://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf), accessed 10 September 2017.
[3] World Bank (2017), 'Kenya – Off-Grid Solar Access Project for Underserved Counties', Washington, D.C. (http://documents.worldbank.org/curated/en/212451501293669530/Kenya-Off-grid-Solar-Access-Project-for-Underserved-Counties), accessed 10 September 2017.
[4] CRA (2013), 'Policy on the Criteria or Identifying Marginalized Areas and Sharing of the Equalization Fund', (http://www.crakenya.org/wp-content/uploads/2013/10/CRA-Policy-on-marginalisation-driteria.pdf), accessed 10 September 2017.
[5] World Bank (2017), 'Kenya – Off-Grid Solar Access Project for Underserved Counties', Washington, D.C. (http://documents.worldbank.org/curated/en/212451501293669530/Kenya-Off-grid-Solar-Access-Project-for-Underserved-Counties), accessed 10 September 2017.
[6] Ibid.

KPLC operates 19 mini grids, all publicly owned and developed. REA developed these mini grids and built their generation and distribution assets. When the mini grids were completed, KPLC took over their operation and maintenance.[7]

Private sector mini grids in Kenya are at least 21.[8] Privately developed systems have recently come at a somewhat slower pace, and despite the absence of clear rules about tariffs, licensing, service quality, and interconnection with the main grid.

The national electricity regulator, the Energy Regulatory Commission (ERC), is working on a draft of regulations for mini grids. These regulations may be used for both fully private mini grid development and the PPP model.[9] Table 1.1 shows key metrics about mini grids in Kenya, including data on mini grid penetration in the country, tariffs and rates, and quality of service.

Table 1.1: Key Metrics for Mini Grids in Kenya

Mini grids Penetration		
Number of mini grids	Number	>21
Average growth in number of mini grids from 2005 to 2015	%	36%
Customers served by mini grids (2015)	Customer, thousands	Approx. 1,000
	People, thousands (4)	4.2
	% of total population	0.01%
	Of the population with access to electricity, % connected to a mini grid	0.03%
Average growth in connections 2005 to 2015	Thousand/year	0.1
	%/year, compound rate	100%
Tariffs and Rates		
Cost of connection for the developer(1)	US$	151-1,000
	% of GDP/Capita	5-36%
Cost of connection for KPLC	US$	1,000
	% of GDP/Capita	36%
Average subsidy per connection (2)	US$	Currently 435, soon 145
	% of GDP/Capita	Currently 15.8%, soon 5.3%
Monthly bill for Tier 2(3) consumption	US$	3.42
	% of GDP/Capita	1.4%
Average tariff(4)	US$/kWh	0.56

[7] ECA (2016), 'Consultancy services for development of regulations, revenue arrangements, and technical requirements for private sector renewable energy mini-grids' (http://www.gmgfacilitykenya.org/images/Kenya%20mini-grids%20PFS_draft%20final%20report%20vol1.pdf), accessed 10 September 2017.
[8] Castalia analysis.
[9] Field interviews, September 2017.

Quality of Service		
Availability of electricity	Hours of service/day	24

Sources: Field interviews and own analysis; Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification'; TFE Consulting (2017), 'Kenya: The World's Microgrid Lab'; Abdullah and Markandya (2009).

Notes: (1) The cost of connection refers to the cost, for the developer, of connecting new customers. US$151-162 for Pico-hydro mini grid serving 65–110 households (1.1kW–2.2kW),[10] and US$1,000 for other mini grid developers.[11]
(2) Average subsidy per connection is for new customers connected to the main grid of KPLC.
(3) 'Tier 2' access to electricity is access that allows for consumption of 73kWh–250kWh/year.[12]
(4) For all mini grids and categories of customers.
(5) The number of people served by the main grid is an estimation calculated by multiplying the number of customers with the average number of people per household, which is assumed 4.4 for Kenya using the 2012/2013 Kenya National Housing Survey from Ministry of Land, Housing & Urban Development.

2 | COUNTRY CONTEXT

Table 2.1 presents summary statistics on Kenya's demographics, economy, governance, and electricity sector.

Table 2.1: Kenya Summary Statistics, 1995, 2005, 2014

		1995	2005	2014
Demographics				
Population	Million	27.4	35.3	44.9
Population growth	Annual average	3%	3%	3%
Rural population	Million	22.4	28.2	34.4
Rural population growth	Annual average	3%	2%	2%
Population density, National	People/sq. km	48.0	63.3	80.9
Economy				
GDP	PPP, 2011 US$ million	9,046.3	18,737.9	61,445.3
GDP per capita	PPP, 2011 US$	2,204.3	2,224.0	2,753.0
Real GDP per capita growth	5-year compound rate	-2%	1%	3%
Debt to GDP ratio	%	69%	51%	49%
Governance				
Ease of Doing Business rank	See Note (1)	N/A	N/A	129

[10] S. Abdullah, and A. Markandya (2009), 'Rural Electrification Programmes in Kenya: Policy Conclusion from a Valuation Study', Working Paper, Bath, UK: Department of Economics, University of Bath.
[11] TFE Consulting (2017), Kenya: The World's Microgrid Lab (http://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/TFE_Report-Microgrids-Kenya.pdf), accessed October 13, 2017
[12] World Bank/ESMAP (2015), 'Beyond Connections – Energy Access Redefined' (https://openknowledge.worldbank.org/bitstream/handle/10986/24368/Beyond0connect0d000technical0report.pdf?sequence=1&isAllowed=y, accessed 4 October 2017.

		1995	2005	2014
Corruption Perceptions Index	See Note (2)	N/A	2.1	2.5
World Bank Governance Indicator	See Note (3)	-0.70	-0.63	-0.59
Electricity Sector				
Electricity connection rate, national	% of population	**10.8**	**20.4**	**36.0**
Urban		*45.1*	*70.2*	*68.4*
Rural		*3.1*	*6.6*	*12.6*
Electrification growth rate	% change in population with a connection, 5-year compound rate	17.6%	8.1%	12.3%
Population with an electricity connection	Thousands	**2,954.6**	**7,208.6**	**16,150.9**
Urban		*2,253.1*	*5,341.3*	*11,813.0*
Rural		*701.5*	*1,867.3*	*4,337.9*
Electrical power consumption	kWh/person /year	127.6	130.2	166.7
	kWh/person with an electricity connection/year	1,182.4	638.5	463.2
Customers served by the grid	'000	**N/A**	**599.42**	**2,481.86**

Source: World Bank Development Indicators (2016), Transparency International (2016), KPLC 'Annual Reports' (2005 & 2015)

Notes: 1) The Ease of Doing Business Index ranks countries from 1 to 190. The closest a country is to 1, the more conducive its regulatory environment is to starting and operating a local firm.
(2) The Corruption Perceptions Index ranks countries on a scale of zero to 10, with zero indicating very high levels of corruption and 10 indicating very low levels of corruption.
(3) The Worldwide Governance Index assign scores to countries from -2.5 to 2.5, with higher values indicating higher quality of governance.

Demographics

Kenya's population was 48.5 million in 2016. Annual population growth has been slowing since the 1980s, when it averaged 3.8%. In 2016, the population increased by 2.5%.[13]

The rural population made up almost 74% of the total in 2016. This proportion tends to decrease in parallel with the annual rate of urbanization, which is 4.15%.[14]

[13] World Bank Development Indicators (2016).
[14] Central Intelligence Agency, 'The World Factbook' (https://www.cia.gov/library/publications/the-world-factbook), accessed 13 November 2017.

The largest two cities are the capital, Nairobi (3.9 million), and Mombasa (1.1 million). The other highly populated areas are in the west, along the shore of Lake Victoria, and along the southeast Indian Ocean coast.

Economy

Kenya had high annual gross domestic product (GDP) growth of 5.8% in 2016, and is one of the strongest and most advanced economies in the region. According to World Bank data, Kenya's total GDP increased from US$9 billion to current US$70.5 billion between 1995 and 2016, with an average annual growth rate of 1.4%. Kenya had GDP per capita of US$2,925 in 2016.

Kenya's economy depends on its agriculture sector, which makes up one third of GDP. Agriculture is also the largest employment sector, creating jobs for approximately 75% of the country's population. An estimated 44.2 million people in Kenya work at least part-time in agriculture, including livestock and pastoral work. Tourism is another important sector for Kenya's economic development: in 2016, tourism-generated revenues increased by 37%.[8]

Governance

Kenya became independent from the United Kingdom in 1963. The current constitution was enacted on 27 August 2010, replacing the original from 1963.[15]

Uhuru Kenyatta was elected to serve for a second 5-year presidency in August 2017. The Supreme Court investigated the results of the elections after objections from the opposition party.[16] Political uncertainty and social unrest may affect private sector investment regardless of the outcome of the investigation.

[15] Central Intelligence Agency, 'The World Factbook' (https://www.cia.gov/library/publications/the-world-factbook), accessed 13 November 2017.

[16] DW (2017), 'Kenya court annuls presidential election result' (http://www.dw.com/en/kenya-court-annuls-presidential-election-result/a-40322932), accessed 10 September 2017.

3 | OVERVIEW OF THE POWER SECTOR

The Government has been working to restructure the power sector in Kenya since the mid-1990s. As the country emerged from an aid embargo, one of the Government's main objectives was to attract private investment in the sector, seeking to reduce dependency on limited public finances.[17]

The Government published a policy framework paper on economic reforms in 1996.[18] The paper stated its intentions to unbundle and restructure the power sector, and to promote private investment. The Government then passed the Electric Power Act of 1997.

The 1997 Act created the Electricity Regulatory Board (ERB) as the sector regulator. It also unbundled the vertically integrated utility KPLC into:

- A public sector generation company (KenGen), and
- A transmission and distribution company (KPLC).

Since the 1997 Act, Independent Power Producers (IPPs) have been able to generate power and sell it to KPLC under a PPA. A competitive bidding process determines prices.[19]

The Ministry of Energy (MoE) published the 'Sessional Paper No. 4 on Energy' in 2004. The Paper set out the policy framework for the national strategies in the energy sector, and enacted in the Energy Act, 2006. The Paper also introduced feed-in tariffs (FiTs) to promote renewable energy. Furthermore, the Paper proposed:

- Setting up a state-owned Geothermal Development Company (GDC),
- Privatizing KenGen through the Nairobi Stock Exchange,
- Creating a Rural Electrification Authority (REA), and
- Separating KPLC into two entities, one for transmission (100% state-owned), and the other for distribution (private sector-owned).[20]

The Energy Act 2006 replaced ERB with the ERC as a single energy regulatory body, and created the REA to speed up rural electrification. The 2006 Act also set up a state-owned company (in 2008) to create new transmission assets: the Kenya Electricity Transmission Company (KETRACO).

KenGen and KPLC are both listed on the Nairobi Securities Exchange. The Government of Kenya holds 70% of KenGen and 51.1% of KPLC, and the private sector holds the remaining shares.

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[17] A. Eberhard, K. Gratwick, E. Morella, and P. Antmann (2016), 'Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries. Directions in Development – Energy and Mining,' Washington, D.C.: World Bank. ©World Bank, https://openknowledge.worldbank.org/handle/10986/23970 License: CC BY 3.0 IGO.

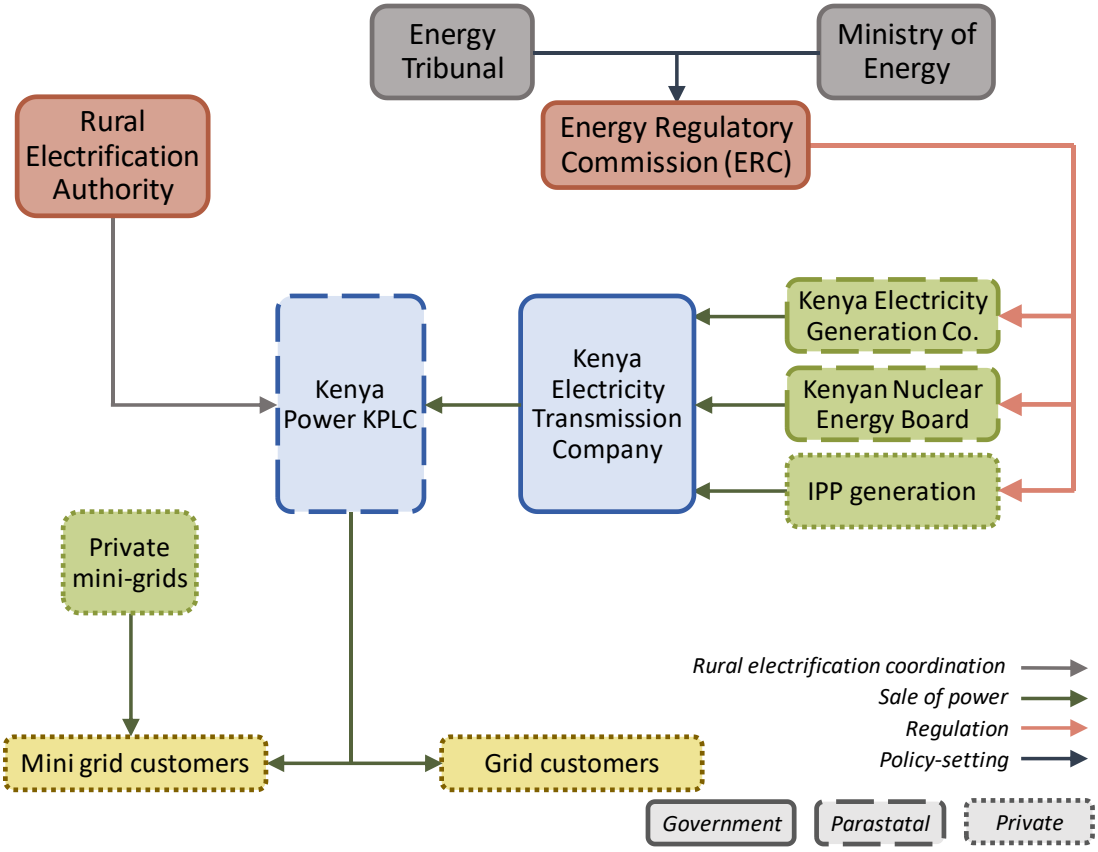
[18] Government of Kenya, with IMF and World Bank (1996), 'Kenya Economic Reforms for 1996-1998: The Policy Framework Paper', (https://www.imf.org/external/np/pfp/kenya/kenya.pdf), accessed 10 September 2017.

