SPOTLIGHT KAMPALA

ILLUMINATING ENERGY INEQUITIES IN INFORMAL URBAN COMMUNITIES

MAIN FINDINGS REPORT

EXECUTIVE SUMMARY

OVERVIEW

Informal settlements and slum communities worldwide face persistent inequities in the accessibility, reliability, quality, safety, and affordability of electricity service. For these communities, a connection to the grid – and, importantly, the ability to translate that connection to access to electricity – is far from a guarantee despite their proximity to the grid. High connection costs, unaffordable electricity tariffs and issues related to tenancy deter households and businesses from seeking formal service. Many opt instead to interconnect through informal electricity suppliers or to share meters between households and businesses, which can limit the decision-making power of the end user in deciding how and when electricity can be used. The aggregation of multiple users also makes it difficult to accurately charge for electricity use. Chronic low voltage, voltage spikes, and frequent, prolonged grid outages are additional factors which suppress electricity consumption.

Informal communities are the economic backbone of modern African cities, and electricity is a critical input to their well-being and livelihoods. The small-scale, informal businesses and manufacturers, which employ an estimated 86% of the workforce in Africa, rely on electricity to power electric appliances, extend operating hours, and light workspaces. Unreliable, unaffordable or low-quality electricity has direct negative impacts on the income generating potential of these enterprises. Informal communities are also a much-needed source of affordable housing for millions, and barriers to electricity access at the household level ensure a reliance on biomass and fossil fuels which disproportionately impacts women. Further, a lack of access to electricity limits improvements in other infrastructure services like water, sanitation, public safety, health and education.

The global attention placed on the energy access challenges of informal communities is not commensurate with the scale of the challenge, and that oversight is undermining the achievement of Sustainable Development Goal 7 (SDG 7) to ensure "access to affordable, reliable, sustainable and modern energy for all" by 2030. In sub-Saharan Africa, over half of the continent's 500 million urban residents live in informal settings, and the overall growth rate of informal communities is expected to outpace that of an already rapidly-expanding urban population. Yet, much of the debate within SDG 7 remains focused on the provision of electricity to rural or remote populations, and engages relatively little with the unique and growing set of access challenges faced by urban and urbanizing communities.

SPOTLIGHT KAMPALA'S OBJECTIVES

Spotlight Kampala is a multi-institutional research collaboration of universities and community advocates that aims to highlight the inequities that informal urban communities face in accessing and using electricity. This report presents the findings of eight months of data collection that included surveys, interviews, remote power quality monitoring, infrastructure mapping, and community forums across 25 of Kampala's approximately 60 informal communities. This research aims not only to provide baseline statistics on important dimensions of access like access rates, affordability, supply reliability and quality, but also to ground these learnings in the daily lived experience of Kampala's informal residents. In doing so, the research teams hope to bridge the divide between researchers and policymakers by providing data that is action-oriented, and can catalyze further action of duty-bearers to find solutions to alleviate urban energy poverty for Kampala's informal communities.

This report details the findings and recommendations which emerged from the research team's collective work to characterize and address inequalities in electricity access in informal communities in Kampala. Although 95% of households and businesses are connected to the electricity grid in some way, the findings show clearly that a connection is not equivalent to electricity access. A number of barriers remain which prevent consumers from using electricity in ways that promise to improve their health, livelihoods, and overall well-being. For many, the conditions of energy access fall short of SDG 7.

KEY FINDINGS

1. **Connection types are diverse to match people's needs, constraints and circumstances**
   The results challenge binary assumptions of connections as legal or illegal, instead revealing a diversity of ways in which users in informal communities connect to the grid. Instead, there are seven unique connection types which respond to people's circumstances, needs, and constraints including purpose or use, tenancy agreements, income levels, and relationship to access supplier, among other factors.

2. **Certain prevalent connection types limit users' autonomy to decide how and when to use electricity**
   Many users who access electricity through an intermediary (e.g., a landlord) must negotiate the terms of access, such as which appliances may be used and when electricity can be used. This introduces unique constraints around a user's autonomy — their ability to decide when and how to use electricity — that in many cases limits access.