[19] A. Eberhard, K. Gratwick, E. Morella, and P. Antmann (2016), 'Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries. Directions in Development – Energy and Mining,' Washington, D.C.: World Bank. ©World Bank. https://openknowledge.worldbank.org/handle/10986/23970 License: CC BY 3.0 IGO.

[20] Government of Kenya (2004), 'Sessional Paper No. 4 of 2004 on Energy' (http://www.erc.go.ke/images/Regulations/SESSIONAL%20PAPER%204%20ON%20ENERGY%202004.pdf), accessed 10 September 2017.

Figure 3.1 illustrates the structure of Kenya's power sector.

Figure 3.1: Kenyan Power Sector Structure



Source: from GIZ, 2016

3.1 Main actors

The main actors in Kenya's power sector are:

- KPLC (the partially state-owned, vertically integrated utility),
- KenGen (the semi-public generation company),
- The REA,
- ERC (the regulator),
- The MoEP, and
- IPPs, which play a significant role in the sector.

Kenya Power and Lighting Company (KPLC)

KPLC is a state-owned utility with 50.1% public and 49.9% private shareholding. It is the single buyer in the power market in Kenya, buying in bulk from all power generators. KPLC then transmits and distributes power to customers, so all generators rely on KPLC for their revenue. Take-or-pay PPAs signed with KPLC support the private sector's role in electricity generation.

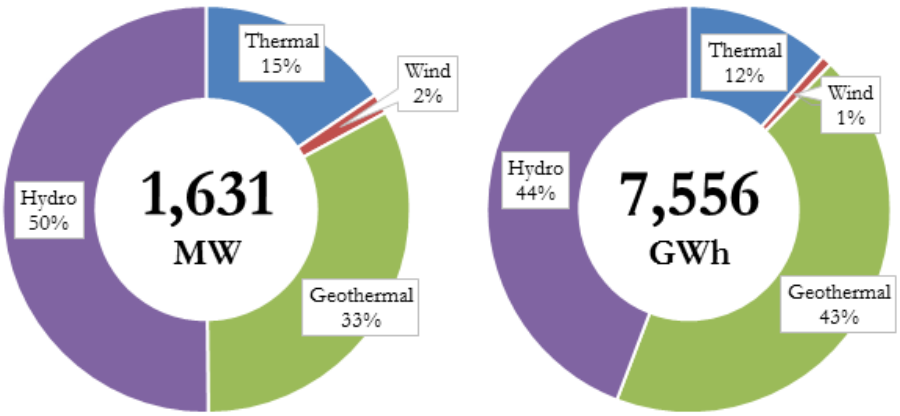
Sessional Paper No. 4 of 2004 set out the current policy framework applying to the electricity sub-sector.[21] KPLC is a major player in this sector, with about 5.9 million consumers in 2017.[22] In the past two years, KPLC has interconnected more than 2 million consumers to the main grid or to mini grids that it operates. At present, KPLC manages and operates the 19 public mini grids.

Kenya Electricity Generating Company Limited (KenGen)

KPLC was split into two different companies in the first reform of the energy sector, under the Electric Power Act of 1997. One company deals with generation, and the other with distribution and transmission. KenGen was established as the generation company in January 1997. It was listed on the Nairobi Securities Exchange in 2006 through an Initial Public Offer (IPO), following the sale of the 30% Government stake.

KenGen generates 74% of total power produced in Kenya,[23] with the rest coming from IPPs. KenGen had a total installed capacity of 1,631MW in 2017, with hydro (50%) and geothermal (33) power plants comprising the most part of this capacity. The rest of the capacity comes from thermal generators and wind farms. Figure 3.2 presents KenGen's total installed capacity and total production in 2017.

Figure 3.2: KenGen's 2017 Generation Mix as Installed Capacity (left) and Total Production (right)



Source: KenGen (2017), Full year results to 30 June 2017

The regulator: Energy Regulatory Commission (ERC)

The ERC is responsible for reviewing and approving electricity tariffs, and for approving PPAs between IPPs and KPLC. The ERC also issues licenses for the renewable energy, petroleum, and electricity sectors. It reviews compliance with technical requirements, approving or rejecting permits and licenses. It also formulates, enforces, and reviews regulations, codes, and standards; and it reviews and adjusts electric power tariffs and tariff structures.

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[21] Government of Kenya (2004), 'Sessional Paper No. 4 of 2004 on Energy' (http://www.erc.go.ke/images/Regulations/SESSIONAL%20PAPER%204%20ON%20ENERGY%202004.pdf), accessed 10 September 2017.
[22] KPLC (2017), Web page (http://www.kplc.co.ke/content/item/1951/kenya-power-confirms-5.9-million-customers-connected-to-the-grid), accessed 7 September 2017.
[23] KenGen (2017), 'Full year results to 30 June 2017' (http://www.kengen.co.ke/sites/default/files/financial-reports/KenGen%20FY16-17%20Investor%20Presentation-18%20Oct%202017.pdf), accessed 20 October 2017.

The ERC's mandate includes working with the REA on grid extension and mini grids.[24] As an independent authority, the ERC also resolves disputes about mini grid tariffs when a complaint is filed between the operator and the customers,[25] subject to it receiving a minimum number of complaints.[26]

Other power sector actors

The **Ministry of Energy and Petroleum (MoEP)** develops energy sector policies and directs public sector entities in planning and executing infrastructure investment projects. The Government contracts the Cabinet Secretary of MoEP each year to implement national energy policies, and to ensure that public entities such as KPLC and REA operate efficiently and deliver quality service to the public.[27]

The Energy Act of 2006 (section 66) established the **REA** in 2007. Its task is to extend rural electrification by connecting public facilities and neighboring 'last mile' homes, excluding non-residential premises.[28] Under the Energy Act, the REA is responsible for the following functions:[29]

- Managing the Rural Electrification Program (REP) Fund,
- Developing and updating the Rural Electrification Master Plan (REMP),
- Promoting sources of renewable energy including small hydro, wind, solar, biomass, geothermal, hybrid systems, and oil-fired components; considering local needs such as electricity for irrigation and supporting off-farm income-generating activities,
- Sourcing and managing additional funds for the REP, and
- Managing the application, tendering, and award of contracts for licenses and permits for rural electrification.

REA uses the REP Fund to build electricity infrastructure. According to clause 79(2) of the Energy Act, the REP Fund is funded by:[30]

- A levy up to 5% on electricity sales (5% of KPLC'S electricity sales),
- Fees and other charges levied by the ERC,
- Appropriations by Parliament,
- Donations, grants, and loans, and
- All other moneys lawfully received or made available for the program as the Minister may approve.

REA's work to advance mini grid development in Kenya includes planning mini grids in remote areas, where the REMP does not plan to extend the grid soon. After REA commissions mini grids, KPLC takes over ownership and sells power to the consumers. REA has stopped building diesel-powered mini grids, which used to be the dominant technology in the country. REA also provides research and information

[24] Field interviews, ERC.
[25] Government of Kenya (2012), 'Energy (Complaints and Dispute Resolution) Regulations, 2012' (http://www.erc.go.ke/images/docs/Energy-Complaints%20and%20Disputes%20Resolution-Regulations%202012.pdf), accessed 15 November 2017.
[26] Field interviews, REA, September 2017.
[27] Government of Kenya (2014), 'Performance Contract Between the Government of the Republic of Kenya and the Ministry of Energy and Petroleum for the Period 1 July 2013 - 30th June 2014' (http://www.devolutionplanning.go.ke/wp-content/uploads/2014/08/Mininistry-of-energyPERFORMANCE-CONTRACT-2013-20141.pdf), accessed 16 November 2017.
[28] 'Last mile' refers to the Last Mile Connectivity Program (LMCP), which focuses on extending the low-voltage network to reach households within a 600m radius of a transformer. As part of the project, REA will connect potential customers in those areas for a connection fee of KES15,000.
[29] Government of Kenya (2006), 'The Energy Act of 2006' (http://www.erc.go.ke/images/Regulations/energy.pdf), accessed 16 September 2017.
[30] Ibid.

for private mini grid developers.[31] The draft Energy Bill 2015 (to be enacted) will transform REA into the Rural Electrification and Renewable Energy Corporation (REREC). REREC's functions will include planning, implementing, and promoting electrification and renewable energy.[32]

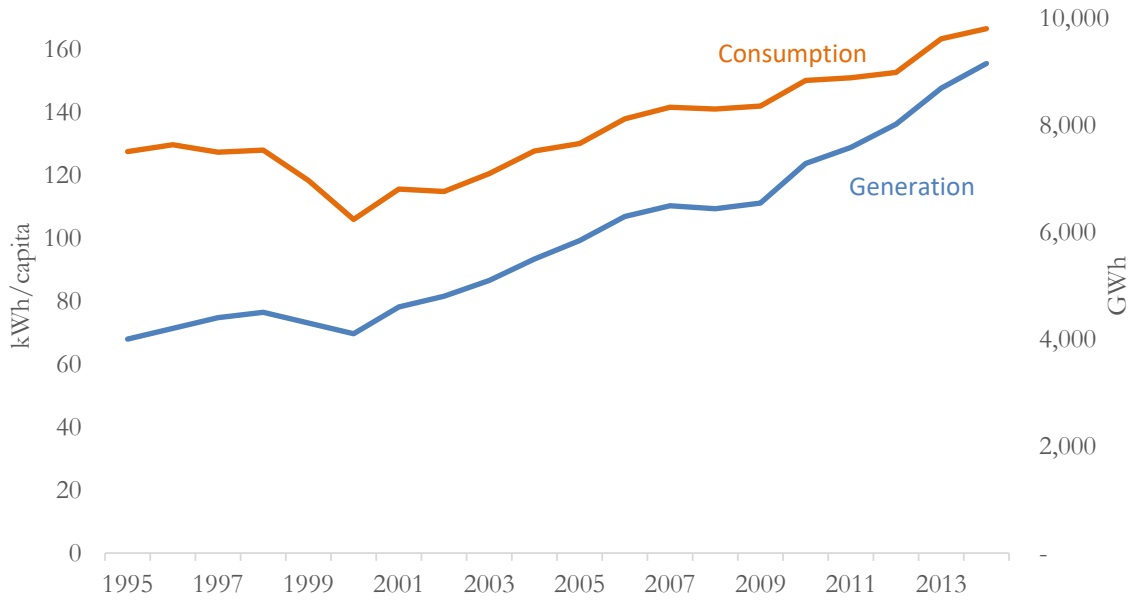
GDC was established in 2008 as a special-purpose public company to develop geothermal resources. It is 100% state-owned and was established through Sessional Paper No. 4 of 2004.

KETRACO was established under the Energy Act 2006 as a 100% state-owned company to construct new transmission lines and operate existing lines.

3.2 EVOLUTION OF THE SECTOR

Total electricity generation in Kenya increased from 4,000GWh to 9,000GWh between 1995 and 2014, with an average annual growth rate of 5%. In the same period, consumption per capita increased by 2% (Figure 3.3). [33]

Figure 3.3: Evolution of Power Consumption (kWh/person) and Generation (GWh), 1995-2014



Kenya had a total installed capacity of 2,370GW in 2017. IPPs accounted for 26% of total power generation (10,205GWh).[34] According to 2014 values, Kenya's installed generation capacity per capita was higher than that of neighboring Tanzania, Ethiopia, and Uganda, but behind Nigeria and Mozambique, as shown in Figure 3.4.[35]

[31] Field interviews, REA, September 2017.
[32] The Energy Bill 2015 of Kenya.
[33] World Bank Development Indicators (2016).
[34] KenGen (2017), 'Full year results to 30 June 2017' (http://www.kengen.co.ke/sites/default/files/financial-reports/KenGen%20FY16-17%20Investor%20Presentation-18%20Oct%202017.pdf), accessed 20 October 2017.
[35] World Bank Development Indicators (2016).

Figure 3.4: Installed Generation Capacity per Capita, 2014

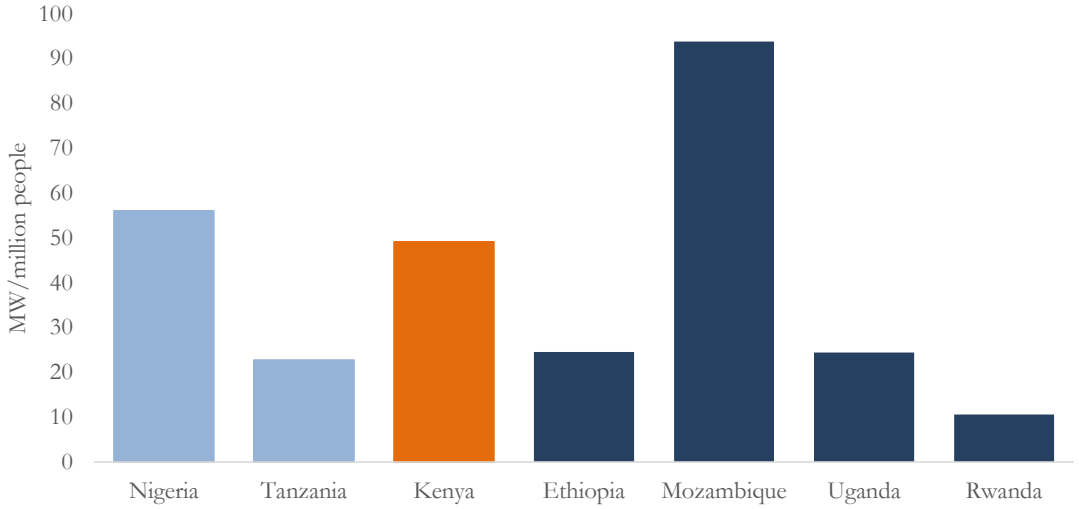
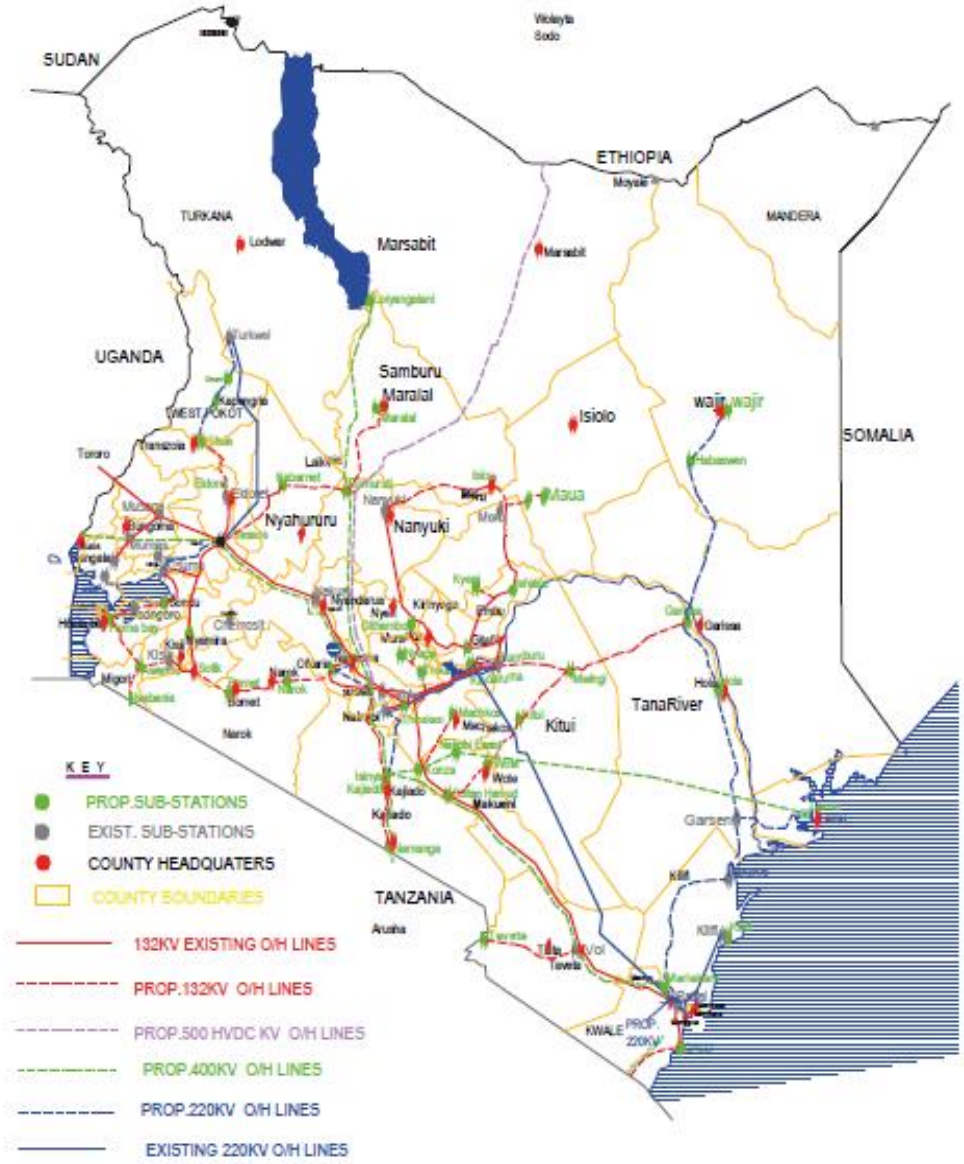


Figure 3.5 shows a map of the transmission network in Kenya. The electricity grid covers the coastal and central areas of the eastern and the western part of the country.[36]

[36] KPLC (2016), 'Annual Report and Financial Statements for the year ended 30th June 2016'.

Figure 3.5: Kenya's Transmission Network, 2017



Source: KPLC (2016), 'Annual Report and Financial Statements for the year ended 30th June 2016'.

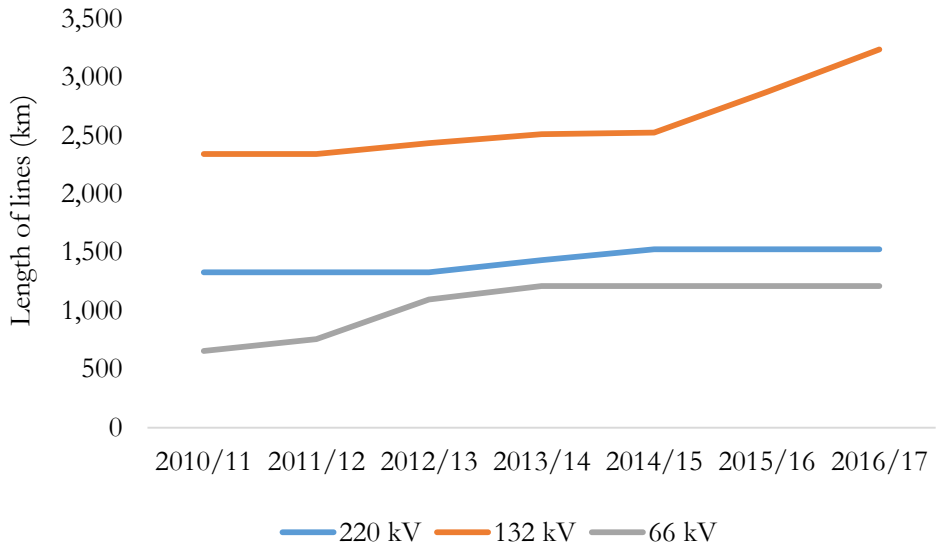
KETRACO implements transmission projects in Kenya. By the end of 2017, transmission lines (200kV, 132kV, and 66kV) covered a distance of 5,978km.[37] The evolution of these lines in the last seven years is shown in Figure 3.6.

Construction started on Kenya's first high-voltage 400kV and 500kV DC lines in 2016, as well as three major regional interconnectors to Ethiopia, Uganda, and Tanzania. The 500kV transmission line will have

[37] KPLC (2017) '2016-2017 Full Annual Report for the Year Ended 30th June 2017' (http://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf), accessed 10 September 2017.

a transmitting capacity of 2,000MW over a distance of 1,045km, which will allow power flow from a 400MW Ethiopian hydro power plant down to Kenya.[38]

Figure 3.6: Evolution of the Transmission Network (km), 2010-2017

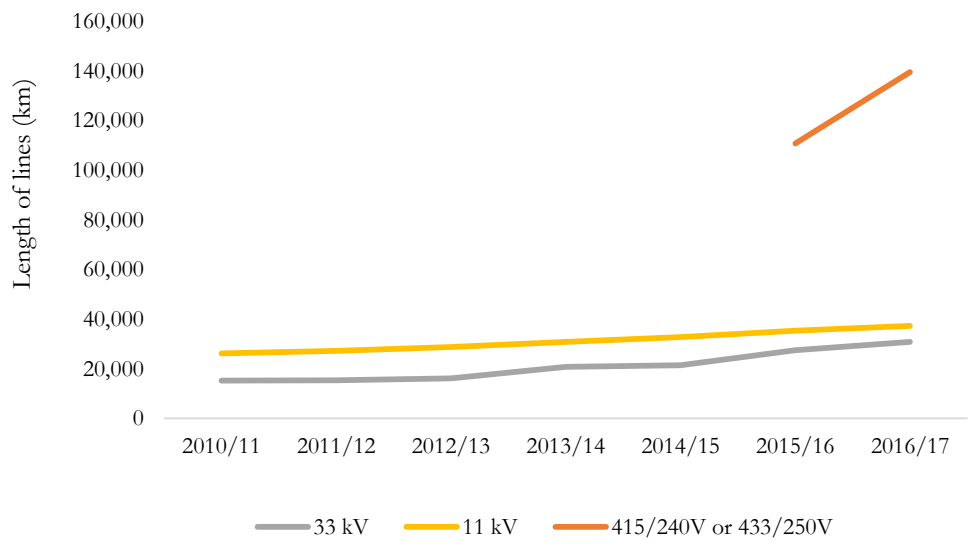


Source: KPLC (2017) 'Annual Report and Financial Statements for the year ended 30th June 2017'

The distribution network consists of 33kV and11kV medium-voltage (MV) lines, which are stepped down to 0.433kV and 0.24kV for interconnecting consumers. In June 2017, the total length of MV lines was 68,080km and the low-voltage lines (415/240V or 433/250V) 139,642km.[39]

[38] Power Africa (2015), 'Development of Kenya's Power Sector 2015-2020' (https://www.usaid.gov/sites/default/files/documents/1860/Kenya_Power_Sector_report.pdf), accessed 5 September 2017.
[39] KPLC (2017) '2016-2017 Full Annual Report for the Year Ended 30th June 2017' (http://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf), accessed 10 September 2017.

Figure 3.7: Evolution of the Distribution Network (km), 2010-2015



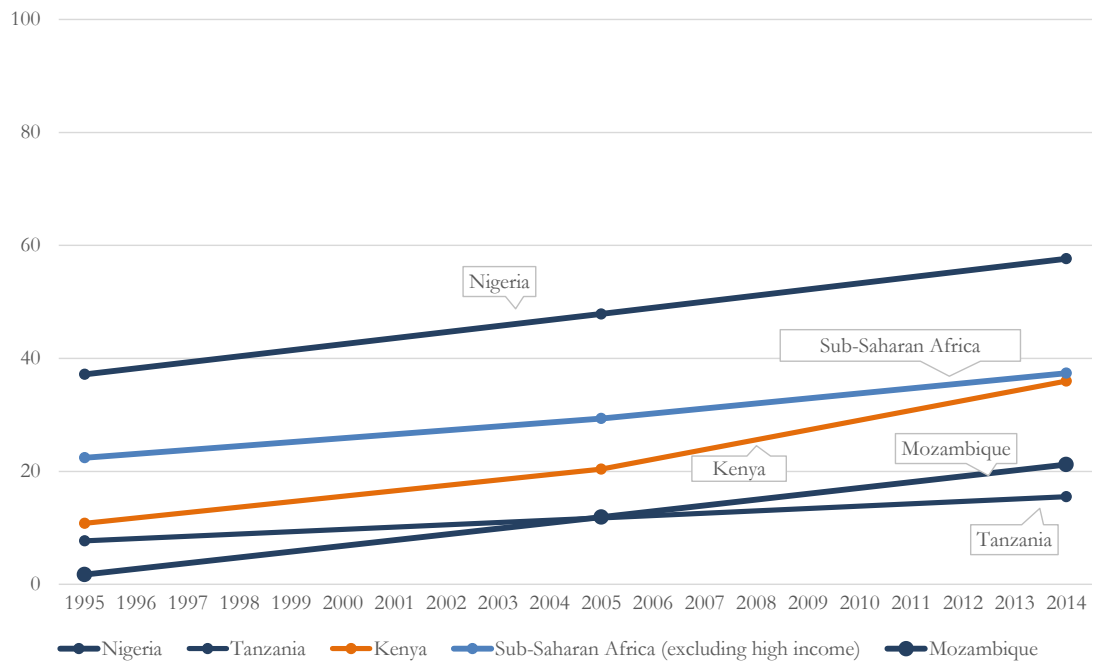
Source: KPLC (2017) '2016-2017 Full Annual Report for the Year Ended 30th June 2017'
Note: Data for LV lines is available as cumulative length of the lines in the system as of 2015/2016 period.