3. **Affordability is a key challenge for connecting to the grid and using electricity**
   Affordability is perhaps the strongest barrier to access. The high cost of connection deters many users from connecting through formal channels, and the high per unit tariff incites households and businesses to ration electricity by cutting off circuit breakers, using electric appliances sparingly, or simply deciding not to purchase certain appliances.

4. *Kamyufus* are last-mile providers who fill service gaps left by the utility

Informal wiremen, known locally as kamyufus, operate as the de facto last-mile service provider in informal communities. Kamyufus are able to meet service gaps by providing responsive access on flexible financial terms. They also provide affordable domestic wiring, educate consumers on electrical safety, and conduct maintenance activities. Though there are valid safety concerns that must be addressed, most kamyufus are relatively skilled and are a valuable resource in providing inclusive access.

5. Poor quality and reliability of power supply suppresses electricity consumption

Data from the power quality sensors revealed chronic low voltage, episodes of high voltage surges, and frequent voltage fluctuations that led to the premature breakage of appliances and disruptions to daily activities. The sensors, which were deployed across both formal and informal communities, show a clear disparity in the number of outages and the quality of voltage experienced. These power quality issues especially discourage productive uses of electricity.

6. Poor quality wiring compromises safety

Given residents' low and unpredictable income levels, people wire their homes and businesses incrementally as they are able to afford it, often with second hand materials. The overall quality of wiring is characterized by low-quality material, wiring that can not safely support required loads, and lack of adherence to safety standards such as grounding. These present significant safety risks to people living in informal communities, with many participants reporting knowing of deaths, injuries and property damage resulting from electricity.

7. The burden of access challenges is disproportionately borne by women

Women are disproportionately impacted by poor access to electricity across their multiple roles as cooks, caregivers, and entrepreneurs. Women are more impacted by safety and security concerns related to electricity and face greater burdens in terms of time and health as they bear the primary responsibility of cooking in households. Access challenges also affect womens' economic opportunities as women are more likely to be engaged in small businesses and home-based work.

8. Physical infrastructure is overburdened and coverage is variable

The physical mapping of electrical distribution systems revealed significant burdens on existing infrastructure, including overloaded utility poles, and transformers serving a high number of users. In most communities, the number of service lines and prepaid meters were significantly lower than the estimated number of households, indicating large concentrations of either non-connected or collectively connected users. Additionally, poor coverage of street lighting was observed, with most street lights concentrated on main roads bordering the communities.

9. Poor communication and mistrust create a negative feedback loop in utility-community relations

Informal communities lack trust in the utility due to inconsistent communication, illegal connection enforcement actions, and poor experiences with customer service. Simultaneously, utilities perceive informal communities as difficult and costly to serve due to high losses, leading to a feedback loop where both parties see little incentive to change their behavior.

PRIORITY ACTIONS TO IMPROVE ELECTRICITY SERVICE DELIVERY IN INFORMAL COMMUNITIES

1. Develop more targeted and innovative subsidy programs to reduce electricity costs for low-income customers

   Reducing the burden of the high cost of electricity emerged as a clear priority for community members.The current lifeline tariff system is not progressive, and uniformly benefits residential customers regardless of income. Implementing tariff reforms, such as a progressive inclining block tariff, or targeted subsidy programs based on socioeconomic status, could enable different consumer groups to cross-subsidize and ensure that subsidies only reach those who truly need them.

2. Continue but improve connection subsidy programs

   Connection subsidy programs such as the Electricity Connections Policy and the Hybrid Connections Credit Scheme play a vital role in enhancing electricity access and reducing non-technical losses in informal communities. To maximize their impact within informal communities, improvements to these programs should seek to increase the efficiency of the process and reduce wait times, expand the programs to partially subsidize pole costs for those in need of single-pole connections, and better target outreach and awareness efforts.

3. Create special provisions for fair and safe access by renters

   Efforts should focus on addressing the specific challenges faced by tenants in informal communities. Potential solutions include allowing renters to apply for individual meters without landlord approval, providing free or discounted meters for relocating renters, and developing specialized sub-metering programs to encourage landlords to bill based on actual, rather than estimated, consumption.