3.3 ACCESS TO ELECTRICITY: MAIN GRID AND MINI GRIDS

The rate of electricity connection was 11% in 1995, and had increased to 36% by 2014, as shown in Figure 3.8.[40] Figures are different when considering actual connections instead of access to electricity (proximity to a distribution line and ability to interconnect). According to World Bank development indicators, 36% of the population in Kenya had access to electricity in 2014; in rural areas, 12.6%, and in urban areas 68.4%.

[40] World Bank Development Indicators (2016).

Figure 3.8: Rate of Electrification (% of population)



Kenya has the target of achieving universal electrification by 2020. In line with this target, the number of customers connected to the national grid has been growing steadily over the last five years, as a result of the Government's Last Mile Connectivity Program (LMCP).

The LMCP aims to connect all people living within 600m of a transformer. The program has US$700 million of funding from multiple donors, including World Bank finance for the Kenya Electricity Modernization Project (KEMP) to increase the rate of grid connection. The LMCP reduces the connection fee charged to households from KES35,000 (US$343) to KES15,000 (US$147), and the fee can be paid in installments. In comparison, each customer pays around US$1,000 for a KPLC connection if the customer is not in an eligible area selected under the LMCP for a connection grant (eligibility is based on planning, in turn depending on resources available, rather than on household characteristics).[41]

Only 2 million customers were connected to the national grid in 2012, representing 16% of Kenya's population. Since then, the LMCP has connected almost 4 million consumers to the grid.[42] Domestic customers totaled 5.8 million in 2017.[43]

Figure 3.9 shows the growth in domestic customers connected by KPLC from 2001 to 2017. As noted in Figure 3.9, 20% of these households were connected under the REP Fund.[44]

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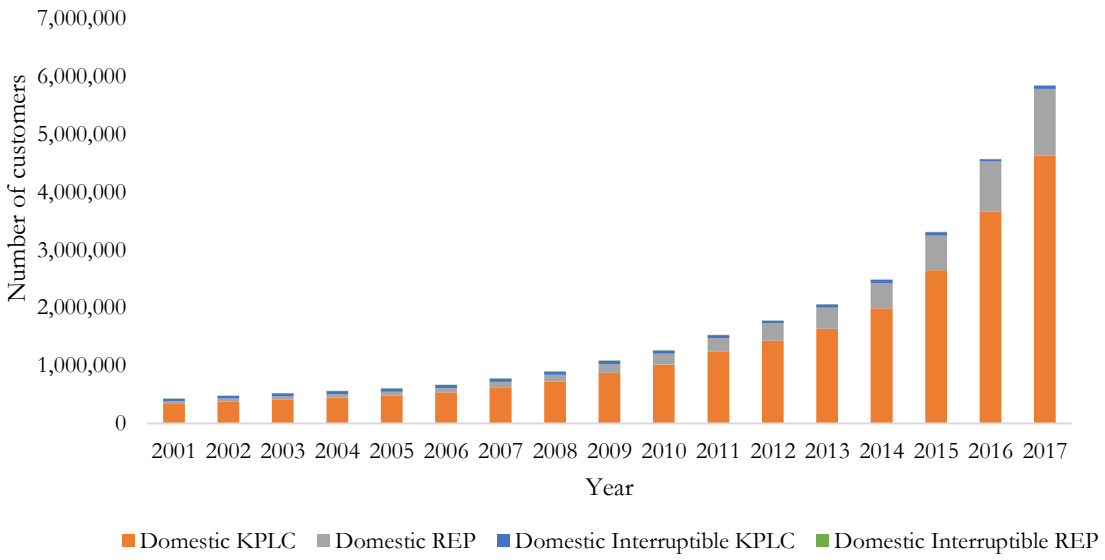
[41] World Bank (2017), 'State of Electricity Access Report 2017' (http://documents.worldbank.org/curated/en/364571494517675149/full-report), accessed 10 November 2017.
[42] KPLC (2017), 'Last Mile Connectivity Program FAQ' (http://kplc.co.ke/img/full/AtNquN6B7LWP_Last_Mile%20Frequently%20Asked%20Questions.pdf), accessed 16 November 2017.
[43] KPLC (2017), '2016-2017 Full Annual Report for the Year Ended 30th June 2017' (http://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf), accessed 10 September 2017.
[44] KPLC (2017), '2016-2017 Full Annual Report for the Year Ended 30th June 2017' (http://kplc.co.ke/AR2017/KPLC%202016%20-%202017%20Annual%20Report-.pdf), accessed 10 September 2017.

Figure 3.9: Rate of Electrification (% of population)



Source: Own illustration from data published in KPLC, 'Annual report 2017'

About 4 million Kenyan households (40% of the total) still had no grid connection in 2017, despite the Government's efforts. The traditional grid extension approach, including the LMCP, is expected to connect 3 million new households. The remaining 10% would be connected through off-grid solutions, such as stand-alone solar systems and mini grids.[45]

In 2015, the study 'Kenya Market Assessment for Off-Grid Electrification' estimated that privately owned mini grids in Kenya served more than 1,000 households. This study was commissioned by the International Finance Corporation (IFC) and the ERC.[46]

Table 3.1 illustrates the differences between the main grid and mini grids in terms of consumers served, price paid by connected consumers, and quality of service.

Table 3.1: Mini grid and Main Grid Summary Statistics, 2017

		Main Grid	Mini Grids
Customers served	Thousands	5,840.0 (June 2017)	1.0
Share of total customers served	%	99.97%	0.03%
Average tariff[(1)]	US$/kWh	0.02 for consumption below 50kWh/month	0.56

[45] World Bank (2017), 'Kenya – Off-Grid Solar Access Project for Underserved Counties', Washington, D.C. (http://documents.worldbank.org/curated/en/212451501293669530/Kenya-Off-grid-Solar-Access-Project-for-Underserved-Counties), accessed 10 September 2017.

[46] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.

		Main Grid	Mini Grids
		0.12 for consumption between 51kWh-1,500kWh/month 0.20 for consumption above 1,500kWh/month	
Availability of electricity	Hours of service/day	24	24

Source: Carbon Africa Limited et al. (2015), KPLC 'Annual Report and Financial Statements 2016/2017'.
Notes: (1) Customers served by grid refers to domestic customers connected to main grid or mini grids owned by KPLC.
(2) Customers served by mini grid refers to households connected to privately owned mini grids.

Table 3.2 compares the progress of connection to the main grid and via mini grids.

Table 3.2: Evolution of Electrification, Main grid and Mini grids

		1995	2005	2015
Population		27.37	35.35	46.05
Urban	*Million*	*5.02*	*7.11*	*10.92*
Rural		*22.35*	*28.23*	*35.13*
Population served by the main grid	'000	N/A	3,057.04	13,884.92
Population served by mini grids	'000	N/A-	N/A	61.1
Population served by private mini grids	'000	N/A	N/A	4.2

Source: KPLC 'Annual Reports' (2016)
Note: The population served by mini grids is an estimate calculated by multiplying the number of customers with the average number of people per household, which is assumed 4.2 for Kenya using the 2012/2013 Kenya National Housing Survey from Ministry of Land, Housing & Urban Development.

4 | POLICY SETTINGS FOR MINI GRIDS

The Government has mainly been resorting to grid extension to increase the electrification rate in the country. Since 2009, however, the Government has accepted that off-grid solutions are more likely to increase electrification in rural areas. Electrification projects in Kenya are funded by the MoEP and built primarily by REA, then handed over for operation by KPLC.

4.1 AN UNCERTAIN POLICY LANDSCAPE

The Government revised the 1997 REMP in 2009 to add other solutions, rather than focusing only on extending the main grid. The 2009 REMP recognized that off-grid electrification approaches were needed to provide power to unserved and remote counties.

While the Government acknowledges the need for mini grid-specific regulation, implementation has been slow. This also affects private sector participation. The ERC is working on a mini grid-specific regulation, with technical assistance from the German Technical Cooperation (GIZ).[47] The draft regulation was issued to the private sector for comments, but interviewees expressed concern that the ERC may not consider this feedback.[48]

Private sector mini grid developers are concerned that their right to supply energy exclusively to an area could be overruled under the Constitution.[49] Applying the Constitution strictly implies that KPLC would have to be split into 47 county units.[50]However, the Constitution also says that energy matters are to be organized by the counties, not the Federal Government.

ERC is considering Nigeria's experience with mini grids to help in drafting the new regulation. Nigeria plans on both top-down and bottom-up approaches, with grants for solicited and unsolicited projects; solicited projects are expected to specify an upper ceiling retail price and number of required interconnections for that price, and then let private developers bid on the required subsidy. Unlike Nigeria, Kenya plans to contract private developers only for construction and operation (the 3-contract model: EPC, PPA, and O&M) rather than full ownership and operation by the private developer, according to the Project Appraisal Document of the World Bank's Kenya Off-Grid Solar Access Project (KOSAP);[51] also, the country plans to have a bidding system in place that just seeks the lowest price per installed capacity.

4.2 POLICY APPROACH TO NATIONAL TARIFF

A national tariff policy applies to KPLC customers. Every consumer connected to KPLC pays the uniform tariff, whether they use its interconnected grid or KPLC mini grids. This policy will probably also apply to the 120 mini grids to be built in the 14 northern counties with support from KOSAP.[52]

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[47] Field interviews, GIZ, September 2017.
[48] Field interviews, private sector developers, September 2017.
[49] Field interviews GIZ, September 2017.
[50] Field interviews, GIZ, September 2017.
[51] World Bank. *Kenya: Off-Grid Solar Access Project for Underserved Counties*. http://projects.worldbank.org/P160009?lang=en (accessed 28 November 2017)
[52] Field interviews, MoEP, September 2017.

4.3 EXPANSION PLANNING

Kenya's National Electrification Strategy (NES) is based on a least-cost expansion plan that covers grid extension, mini grids, and solar home systems (SHS). According to MoEP, the NES in Kenya focuses on two main approaches:[53]

- Grid extension using medium-voltage lines, and
- Off-grid electrification solutions, developing mini grids in rural areas where the national grid will not be available for at least ten years (planning information is publicly provided).

In its role overseeing how the NES is applied, the REA follows a grid extension plan that is available to the public. REA builds the grid, and transfers it to KPLC for operation. The ERC has clarified that REA is not allowed to enter the distribution business.[54] Hence, REA is a funder rather than an owner or operator.

KPLC also extends the grid, which creates coordination problems because KPLC and the REA each have their own grid extension plans. The REA has awarded contracts for grid extension in areas where KPLC had already extended the grid.[55] KPLC's Five Year Corporate Strategic Plan states that it aims to build 3,200km new HV and MV power lines per year, and add 1.2 million customers per year from 2017 until 2020.[56]

The LMCP will also contribute to grid extension work. It promotes grid densification in areas that are 600m or more from existing distribution infrastructure.[57]

In 2011, the Scaling-up Renewable Energy in Low Income Countries Program (SREP) planned for 27 new public sector mini grids and the hybridization of 12 existing diesel-fueled mini grid sites. The program sought private sector participation in developing the existing sites, with an opportunity to implement 3MW of renewable hybrid systems in existing sites under FiTs.[58]

The project was approved as part of a country investment plan in 2014, but the private sector has not developed a full project proposal.[59]FiTs and results-based financing schemes were supposed to attract private mini grid developers to the hybrid projects. Reasons for lack of proposals may be the FiT being too low for hybrid systems (US$ 0.20 per kWh), combined with a limited revenue stream because of uncertainty of being able to feed solar power given operational constraints by diesel generation.

The World Bank approved US$150 million in finance to KOSAP in 2017, to increase access to modern energy services in underserved counties from 2018 until 2025. The total amount will probably be paid in unadjusted disbursements. US$40 million of the total amount will be used to develop mini grids at 120

[53] Field interviews, MoEP, September 2017.
[54] Field interviews, GIZ & REA, September 2017.
[55] Field interviews, REA, September 2017.
[56] KPLC (2017), 'Five Year Corporate Strategic Plan 2016/17- 2020/21' (http://kplc.co.ke/img/full/ghF3ofEfRLnX_Strategic%20booklet%20final%202016.pdf), accessed 15 October 2017.
[57] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[58] Government of Kenya (2011), 'Scaling-up Renewable Energy Program (SREP): Investment Plan for Kenya'. (http://www.climateinvestmentfunds.org/sites/default/files/Kenya%20IP_0.pdf) , accessed 27 September 2017.
[59] ECN (2014), 'Trends and opportunities in multilateral climate funds' (https://www.ecn.nl/publicaties/PdfFetch.aspx?nr=ECN-E--15-014), accessed 17 October 2017.

sites, serving approximately 27,000 consumers in total. REA and KPLC will jointly oversee this component.[60]

5 | OVERVIEW OF THE MINI GRID SECTOR

Kenya has three different ownership/operating models for its mini grids:[61]

- Public mini grids,
- Community-owned mini grids, and
- Privately owned mini grids.

This study focuses on mini grids in the private sector. However, the other mini grids are explained as part of an overview of the mini grid sector in Kenya.

KPLC's public mini grids dominate the sector in Kenya, but some private mini grid companies also operate (see Appendix). Four known companies operate at least 21 mini grids: Powerhive, Talek, PowerGen, and RVE.Sol.[62] Many unregulated private mini grid operators also supply power to customers, using a small diesel generator where there is no grid connection.[63]

Privately owned mini grids

Private companies own and operate mini grids throughout the country. These mini grids typically have an installed capacity below 100kW. More than 21 private mini grids serve between 1,000 and 2,500 customer households, with an aggregate capacity of approximately 500kW.

Companies such as PowerGen, SteamaCo, and Powerhive had installed between 10 and 15 mini grid sites by 2014 (between 2kWp and 15kWp in size). Other mini grid players in Kenya include IPS Kenya, RVE.Sol, Wind for Prosperity Kenya, Greenpower Engineering, Ofgen, KMR Infrastructure, and Skynotch Energy Africa.

Private mini grids on agricultural estates are not included in this study, since they have a special license to generate electricity for their own use and not for sale. These mini grids mostly have installed capacity over 1MW. Their total installed capacity in Kenya is estimated as 65MW.

Community-owned mini grids

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[60] World Bank (2017), 'Kenya – Off-Grid Solar Access Project for Underserved Counties', Washington, D.C. (http://documents.worldbank.org/curated/en/212451501293669530/Kenya-Off-grid-Solar-Access-Project-for-Underserved-Counties), accessed 10 September 2017.

[61] Economic Consulting Associates (ECA) (2014), 'Project Design Study on the Renewable Energy Development for Off-Grid Power Supply in Rural Regions of Kenya' (https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58e33060a5790ae65cd2f35f/1491284070829/ECA+Kenya+Minigrids+Report+-+revised+final%281%29.pdf), accessed 19 September 2017.

[62] Field interviews and own analysis, September 2017.

[63] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.

Communities own and operate some mini grids, operating and maintaining the whole system from generation to distribution to collection of payments. The communities usually have management committees with a chairman, vice-chairman, treasurer, and a manager responsible for technical operation of the system.[64]

Hydro power mini grids in Thima, Kathamba, Tungu Kabiri, and Kipini are examples of community-owned mini grids. Kathamba, Thima, and Kipini supply power to 290 customers, mainly households, while Tungu Kabiri provides power to small businesses. No information on their tariff structure is publicly available.[65]

Publicly owned and operated mini grids

REA owns 19 public mini-grid stations, operated by KPLC; these are all diesel-fired in combination with wind, wind and solar, or solar.[66] REA and KPLC have signed a Service Level Agreement (SLA) stating that KPLC will operate and maintain all of REA's off-grid power stations. KPLC's operation and maintenance costs are covered through retail electricity tariffs from both main grid and mini grid retail customers.[67] KPLC's mini grid customers are charged the same tariff as KPLC's main grid customers. But KPLC's actual operation and maintenance expenses on mini grids are higher than the revenues produced by tariffs charged to its mini grid customers. The shortfall in revenues is recovered through cross subsidies paid by KPLC's non-mini grid customers.

KenGen owned two isolated mini grids (Garissa and Lamu) that were decommissioned in June 2016 due to high operation costs and the arrival of the national grid. The two mini grids had a total installed capacity of 9MW, and no compensation was paid for their generation assets.[68] A new transmission line connected the area to the national grid in 2016, from Kindaruma to Garissa and from Mombasa to Lamu.[69] Indian companies Tata Projects and KEC International constructed the transmission lines under the Kenya Electricity Expansion Project (KEEP), funded by the World Bank.[70] The mini grid generators were relocated and the area is now connected to a more stable and reliable supply from the main grid.[71]

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[64] ECA (2014), 'Project Design Study on the Renewable Energy Development for Off-Grid Power Supply in Rural Regions of Kenya, Economic Consulting Associates' (https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58e33060a5790ae65cd2f35f/1491284070829/ECA+Kenya+Minigrids+Report+-+revised+final%281%29.pdf), accessed 19 September 2017.

[65] Lights Power Actions (2017), Electrifying Africa (http://www.africaprogresspanel. org/wp-content/uploads/2017/03/APP_Lights_Power_Action_Web_PDF.pdf), accessed 19 September 2017.

[66] One wind diesel (Marsabit, 500 kW wind, 2400 kW diesel); one wind/solar diesel (Habaswein, 800 kw diesel, 50 kw wind, 30 kw solar); others solar diesel (Mandera (300 kW solar, 1600 kW diesel), Hola (800 kW diesel 60 kW solar), Merti (138 kW diesel, 10 kW solar), and Elwak (360 kw diesel, 50 kw solar)).

[67] REA (2011), 'Rural Electrification Program in Kenya', AEI Practitioners Workshop, Dakar, Senegal (http://siteresources.worldbank.org/EXTAFRREGTOPENERGY/Resources/717305-1327690230600/8397692-1327691237767/Rural_Electrification_in_Kenya_presentation_Final_11thNov2011.pdf), accessed 19 September 2017.

[68] KenGen, 'Integrated Annual Report & Financial Statements for the Year ended 30 June 2016' (http://www.kengen.co.ke/sites/default/files/financial-reports/KenGen%20Annual%20Report%202016_0.pdf), accessed 5 November 2017.

[69] KenGen, 'Integrated Annual Report & Financial Statements for the Year ended 30 June 2016' (http://www.kengen.co.ke/sites/default/files/financial-reports/KenGen%20Annual%20Report%202016_0.pdf), accessed 5 November 2017.

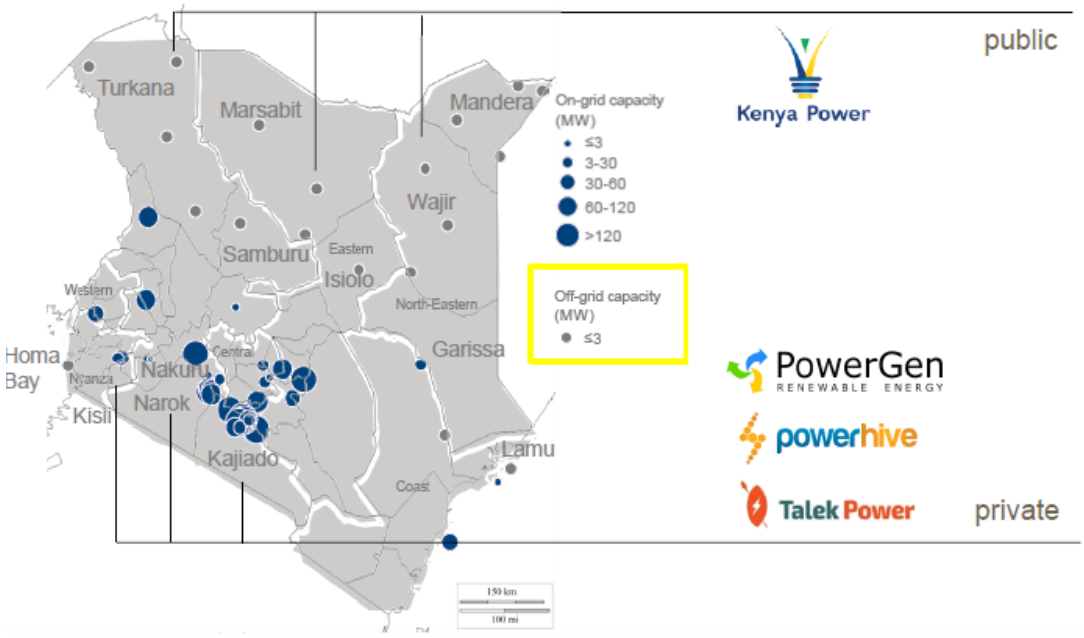
[70] KETRACO (2012), 'Annual Report and Financial Statements 2011/2012' (https://www.ketraco.co.ke/opencms/export/sites/ketraco/about/reports/Annual_Report_2011-2012.pdf), accessed 20 October 2017.

[71] KenGen, Web page 'Off grid stations' (http://www.kengen.co.ke/?q=content/offgrid-stations), accessed 5 November 2017.

The REA plans and implements new mini grids using income generated from the Rural Electrification Levy (5% of all consumer bills[72]) and other sources (see section 3.1). REA has 11 mini grid sites currently under construction.[73]

Figure 5.1 illustrates the sites of public and private off-grid stations in Kenya.[74]

Figure 5.1: Public and Private Off-Grid Stations in Kenya



Source: GIZ (2016)

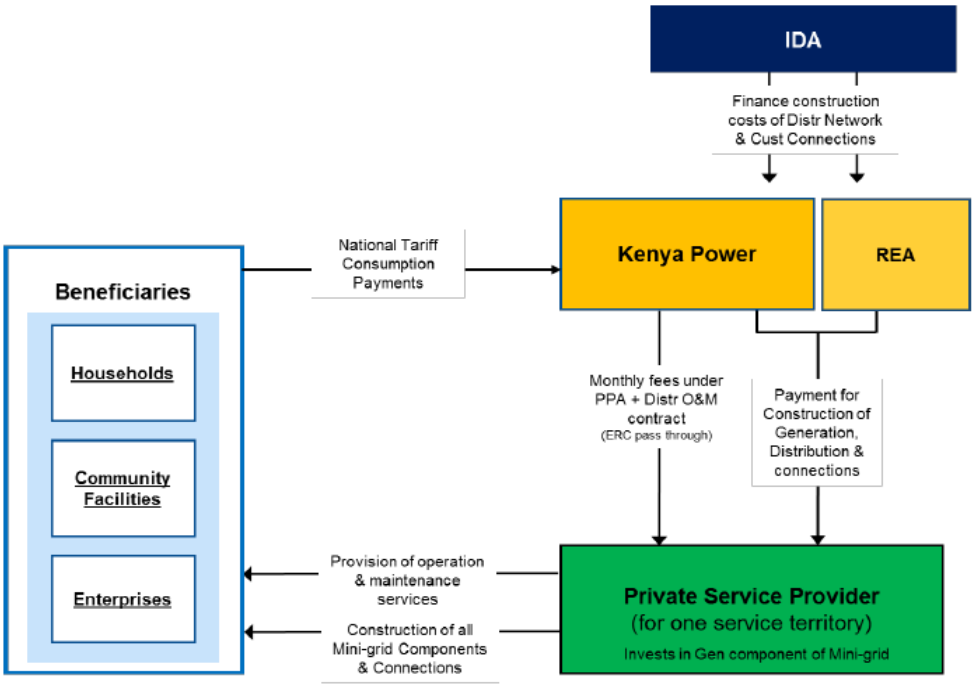
KOSAP will establish more mini grids under public-private partnership with private developers. To do this it will use a set of contracts, including: PPAs for generation, which grant operational rights for seven to ten years until the private investment is recovered; EPC contracts to build the distribution assets of the mini grid, paid by the REA; and O&M contracts to maintain the distribution assets. At the end of the contracts periods, ownership of all generation and distribution assets is transferred to the Government, and customer relations are owned by KPLC from the beginning. A competitive bidding process is to set the PPA price per unit.[75]

Some mini grid players in Kenya believe that the program will make KPLC more powerful.[76] Customer will have a contract with KPLC, and KPLC will manage retail and billing using its system and tariffs. The private mini grid developers expressed concern that KOSAP could standardize PPAs between the private sector and KPLC, and only allow for generation business.[77] The concern stems from private sector mini

[72] Government of Kenya (2006), 'The Energy Act of 2006' (http://www.erc.go.ke/images/Regulations/energy.pdf), accessed 16 September 2017.
[73] ESMAP (2016) 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[74] GIZ (2016), 'Mini-Grid Regulation and Practical Experiences from Kenya' (https://www.giz.de/fachexpertise/downloads/2016-en-kenya-regulation-experiences-jasmin-fraatz.pdf), accessed 16 September 2017.
[75] Field interviews, GIZ, September 2017.
[76] Field interviews, GIZ, September 2017.
[77] Field interviews, GIZ, September 2017.

grid operators seeing direct access to the customer as the key value. Electricity sales allow access to the customer, but the real business case lies with selling internet, advertising, and other value-added services.[78]

Figure 5.2: KOSAP Implementation Plan



Source: World Bank (2017)

5.1 MINI GRIDS TECHNOLOGIES

Private mini grids have an estimated 500kW of total installed capacity, using hybrid technologies consisting of wind, solar, hydro, battery storage, and diesel generators for backup. Most privately developed mini grids have installed capacity below 100kW, excluding estate mini grids, which generate power for their own consumption.

Private mini grids deploy customized systems to monitor and control consumption, and to collect revenues. Such systems range from rudimentary to sophisticated smart technologies with automatic monitoring, control, and payment functions. GIZ is one of the players that has implemented smart technologies on its solar PV mini grids in Kenya.[79] M-Kopa, PowerHive Ltd, and SteamaCo are also implementing smart technologies in their mini grids.[80]

[78] Field interviews, private sector mini grid developers, September 2017.
[79] ECA (2014), 'Project Design Study on the Renewable Energy Development for Off-Grid Power Supply in Rural Regions of Kenya, Economic Consulting Associates' (https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58e33060a5790ae65cd2f35f/1491284070829/ECA+Kenya+Minigrids+Report+-+revised+final%281%29.pdf), accessed 19 September 2017.
[80] E. Njoki and L. Waters, Practical Action Consulting (2016), 'Market Analysis: Real-time Monitoring, Control and Payment Technologies for Mini-grids in Kenya and Rwanda'. (http://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Market_Analysis_Kenya_and_Rwanda.pdf), accessed 19 September 2017.