4. Densify and upgrade distribution infrastructure and street lighting

   Overloaded distribution infrastructure is the likely cause of supply challenges related to power quality and reliability. Capital investments to improve transformer coverage and capacity would alleviate these issues, lessen the burden of damaged appliances, and increase willingness to pay for electricity while discouraging the use of unmetered connections. Expanding the coverage of street lighting is also an important area of investment that would particularly benefit women.

5. Develop programs aimed at improving internal wiring conditions

   To address the safety risks posed by unsafe wiring conditions, governments and development partners should develop assistance programs for replacing or upgrading existing wiring. Bulk purchasing schemes and import tax reductions can help reduce costs, while innovative financing schemes involving the private sector can make internal wiring upgrades affordable for low-income customers. Standardized technologies like "ready boards" can also be introduced to lessen the cost burden of internal wiring and ensure minimum safety standards.

6. **Move beyond "regularization" and explore alternative service delivery schemes**

   A one-size-fits-all approach to electric service delivery struggles to meet the low ability to pay of customers in informal communities. Instead of seeking to "regularize" informal customers, service providers should explore alternative ways to safely and cost-effectively provide electricity access. This could take the form of alternative technological systems, such as solar home systems, or new delivery models like community-based distribution models.

7. **Provide more responsive customer service through local agents**

   Improving the responsiveness of utility customer service was identified as a pressing need by communities. To address these gaps, utility providers could establish community-based agent networks, potentially involving *kamyufus*, who can effectively communicate with residents, address concerns, and offer prompt assistance. This model would not only improve customer satisfaction but also provide a pathway for women to enter the technical workforce, decrease unmetered connections, and promote safer and more inclusive access to electricity.

8. **Recognize *kamyufus* as valuable sources of human capital and seek opportunities to utilize them**

   Kamyufus play a vital role within the electricity supply chain in informal communities. Accordingly, policymakers should view kamyufus as a valuable source of human capital in efforts to provide more flexible and responsible services to low-income populations. Policymakers should seek to leverage their knowledge and relationships to provide inclusive access, considering innovative approaches such as training *kamyufus* as local utility representatives or using them as communication channels for electricity service-related information.

9. **Shift away from punitive approaches to curb electricity theft and toward community engagement**

   Efforts to combat electricity theft in informal communities have primarily relied on punitive enforcement measures. However, in Kampala, such actions serve to further marginalize many who would prefer to connect legally, but must resort to unmetered connections due to affordability and service barriers. A more effective approach would involve identifying the main drivers of unmetered connections and addressing them in partnership with communities.

10. **Build stronger communication channels between sector stakeholders and communities**

    To address mistrust and misconceptions surrounding electricity services in informal communities, stakeholders should enhance communication efforts to engage and inform communities, rebuild trust, and establish positive relationships. Identifying appropriate communication channels is important to reach residents who may not have access to digital mediums. These communication efforts should be interactive, allowing stakeholders to also solicit feedback from community members to improve service quality and safety.

11. **Emphasize participatory approaches to transforming electricity service delivery**

    It is essential that any efforts to improve electricity service in informal communities include participatory approaches that empower communities to actively participate in planning and implementation. By ensuring the community's needs are voiced and considered, these approaches foster a sense of empowerment and collective responsibility, enabling community members to actively shape their energy futures.

12. Recognize the unique challenges of informal communities within the broader SDG 7 agenda

As urbanization continues and the global population living in informal communities increases, energy poverty will become more prevalent in urban areas. To ensure a just and inclusive urban future, it is crucial to mainstream efforts in understanding and addressing the unique challenges faced by informal urban communities into the Sustainable Development Goal 7 agenda.

As the Government of Uganda works to define a new structure for its electricity sector following the conclusion of Umeme's concession in 2025, the research team hopes that this body of evidence will aid policymakers in understanding the unique barriers faced by Kampala's informal communities, and guide constructive discussions towards the shared objective of inclusive electricity services for all.