The 21 public mini grids had a total installed capacity of 24.8MW in 2016, consisting of 23.7MW thermal, 0.55MW wind, and 569kW solar.[81] Two of these mini grids were decommissioned in 2016. They were operated by KenGen and had generation capacity of 9MW. KPLC operates the remaining 19 mini grids.

KPLC's mini grid sites range from 184kW to 3,400kW capacity, serving 80 to 4,100 customers. Most of these systems are diesel-based and hybridized with solar and/or wind generators, and average fuel costs between US$0.28 and 0.55/kWh (KES29 to KES57/kWh). KPLC's mini grid customer demand ranges between 200W and 400W per month, with most customers using 50kWh to 100kWh.

Renewable energy investment costs vary for hybridization of KPLC stations with solar PV. Costs range from USD$5,100 to US$13,575 per kWp, depending on economies of scale and other factors.[82] A public-private partnership (PPP) model will be used to hybridize the KPLC stations. However, the model does not yet define the exact extent of private sector involvement.

Mini grid developers must follow the national standards and the Kenya grid code. However, some mini grids use the more stringent IEC standards[83] instead of the code, such as Powerhive mini grids. According to Powerhive, it uses higher technical standards to ensure a longer lifetime of the assets.[84]

5.2 BUSINESS MODELS

The private sector mini grid developers focus on densely populated areas. Projects are funded mostly by grant financing from development partners. Some private companies, such as flower farms and tea estates, generate power for their own operations and sell excess power to KPLC.[85] The main mini grid business models used in Kenya are explained below. For now, there is no operator planning on operating a mini grid that would parallel KPLC's and offer more reliability to retail customers.

IPP/SPP Model/Separate Genco-DISCO

Mini grids generate and sell power to a utility company, large power consumer off-taker, or a single buyer. The mini grid company operates as a small power producer (SPP), which supplies power and receives payment under a PPA. The PPA addresses the associated risks of main grid extension and tariff adjustment.

Mini grids are developed using a PPP model. The Government invests in land, electricity distribution network, and basic support infrastructure through REA. The private developer invests in generation assets and operates the system.[86] The generation assets are typically handed over to KPLC after 7 to 10 years. The private mini grid company is not involved in grid operations, distribution, customer

[81] Patrick Thaddayos Balla, 2017. 'Environmental and social management framework. Kenya : s.n. http://documents.worldbank.org/curated/en/543161490352369110/Environmental-and-social-management-framework, accessed 15 October 2017.
[82] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[83] IEC standards are defined by the International Electrotechnical Commission. They are widely accepted as the highest international standards for power systems and their components.
[84] Castalia field interview, Powerhive
[85] Business Sweden, 2017.
[86] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.

connections, or revenue collection. KPLC is responsible for retail distribution of electricity and dealing with customers. The sites in this model are usually located far from the main grid.

The planned 'Wind for Prosperity' portfolio is an example of the PPA model, integrating a new wind-based IPP into many existing KPLC mini grids in Kenya.[87] Under KOSAP, 120 mini grid sites are planned with this model.

Distribution concession model/Combined Genco-DISCO

The mini grid developer is responsible for both distribution and supply. It generates power or buys electricity from the national grid and sells it to the end customers. This model gives the operator exclusivity for a predefined period and an allocated area, so that the company can achieve a return on investment once the mini grid starts operating. The private company is responsible for grid operations, distribution, supply, and revenue collection.

This model is used in very remote areas. Mini grid sites are usually also larger in size to justify the transaction costs.[88]

ERC approves tariffs for retail customers by granting a permit or license to the company. Subsidies may be required depending on the tariff model.[89] PowerHive has been operating under this model since 2015 in Kisii and Nyamira counties with a license for electric power generation, distribution, and supply.

Electricity supply cluster model

Systems usually have an installed capacity below 50kW, based on either diesel generators or solar PV systems. They are typically modular and mobile, and can be relocated if the main grid arrives. This model is used by the small, unregulated operators that have existed in Kenya for a long time. They typically supply power with a diesel generator and target small, clustered load centers.

The developers provide very low connection fees and fixed monthly charges. Tariffs are cost-reflective (US$0.8/kWh and above) and not regulated, since they operate without a license. Tariffs are below the equivalent cost of traditional energy sources, such as kerosene, dry cell batteries, and cellphone-charging services. Lower connection costs mean immediate electrification, and higher tariffs recover the investment quickly, usually in less than 10 years. Developers use modern technology for control, monitoring, metering, and payment collection.

Developers also target areas with energy access but low electrification rates, because the business model focuses on electricity supply. The model is based on low capital costs, quick deployment, high customer demand, and a short payback period. SteamaCo and PowerGen use this model in Kenya.[90]

Diversified revenue stream

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[87] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[88] Ibid.
[89] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[90] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.

Some mini grid operators have diversified revenue streams, generating additional revenues from other business activities. Power supply to customers is still the core business, but operators also provide additional services, such as setting up a small shop, distributing solar lanterns, phone charging, and electricity to provide services such as internet, printing, photocopying, water pumping, or agricultural processing.[91]

RVE.Sol and PowerHive are two mini grid operators with diversified revenue streams. As well as power, they sell other essential infrastructure services. RVE.Sol sells water and leases electrical appliances, and PowerHive sells internet as a service.[92]

Public model

REA is responsible for building generation and distribution assets. KPLC operates and maintains the assets. ERC approves uniform tariffs for mini grid customers, which apply to all retail KPLC customers. The electricity tariff is around $0.20/kWh, but changes every month depending on pass-through costs such as monthly fuel and forex fluctuations, and semi-annual changes due to inflation.

Payment methods

Mini grids in Kenya use traditional payment methods, as well as pre-payment methods enabled with mobile technology. The PAYG model originated in Kenya. It meets the challenges of extending end-user finance and collecting payments from remote customers, who often have unpredictable and limited cash flow.[93]

Pre-payment meters for grid connections have been used in Kenya since 2009, because cellular networks are widespread and mobile money platforms are popular.[94] SteamaCo and Powerhive have a cloud-based remote system for metering and payments on their mini grids, which monitors energy use, lets people pay for power using their mobile phones, and quickly troubleshoots problems.[95]

Public mini grids use post-paid or prepaid meter-billing systems for payment. Customers using prepaid systems pay through platforms such as M-PESA and tokens bought from vendors.[96]

Project acquisition

The private mini grid developers use GIS-based mapping technology to build new mini grid portfolios. One of these developers, Powerhive, uses the proprietary SWARM tool to identify potential customers

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[91] Ibid.
[92] Field interviews.
[93] WRI (2016), 'Stimulating Pay-As-You-Go Energy Access in Kenya and Tanzania: The Role of Development Finance' (https://www.gogla.org/sites/default/files/recource_docs/stimulating_pay-as-you-go_energy_access_in_kenya_and_tanzania_the_role_of_development_finance.pdf), accessed 19 September 2017.
[94] E. Njoki and L. Waters, Practical Action Consulting (2016), 'Market Analysis: Real-time Monitoring, Control and Payment Technologies for Mini-grids in Kenya and Rwanda'. (http://sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/Market_Analysis_Kenya_and_Rwanda.pdf), accessed 19 September 2017.
[95] Ashden Awards (2015), 'SteamaCo, Kenya: Remote controlled microgrids for rural areas' (http://www.ashden.org/winners/SteamaCo15), accessed 19 September 2017.
[96] ECA (2014), 'Project Design Study on the Renewable Energy Development for Off-Grid Power Supply in Rural Regions of Kenya, Economic Consulting Associates' (https://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/58e33060a5790ae65cd2f35f/1491284070829/ECA+Kenya+Minigrids+Report+-+revised+final%281%29.pdf), accessed 19 September 2017.

and design sites based on demographics, technical features, and financial viability. Income per capita is also factored in.

Private sector mini grid developers must first seek approval from their investment committee. Then they evaluate the villages' education level, income, household size, appliances, energy consumption, and willingness/ability to pay.[97]

6 | AUTHORIZING MINI GRID OPERATORS

Mini grids are currently subject to no specific regulations. ERC grants permits and licenses for mini grids based on the Energy Regulation of 2012, which applies to all power sector participants and provides a permitting and licensing framework separated into generation, distribution, and retail sale of power. (Some developers refer to 'concessions', but these describe business models rather than the authorizations that ERC grants.)

Table 6.1 summarizes the required authorization for mini grids as published on ERC's website. Until new legislation is passed, installed mini grid capacity below 3MW requires a permit. Systems with capacity greater than 3MW require a license. The difference is based on capacity, but permits and licenses require the same application process, grant the same rights, and come with the same obligations.[98]

The 2012 regulations did not address exclusivity, but this is included in the draft 2015 Energy Bill (still to be enacted). It will most likely be part of the new regulation when the Act enters into force.[99] Until now, licensed private mini grid companies have had exclusive rights and obligations to supply power for a period of 25 years. ERC is focusing primarily on authorizing the larger systems (above 1MW).[100]

Table 6.1: Required Authorization for Mini Grids

Undertaking or activity	Required authorization	Applicable regulation
Generation of electricity not exceeding 1MW for own use	None	**Energy (Electricity Licensing) Regulations 2012**
Generation and supply of electrical energy not exceeding 3MW	Permit	
Generation, transmission, distribution, and supply of electrical energy exceeding 3MW	License	
Electrical installation work at the premises of a customer	Electrician's license and Certificate of Registration as an electrical contractor	**Electrical Power (Electrical Installation Work) Rules 2006**

Source: http://www.erc.go.ke

[97] Field interviews, Powerhive, September 2017.
[98] Field interviews, GIZ, September 2017.
[99] Field interviews, GIZ, September 2017.
[100] Field interviews, ERC, September 2017.

MoEP is planning to amend the grid code to make it easier for the mini grid sector to interconnect customers. It plans to roll out the amended grid code and the new ERC regulation together.[101]

Operators usually need a memorandum of understanding with the community before a license is granted. In addition, any stakeholder (KPLC, local government, villagers, the public, etc.) may object to a permit or license. For example, KPLC objected to the Talek license. ERC did not accept the complaint and decided in favor of Talek mainly because KPLC had made mistakes in its dispute (mainly of a formal nature in the application).[102]

Several private sector companies have been licensed to generate electricity but, apart from KPLC, only two (Powerhive and Talek Power Company) have received provisional distribution permits or licenses; provisional permits or licenses allow operation and, if nothing in the process is found, lead to a final authorization. The distribution license process is costly and lengthy for mini grids. Licensing costs can exceed 10% of a project's capital costs,[103] and the licensing and permitting process can take up to three years. GIZ has published a guide to mini grid licensing to help mini grid developers with the process.

The licensing process for power generation, distribution, and retail is designed for large projects and large utilities (e.g. multi-MW IPPs). PPAs are also designed with larger organizations in mind. Developers have to deal with MoEP, the ERC, and the county governments to get a permit or license, as well as obtain clearance from several government entities:

- National Environment Management Authority (NEMA),
- Ministry of Lands for way-leaves,
- Water Resource Management Authority for hydro projects,
- Kenya Civil Aviation Authority for wind projects.

Powerhive East Africa Ltd was the first private company to receive a utility license to generate, distribute, and sell electricity to the Kenyan public. Powerhive was granted the license in 2015 after more than two years operating successful renewable energy mini grid pilot projects, serving around 1,500 people in four villages in Kisii, Kenya. Powerhive was guaranteed the exclusive right to supply power for 25 years county-wide, with performance goals attached to keep exclusivity in each county.[104] Powerhive is regulated as a utility, which means it can access government-sponsored incentives.[105]

The licensing process includes negotiating tariffs. Customer tariffs are negotiated with the ERC, but in May 2016 Powerhive was the only entity with an approved tariff schedule.[106] Powerhive engaged a tariff consultant to develop a tariff that would be approved by ERC, and provided four options to ERC.[107] ERC approval is required for any tariff change, as defined in the license. Customers have signed a contract with Powerhive, and this contract must be changed with every customer if the tariffs change.

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[101] Field interviews, MoEP, September 2017.
[102] Field interviews, GIZ, September 2017.
[103] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[104] Field interviews, Powerhive, September 2017.
[105] Powerhive, 'Low Carbon Microgrid Long Case Study'.
[106] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[107] Field interviews Powerhive, September 2017.

7 | TECHNICAL AND SERVICE STANDARDS

Mini grids must comply with the Kenya Electricity Grid Code's electricity connection and distribution technical requirements. A mini grid's wiring work in households must comply with applicable codes, standards, and the Electric Power (Electrical Installation Work) Rules 2006. A technical report by an electrical engineer must declare compliance with standards and the grid code. The engineer must be registered with the Institution of Engineers of Kenya (IEK).

Before a mini grid is constructed, the developer must submit an Environmental and Social Impact Assessment (ESIA) to the National Environmental Management Authority (NEMA), to obtain an ESIA license. Then ERC checks compliance with the grid code and ensures installed capacity meets local demand.[108]

The Government required the LV distribution for the 50kWp GIZ/Narok County mini-grid pilot (of Talek Power Company) to be built according to the guidelines of the National Grid Code. These guidelines allow subsequent integration into the national grid.[109]

Powerhive does not follow the Kenya grid code and instead uses the more stringent IEC standards.[110] KPLC and ERC have since realized that the high grid code standards can drive up cost, and intend to streamline the technical grid code.[111]

8 | TARIFFS, FINANCING, AND SUBSIDIES

Access to finance is a challenge for private mini grid developers in Kenya. Finance is difficult to access for projects with installed capacity less than 100kW, since they are not licensed and are not officially recognized by ERC.[112] A limited number of financial institutions and banks are interested in mini grid businesses. For example, Powerhive financed all its existing projects using equity investment.[113]

8.1 SETTING RETAIL TARIFFS

Tariffs for private mini grid customers are cost-reflective, and every operator uses different tariff systems. Mini grids must submit their models to the regulator for approval and to obtain a license. The ERC consults with the community on the tariff. For example, Powerhive uses a GIZ-provided tool to set

[108] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[109] Ibid.
[110] Field interviews, Powerhive, September 2017.
[111] Field interviews, GIZ, September 2017.
[112] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[113] Field interviews, Powerhive, September 2017.

retail tariffs. The tool calculates realistic and applicable electricity tariffs based on the levelized cost of electricity. Powerhive focuses on reducing the variable costs as much as possible.[114]

The GIZ licensing manual states that a tariff model is submitted to ERC in the form of an Excel spreadsheet explaining the cost calculation. The maximum internal rate of return (IRR) is limited to 18% by ERC, which establishes a fair return to the investor and a fair tariff for the end user.[115] The Government has a uniform tariff policy stating that tariffs should be affordable for retail customers. Its goal is to cross-subsidize tariffs for public mini grid customers in rural areas through higher payments from all other KPLC customers.[116] GIZ helps the regulator to develop a financial model for the tariffs, and to value distribution.[117]

Whether tariffs will be uniform or cost-reflective for mini grids is unclear. Private sector distributors also need to know whether they will be allowed to charge and enforce cost-reflective tariffs. The retail price of electricity ranges between US$0.15 and US$0.20/kWh, and the Government has declared its intention to lower this by as much as 50%. Mini grid operators are likely to need grants if they are to compete with KPLC's retail prices.

Table 8.1: Evolution of Tariffs, Isolated and Connected Mini grids

		2015
Isolated mini grids	KES/kWh	70-83 (cost reflective)
	US$/kWh	0.67-0.8 (cost reflective)
Connected mini grids	KES/kWh	21 (same as national tariff)
	US$/kWh	0.20 (same as national tariff)

Source: Field interviews, GIZ, September 2017; Own analysis (Talek Tariff); ESMAP (2016)

8.2 TYPE OF SUBSIDIES AVAILABLE

The combined Government and donor-funded grid electrification program, LMCP, closes the finance gap for rural customers to access electricity. Government provides subsidies to reduce the cost of connection (currently KES45,000, soon to reduce to KES15,000).[118] The United States Agency for International Development (USAID) and the Swedish International Development Authority (Sida) are sponsoring an aid facility of €26.6 million in Kenya and Tanzania, which will provide a 50% shared loss guarantee for loans to energy borrowers, including mini grids.

The Kenya Electricity Modernization Project (KEMP) is implementing a mini grid project at a cost of US$10 million, financed by the World Bank's International Development Association (IDA) and a SREP Grant.[119] REA is the implementing agency, and the Government has signed a Project Financing Agreement with IDA.

[114] Field interviews, Powerhive, September 2017.
[115] The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2015), 'How do we license it? A guide to licensing a mini-grid energy service company in Kenya' (https://www.giz.de/en/downloads/GIZ2015-ProSolar-Licensing-Guidebook.pdf), accessed 20 October 2017.
[116] Field interviews, MoEP, September 2017.
[117] Field interviews, GIZ, September 2017.
[118] Field interviews, REA, September 2017.
[119] Presentation, SREP round table, Kenya, 2017 (https://climateinvestmentfunds.org/sites/default/files/country/srep_kenya.pdf), accessed 20 October 2017.

KPLC's mini grid sites will be retrofitted with solar and wind energy technology funded by a €33 million loan from the Agence Française de Développement (AFD) under a PPA-based business model.[120]

Germany's KfW Development Bank provides €15 million for the development of three mini grids in the Turkana and Marsabit counties The private sector will participate through a reverse bidding process (auction model); we could not learn what the bidding factor will be—possibly lowest tariff. The private sector will build, own, and operate the generation component of each mini grid, and KPLC will be responsible for distribution.

GIZ is providing technical assistance on mini grid policy. It will also help with implementing mechanisms (e.g. tariff structures, licensing), capacity building with focus on solar technicians, and support for pilot projects. The project targets three mini grids with a total budget of €7.5 million.

GIZ is also cooperating with Barclays Bank of Kenya in a Results-Based Financing (RBF) project. The project will offer incentives to project developers to create a market for mini grid electricity generation, and to trigger private sector investment. The United Kingdom's Department for International Development (DFID) is funding the project, with GIZ's Energizing Development as the hosting partner and GIZ as the implementing partner. The project targets up to 20 mini grids (<50kW), with a total budget of €2.1 million.[121]

DFID will support project preparation and leverage private investment in green mini grids (GMGs), with support from the International Climate Fund (ICF). AFD is the implementing partner. The project will target 600,000 new connections by 2020, with a total budget of GBP 30 million.

The World Bank is also providing US$11 million to support mini grid development. USAID will provide Powerhive with TA and OPIC debt financing to enable them to upscale. This project targets 100 villages in Kisii.

The Embassy of Spain is providing US$16 million for mini grid development (solar-wind-diesel hybrids). Hybrid mini grids will be developed at five sites in Turkana, Napeitom, Kerio, Lokamarinyang, Illaut, and South Horr.

FiTs for solar, set by the ERC, are US$0.20/kWh for installations connected to mini grids (US$0.12 for grid-connected systems).[122] Table 8.2 provides a summary of subsidies available for mini grids.

Table 8.2: Overview of Subsidies Available

Project stage	Implicit Subsidies	Explicit Subsidies
Design	N/A	Technical Assistance for feasibility studies, environmental impact assessment, market assessment and development, structuring community engagement, access to land, etc

[120] AFD, April/July 2015. 'Kenya: Preparation of a program for the promotion of investments in Green Mini Grids' executed by AFD with support from Economic Consulting Associates and EED Advisory a part of DFID's Green Mini Grids Kenya program https://devtracker.dfid.gov.uk/projects/GB-1-203990, accessed 20 October 2017.
[121] endev, Barclays Bank of Kenya Ltd (BBK), GIZ, 'INVESTMENT IN SOLAR PV HYBRID MINI-GRIDS IN TURKANA COUNTY Call for Expression of Interest by Private Companies' (https://energypedia.info/images/8/8f/Kenya_Mini-Grids_RBF_Project_Brief.pdf), accessed 20 October 2017.
[122] Ministry of Energy (ME), Kenya (2012), 'Feed-in-tariffs policy on wind, biomass, small-hydro, geothermal, biogas and solar resource generated electricity'.

Project stage	Implicit Subsidies	Explicit Subsidies
Finance	Credit Lines	Technical assistance for business and financial planning, e.g. developing business plans, financial models, corporate structuring, financial management procedures
Construction	Capital Grants Construction Progress Incentive (RBF): payments based on pre-agreed project implementation milestones. Power Plant Commissioning Incentive (RBF): one-time payment as contribution to the investment cost after the mini grid power plant is completed and commissioned	Technical assistance, capacity building for solar technicians
Operation	Output-based grants Connection Incentive (RBF): pre-agreed per customer per quarter payment for every paying customer during first 2 years of operation. Energy Production Incentive (RBF): quarterly pre-agreed incentive on the amount of electrical energy produced from solar PV and delivered to the customers for the first 2 years of operation FiT	Technical assistance, capacity building for solar technicians

Sources: Barclays Bank of Kenya Ltd (BBK)

8.3 ELIGIBILITY TO GET SUBSIDIES AND SOURCES OF MONEY FOR SUBSIDIES

Table 8.3 summarizes eligibility and sources of funds by subsidy.

Table 8.3: Eligibility and Sources of Funds, by Subsidy

Subsidy	Conditions	Eligibility	Sources of Funds
Technical assistance for design and finance	GBP 30 million for project preparation and capital 20 projects = >GBP 1.5 million per project	Entity registered in Kenya; must be a Kenyan entity if in execution stage Compliant with AFD's rules on nationality, corruption, fraud or anti-competitive practices, and integrity	DfID (donor), AFD (implementing agency)
Technical assistance for design,	€7.5 million for capacity building for solar technicians	Solar-hybrid mini grids Focus on ESCO/Concession	GIZ

Subsidy	Conditions	Eligibility	Sources of Funds
finance, construction, and operation	and support to pilot projects Up to three projects	model Focus on Turkana and Marsabit	
Capital grants	€15 million for CAPEX Reversed bidding process Three projects = >€5 million per project	BOO model for generation component; KPLC is responsible for distribution Location: Dukana, Kalokol, and Ngurunit	KfW
RBF grants	€2.1 million for CAPEX, connections, and production incentives (premium per kWh supplied) Reverse bidding process Up to 20 projects => €100,000/project	Company or association registered in Kenya No grants from other donors Solar and wind mini grids between 10 and 50MWp >40 paying customers	DfID (donor), EnDev (hosting agency), GIZ (implementing agency), and Barclays Bank of Kenya (implementing agency)
FiT	Tariffs (US$/kWh): 0.0825 for 500kW, 0.105 for >500kW (hydro), 0.10 (biomass, biogas), 0.11 (wind), 0.12 (solar)	FiT	Tariffs (US$/kWh): 0.0825 for 500kW, 0.105 for >500kW (hydro), 0.10 (biomass, biogas), 0.11 (wind), 0.12 (solar)

Subsidy eligibility plays an important role in how funds are used. Production incentives (premium per kilowatt hour delivered) are available for mini grids that produce energy from renewable sources with low or zero marginal generation cost. Some have pointed out how operators may seek to 'game' the system to maximize subsidies, which would require stricter definition of eligibility criteria and subsidy rules.[123]

An operator may use demand side management technologies or create additional revenue streams for productive use (heating/pumping water, mill etc.) with excess power, as in the diversified revenue stream model. Some operators have already adopted this model.

8.4 Level of subsidies

Consumers can afford the services provided by the public mini grids because of the national uniform tariff. However, private sector mini grid tariffs may not be as affordable because the uniform tariff does not apply to them. In one case, Powerhive successfully built a mini grid and KPLC also connected consumers to its grid, suggesting that consumers are willing to pay a higher tariff if the service provided

[123] A solar-diesel hybrid mini grid provides an example of how an operator game the rules to receive a subsidy. When solar power production is higher than customer demand and the storage capacity is full, the operator does not receive a subsidy for excess production because it is not supplied. However, by increasing demand on the customer side, the operator also increases the amount of subsidy received. This example applies any time that the marginal cost of generation is less than the subsidy amount. Solar and hydro power both have zero marginal cost of generation.

justifies the higher price; however, Powerhive mostly respects a 600 meter distance rule based on frequent communication with KPLC.

The subsidies could allow all consumers to receive electricity at affordable rates, if the Government required KPLC to offer the uniform tariff to all mini grid customers. The private sector would only be involved on an EPC, PPA, and O&M contracts basis. However, tariffs for KPLC's mini grid customers are not cost-reflective and are cross-subsidized by urban customers. Without grants or tariff subsidies, mini grid operators cannot compete with retail prices.[124]

Following the KOSAP model might help foster investments in mini grids. The PPA with KPLC guarantees the revenue stream of electricity sales, and O&M is cost covered through the O&M contract. However, some of the mini grid operators may consider this model unattractive as their biggest revenue stream comes from providing value-added services to customers. It is unclear at this stage what effect KOSAP will have on the sector.

The LMCP decreases the connection fee charged to households from KES35,000 (US$343) to KES15,000 (US$147), and households can pay the fee in installments. In comparison, KPLC charges customers around US$1,000 for each connection (KPLC customers are also eligible to receive a LCMP subsidy, when they are in an area that the LCMP has defined for interconnection). The LCMP subsidy helps more customers to connect to the grid, once a mini grid is built or the main grid arrives.[125]

Kenya seems to be consistently attracting support programs, NGOs, donor agencies, and financing institutions such as the World Bank and the IFC to support its grid extension, as well as the mini grid programs. Therefore, the level of overall access to finance should be sufficient to continue with current plans for electrification.

8.5 REGULATORY TREATMENT OF SUBSIDIES

ERC does not specify how grants are to be treated in the regulations. However, ERC takes third-party grants into consideration when it values mini grid assets for a buy-out option.[126]

9 | HANDLING THE RELATIONSHIP WITH THE GRID

Kenya has no clear set of regulations dealing with grid arrival. Shortly after Powerhive built a mini grid, KPLC extended the grid. As noted, households in that area now have two parallel connections, but prefer Powerhive because the supply quality is significantly higher.[127]

Kenya is pursuing a twofold strategy for future regulation: a pure IPP model, and an extended generation and operation model. For mini grid developers, the new business model promoted by the

[124] Field interviews, September 2017.
[125] World Bank (2017), 'State of electricity access report 2017' (http://documents.worldbank.org/curated/en/364571494517675149/full-report), accessed 10 November 2017.
[126] Field interviews, ERC, September 2017.
[127] Field interviews, REA & Powerhive, September 2017.