AUTHORS

Jess Kersey[1], Judith Mbabazi[2], Civian Kiki Massa[3], Lydia Letaru[4,5], June Lukuyu[6], Elena van Hove[7], Paul Kyoma[8]

[1] Energy and Resources Group, University of California, Berkeley

[2] Urban Action Lab, Makerere University

[3] Electrical and Computer Engineering, University of Massachusetts, Amherst

[4] Department of Geomatics and Land Management, Makerere University

[5] YouthMappers

[6] Electrical and Computer Engineering, University of Washington

[7] Laboratory for Energy and Power Solutions, Arizona State University

[8] Independent researcher

EXPERT REVIEWERS

Dr. Paul Mukwaya[1], Dr. Dan Kammen[2], Dr. Jay Taneja[3], Dr. Nathan Johnson[4], Sumaya Mahomed[5]

[1] Urban Action Lab, Makerere University

[2] Energy and Resources Group, University of California, Berkeley

[3] Computer Science, University of Massachusetts, Amherst

[4] Laboratory for Energy and Power Solutions, Arizona State University

[5] Independent energy access consultant

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the Local Council leaders who supported the work, and the many community members and subject matter experts who graciously shared their time to participate. We also acknowledge the support of ACTogether Uganda and the National Slum Dwellers Federation of Uganda, specifically Junior Wamala, Waiswa Kakaire, Michael Ayebazibwe, Zam Byakika, Francis Ssebuguluse, and Josephat Ndawula, for their crucial role in facilitating community participation and engagement in the development and execution of the research.

The team at University of California, Berkeley thanks Dr. Veronica Jacome and Dr. Layla Kwong for their guidance and advising. We also acknowledge financial support from the Katherine S. and James K. Lau Graduate Fellowship in Climate Equity, the Andrew and Mary Thompson Rocca Pre-Dissertation Research Award in African Studies, and the Mastercard Foundation. This work is also an output from the research initiative 'Structural Transformation and Economic Growth', a program funded by the Foreign, Commonwealth & Development Office (FCDO), contract reference STEG_LOA_1420_Kersey. The views expressed are not necessarily those of FCDO.

From the University of Massachusetts Amherst and the University of Washington, we acknowledge financial support from Electricity Growth and Use in Developing Economies (e-GUIDE), an initiative which seeks to transform the approaches used for planning and operations of electricity infrastructure in developing regions. This support was generously provided from The Rockefeller Foundation under grant 2018 POW 004.

From Arizona State University, we acknowledge YouthMappers and the Laboratory for Energy And Power Solutions for time, expertise, and financial support and in-kind contributions. ASU is the fiscal lead in the network of universities for YouthMappers, which is supported by US Agency for International Development (USAID) Cooperative Agreement Number 7200AA18CA00015. YouthMappers® is a registered trademark.

The team would like to acknowledge the following Makerere University YouthMapper students who supported the mapping work: Nuwagaba John Peter, Okwii Emmanuel Christian, Arineitwe Innocent, Kasaga Edward, Muhinda Keith, Namatovu Najah, Kayemba Kennedy Mutebi, Nampeera Lynn, Ainomujuni Griffin, Masaba Mathias, Nakabira Erica, Gafabusa Shiphrah, Katongole Umar, Nakimbugwe Lydia, Kasande Jemimah, Kiyemba Moses Kelvin, and Namuli Aisha Namuyanja. We also acknowledge the following community youth: Kisakye Ruth, Mukungu Abby, Nangosha Denis, Nalukenge Juliet, Kiyiwa Simon, Marufu Yiga, Bashiri, Nankabirwa Bitijuma, Benon Lutakoma, Susan Namuga, Haruna Mukomazi, Wendega Regani, Kalungi Joelia, Namatovu Amina, Mirimo Ronald, Edawula Edward, Kakinda Robert, Mande Geofrey, Kasirivu Steven, Bakalundi Mathew.

Data Availability

Supporting data and resources are available on Harvard Dataverse at the following permanent link: ***https://doi.org/10.7910/DVN/P1SIME.*** Methodological resources, like survey and interview templates, are currently available. Raw datasets will be uploaded for public use after the academic publishing process is concluded. All resources will be redacted to remove any personally identifiable information like GPS coordinates, names, or phone numbers. The names of the participating communities are also removed for their privacy and protection.