World Bank and the Government relies on KPLC having a monopoly on retail and distribution. Private operators would split their business into:[128]

- Generation (IPP – selling to KPLC), and
- Distribution (operated and maintained by the private sector, but assets belong to REA and customers to KPLC).

At the same time:

- KPLC would offer customers a uniform tariff, and
- The tariff would be cross-subsidized by all other KPLC customers in Kenya.

Some mini grid operators, such as Powerhive, currently meet with KPLC each week to discuss grid expansion and to select mini grids to address. Together, they agree to select areas that are at least 1km away from the grid.[129]

9.1 WHAT HAPPENS WHEN THE GRID ARRIVES

Regulations do not yet clarify what happens when the main grid reaches a village powered by a mini grid. ERC is working on possible models, such as:

- KPLC buys the assets of the mini grid, or
- The mini grid operator sells the energy produced to KPLC, who resells to the retail customers.

For developers who already operate mini grids, the biggest concern is the lack of a clear regulation about grid arrival. ERC is trying to define a valuation process for the assets that KPLC could acquire in the options outlined above. ERC must consider possible grants, provided as either CAPEX or OPEX subsidies to the mini grid operators. ERC is currently consulting with GIZ on this process.[130]

ERC thinks it unlikely that mini grids will continue to sell power to retail customers when they can connect to the main grid. The MoEP agrees, and maintains that the mini grid customers must be transferred to KPLC when the main grid arrives. Some of the local mini grid developers oppose the rules that propose asset buy-out when the grid arrives.[131]

The Government is likely to adopt the same setting suggested by KOSAP to regulate the mini grid sector. Its decision will be influenced by the financial aid from the World Bank, and KPLC's good financial performance compared to other African utilities. The KOSAP model suggests that mini grids will be developed under a PPP model: KPLC will sell power to customers at national tariff level and the developers will be responsible for EPC and O&M for the agreed period.

Some of the operators are concerned about losing the direct relationship with customers, but others see this as a positive opportunity. The model would remove the risk associated with uncertain demand and revenue collection, as KPLC would buy energy in bulk with a PPA under the KOSAP model.

[128] Field interviews, GIZ, September 2017.
[129] Field interviews, Powerhive, September 2017.
[130] Field interviews, ERC, September 2017.
[131] Field interviews, Powerhive, September 2017.

9.2 WHOLESALE TARIFF SETTING

Current regulations in Kenya do not allow wholesale tariff setting for mini grids for purchase or sale of power. Mini grids either:

- Are operated by the same company for generation and distribution, so don't purchase electricity (public and private), or
- Are operated by the same company for generation and distribution, with another company generating into the mini grid through a PPA with a defined FiT.

The Energy Bill of 2015 (still to be enacted) is expected to introduce a Wholesale Spot Market. The market will determine the price of electricity if there is no bilateral contract between the seller and purchaser of electricity. Generating companies will access the national transmission grid freely in a competitive electricity market.[132] However, this applies only to the main grid, as the number of generators in the mini grid sector is limited.

9.3 OBLIGATION OF UTILITY TO PURCHASE OUTPUT

Current regulations in Kenya contain no obligation to purchase electricity from a mini grid. However, when KPLC connects the grid to a mini grid, it can choose to buy electricity from the mini grid developer through a PPA. No mini grid currently sells electricity to KPLC.

9.4 POWER PURCHASE AGREEMENTS

Mini grids can use existing PPAs when they operate in fuel-saver mode only to supply energy (kWh). This setup typically applies when KPLC is hybridizing an existing diesel-based mini grid. In this case, the private sector mini grid developer only invests in and operates the solar PV (or any other renewable energy-based) technology, producing energy. These PPAs are not suitable when a supplier must meet both capacity and energy requirements.[133] The PPA price per unit will come from the public entity bids in the competitive tendering process.[134]

The existing PPAs are available on the ERC website, where KPLC is referred to as 'the Buyer'. Two simplified PPAs are in place:

- A standardized PPA for Renewable Energy Generators of 10MW or less. The tariffs offered are technology-specific, but the standardized PPA is the same for each technology, and
- A standardized PPA for Renewable Energy Generators greater than 10MW.

Standardized PPAs are agreed under the FiTs Policy issued by MEM.[135]

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[132] KPLC (2017), Five Year Corporate Strategic Plan 2016/17–2020/21. (http://kplc.co.ke/img/full/ghF3ofEfRLnX_Strategic%20booklet%20final%202016.pdf), accessed 15 October 2017.
[133] ESMAP (2016) 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[134] Field interviews, GIZ, September 2017.
[135] ERC website available at (http://www.erc.go.ke/images/docs/Standardized_PPA_for_Small_Scale_Generators_less_than_10%20MW.pdf), accessed 25 October 2017.

10 | LESSONS LEARNT

Kenya has until recently been regarded as a center for innovation on mini grids in Africa and beyond. A strong private sector engagement benefitted from the ability to apply one's own cost-reflective tariff if the rate of return was 18% or lower, despite a uniform tariff. The regulation set technical standards to follow, but was loose enough to attract various business models. Because Kenyans had relatively high purchasing power, mini grid developers also saw an opportunity to sell value-added services to mini grid customers.

But Kenya's mini grid sector boom seems to have stalled, and uncertainty about the upcoming mini grid-specific regulation is increasing risk perception and generally causing concern among private investors. ERC set out by appropriately asking for feedback from the private sector on the new regulation; but it is unclear whether it has incorporated the feedback received. Kenya also benefits from several sources and types of support—grants, debt or other financing, and subsidies from various programs—that risk having a 'gold rush' effect attracting companies that, according to some developers interviewed, are not qualified to deliver.

Private mini grid developers interviewed agreed that KOSAP risks depressing the mini grid market in Kenya by jeopardizing the chances of private equity investment. A major objection to KOSAP is its possible effect on existing regulation and the new mini grid regulation. Many of the already proven and implemented models would no longer be feasible. Programs as KOSAP are seen as hindering innovation and additional revenue streams, putting control back with KPLC that already enjoys a quasi-monopoly. Some suggest that MoEP and ERC consider leaving existing agreements unchanged; and keep the market open for models that work outside the KOSAP program, which comes with limited funding.

Appendix A: Mini grid market players in Kenya

Company: Powerhive [136,137,138]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
California-based company with a Kenyan subsidiary Founded in 2011 by two international entrepreneurs	The first MG in 2012 As of 2013, 4 sites in Kenya with a total capacity of 80MW (solar) and 300 customers As of 2017, it is building a portfolio of 20 MGs in west Kenya	Mini grid Solar + storage	Developer of village-scale renewable MGs, using solar with battery storage Primary business is information, monitoring and payment systems As well as power, Powerhive sells internet as a service First company after KPLC to be formally licensed by ERC for 25-year generation and distribution It is pursuing a franchise model, wanting others to use its branding and technology Targeting rural customers and not anchor clients Connection fee is US$8 per customer	In 2016, it closed Series A 20 Million (Total, First Solar, Caterpillar, and Leonardo DiCaprio) All existing projects are equity financed US$500,000 was granted by USAID, aiming to increase productive use with innovative business models (TA and OPIC debt financing)[139]

[136] Field interviews, Powerhive, September 2017.
[137] Powerhive webpage (http://www.powerhive.com), accessed 15 September 2017.
[138] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[139] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.

Company: Talek Power Company[140]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
Talek Power Company is a Special Purpose Vehicle (SPV), owned by the County Government of Narok [141] It was established by GIZ	40MWp solar/ 10MWp diesel backup MG, with 3km distribution network in a low voltage 3-phase system with 200 customers Initially planned to connect 250 customers Tariff was KES70/kWh (US$0.67/kWh), not cost-reflective	Mini grid Solar	Talek is the 2nd MG (after KPLC and Powerhive) to receive a license/ permit (25 years) Not all customers are directly metered, but use sub-metering and connection sharing Welthungerhilfe built the fence of the power plant in Talek When the project was implemented, the grid was 70km away, but now it comes as close as 30km After 2 years in operation, GIZ did an impact assessment in April that found that since commissioning, 120 new local jobs have been created, new shops opened, and new productive users being generated People used to travel to Narok, the next big city, but now stay in Talek, as more services are offered locally, such as welding and woodwork[142] Critics did not see GIZ as the right player to operate a mini grid for profit, therefore handed the project over to county government	GIZ

[140] Field interviews, GIZ, September 2017.
[141] The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2015), 'How do we license it? A guide to licensing a mini-grid energy service company in Kenya' (https://www.giz.de/en/downloads/GIZ2015-ProSolar-Licensing-Guidebook.pdf), accessed 20 October 2017.
[142] The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH (2015), Talek Youtube video (https://www.youtube.com/watch?v=SkuOWcgH_0I), accessed 17 November 2017.

Company: PowerGen[143] [144]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
Kenya-based company Founded in 2011 Active in Kenya, Tanzania and Zambia	Over 15 operational mini grid systems (>10 together with SteamaCo) Over 35kW installed capacity Over 500 customers including client projects	Mini grid Wind, solar, batteries Wind turbine manufacturer	Investor & operator of mini grids Electricity supply cluster model Standalone systems The GridX project at James Finlay tea estate in Kericho with Clean Star Ventures[145]	USAID
Company: SteamaCo[146] [147] [148]				
Kenya-based company **Formerly access:energy** **Active in Kenya, Tanzania and Nepal**	Its first micro grid in Kenya was at Remba Island on Lake Victoria for PowerGen >10 together with PowerGen	Mini grid Systems provider	Providing industrial automation services to mini grids and other technology types, including remote monitoring and pay-as-you-go systems Electricity supply cluster model Primary business is information platforms and payment systems	Ashden Awards, 2015

[143] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[144] Powergen Webpage, (http://powergen-renewable-energy.com/aboutpre/), accessed 16 September 2017.
[145] Gridx project Webpage (http://www.gridx-kenya.com), accessed 16 September 2017.
[146] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[147] Ashden Awards (2015), 'SteamaCo, Kenya: Remote controlled microgrids for rural areas' (http://www.ashden.org/winners/SteamaCo15), accessed 15 October 2017.
[148] SteamaCo webpage (http://steama.co), accessed 5 October 2017.

Company: Wind for Prosperity Kenya[149]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
Danish-Kenyan consortium from Maara Energy, Vestas & Frontier Investment Management	Hybridization of KPLC's existing and planned diesel off-grid stations with wind technology	Main grid and mini grid Wind for mini grids	Private developer, investor, and operator of wind power systems as an IPP	
Company: Green Power Engineering[150]				
A Kenyan private company/NGO	Identified 10 sites ranging from 60 to 500MW to supply up to 10,000 households One site has been built although the distribution network is not operational	Mini grid Small hydro	Private developer/NGO, who designs, plans, develops, and operates community-owned small hydro plants and distribution networks in southern Kenya	With government, donor and local community support, one site has been built although the distribution network is not operational

[149] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.
[150] Ibid.

Company: RVE.Sol – Rural Village Energy Solutions Lda.[151] [152] [153]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
Social enterprise with investors: KIC InnoEnergy RKW	Provides power to 47 small businesses and households through its first pilot project with 7.5MW PV – production level: 600MWh/month (AC).	Mini grid Containerized Solar	Containerized technology, includes RE generation, mini grid distribution, remote monitoring, PAYG service access, and potable water production RVE. Sol has received permit/ license Beside power and water, RVE.Sol leases equipment to the customers	RVE.Sol invested US$87,000 in its pilot project up to 2015, with a further €30,000 raised through crowdfunding facilitated by www.jointrine.com The project cash flows contemplate annual utility revenues of €17,500 versus OPEX of €7,000, generating average annual net cash of €5,000 after expenses and debt service. Break-even is expected in 2020

[151] Field interviews.
[152] Alliance for Rural Electrification Webpage (https://www.ruralelec.org/project-case-studies/rvesol-kudura-sustainable-development-solution-rural-energy-water-power-change), accessed 17 November 2017.
[153] RVE.Sol Webpage (http://www.rvesol.com/), accessed 17 November 2017.

Other mini grid companies [154] [155]				
Investors	**Number of sites and customers (existing/projects)**	**Technology**	**Business model**	**Funds/Grants/Donors**
Oserian Development Company Virunga Power Kenya Tea Development Agency Power Limited	9 sites An estimated installed capacity of 65MW	Large industrial operators such as tea factories or flower farms	Generation for own use, and supply the excess to KPLC under a PPA ERC issues licenses for self-consumption of the generated power and not for selling electricity to retail customers As an exception, power may be supplied to retail consumers inside the estates, e.g. workers' houses on their land	Own capital
* The other private mini grid developers active in Kenya are known as IPS Kenya, Ofgen, KMR Infrastructure, Skynotch Energy Africa.				

[154] ESMAP (2016), 'Current activities and challenges to scaling up mini-grids in Kenya, Energy Sector Management Assistance Program' (https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf), accessed 27 September 2017.
[155] Carbon Africa Limited et al. (2015), 'Kenya Market Assessment for Off-Grid Electrification' (http://www.renewableenergy.go.ke/asset_uplds/files/ERC%20IFC%20mini-grids%20-%20final%20report%20-%20Final.pdf), accessed 15 October 2017.