Attributions

ISBN 979-8-218-23625-0

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COLLABORATING PARTNERS

Urban Action Lab, Makerere University

Urban Action Lab is a practice-focused laboratory within Makerere's Department of Geography, Geo-informatics & Climatic Sciences coordinated by Dr. Paul Mukwaya. It was established to respond to growing demand from cities to find transformative solutions to complex urban challenges. Its mission is to be a knowledge-based, action-oriented research lab which engages in multi-stakeholder platforms to stimulate and facilitate action towards sustainable urban development and enhance university education and research on urban challenges.

ACTogether Uganda

ACTogether was established in 2006 as an independent Ugandan organization affiliated with the international network of Shack/Slum Dwellers International. ACTogether Uganda's mission is to have fair and inclusive Ugandan cities with united and empowered urban poor communities, who have the capacity to voice, promote, and effectively negotiate for their collective interests and priorities. Their role within the collaboration focuses on mobilizing community participation and leveraging the findings in advocacy efforts.

University of California, Berkeley

The University of California, Berkeley (UC Berkeley) is the lead institution of Spotlight Kampala. Within UCB, the project is led by Jess Kersey and Dr. Daniel Kammen within the Energy and Resources Group (ERG). ERG is a collaborative community of graduate students, faculty, researchers, and over 600 alumni across the globe who work across disciplines to create equitable solutions towards a sustainable environment. ERG has a 50-year history of outstanding research, education and outreach to government, industry, and civil society at the state, national and international levels. Also at UC Berkeley, the work is affiliated with the Renewable and Appropriate Energy Lab, whose mission is to help renewable energy technologies realize their full potential in contributing to environmentally sustainable and socially just development.

University of Massachusetts, Amherst

The University of Massachusetts, Amherst is a public research university located in New England. The Systems Towards Infrastructure Measurement and Analytics lab (STIMA), directed by Dr. Jay Taneja, Assistant Professor of Computer Science, studies the application of computing tools to measuring and managing infrastructure in industrialized and developing regions. They focus on energy infrastructure, building systems, transportation, water and also sanitation systems. Their role within the spotlight project focuses on the measurement and analysis of power quality and reliability.

University of Washington

The University of Washington is a public research university in Seattle, Washington. This work is supported by the InterDisciplinary Energy Analyses for Society (IDEAS) Research Group directed by Dr. June Lukuyu, Assistant Professor of Electrical and Computer Engineering,that focuses on developing and planning for inclusive, sustainable and integrated energy systems and technologies for underserved communities, centering on promoting social and economic development. Their role within the collaboration focuses on the measurement and analysis of power reliability and quality.

Arizona State University

Arizona State University (ASU) is a leading US Center of Excellence in research and development with presence in over 100 countries. This work was supported by the Laboratory for Energy And Power Solutions (LEAPS) that strives to create technical and business solutions that facilitate the global transition to a resilient low-carbon economy. LEAPS is a 40-person team providing energy solutions from concept to construction with a focus on innovating at the intersection of stakeholder value propositions, technology, business models, and policy.

YouthMappers®

YouthMappers is an international network of university-based, student-led, faculty-mentored chapters that create and use spatial data to highlight and address development challenges worldwide. YouthMappers organize, collaborate, and implement mapping activities that respond to actual needs around the globe with data made publicly available through open platforms. Activities focus on open mapping to build technical and youth leadership skills. Students from the award-winning chapter at Makerere University were joined by youth from informal communities to complete the mapping campaign.

nLine

nLine is a measurement company providing high spatiotemporal resolution data and insightful analysis of key performance indicators of critical infrastructure, initially focusing on electricity grids. The company has developed an innovative, cost-effective, adaptable, and scalable technology called GridWatch, which leverages remote sensors to efficiently gather data. Subsequently, this data is meticulously analyzed, leading to actionable insights that are valuable for stakeholders and various interest groups involved in policy-making.

In the context of Spotlight Kampala, nLine has made significant contributions in the area of remote monitoring. Their technology, designed to assess power quality and reliability, has been instrumental in measuring these aspects within both formal and informal settlements. The nLine team has played a crucial role in generating invaluable insights that have greatly enhanced the understanding of diverse grid experiences within the communities involved in the Spotlight Kampala project. More information on nLine and how to collaborate can be found on **www.nline.io.**

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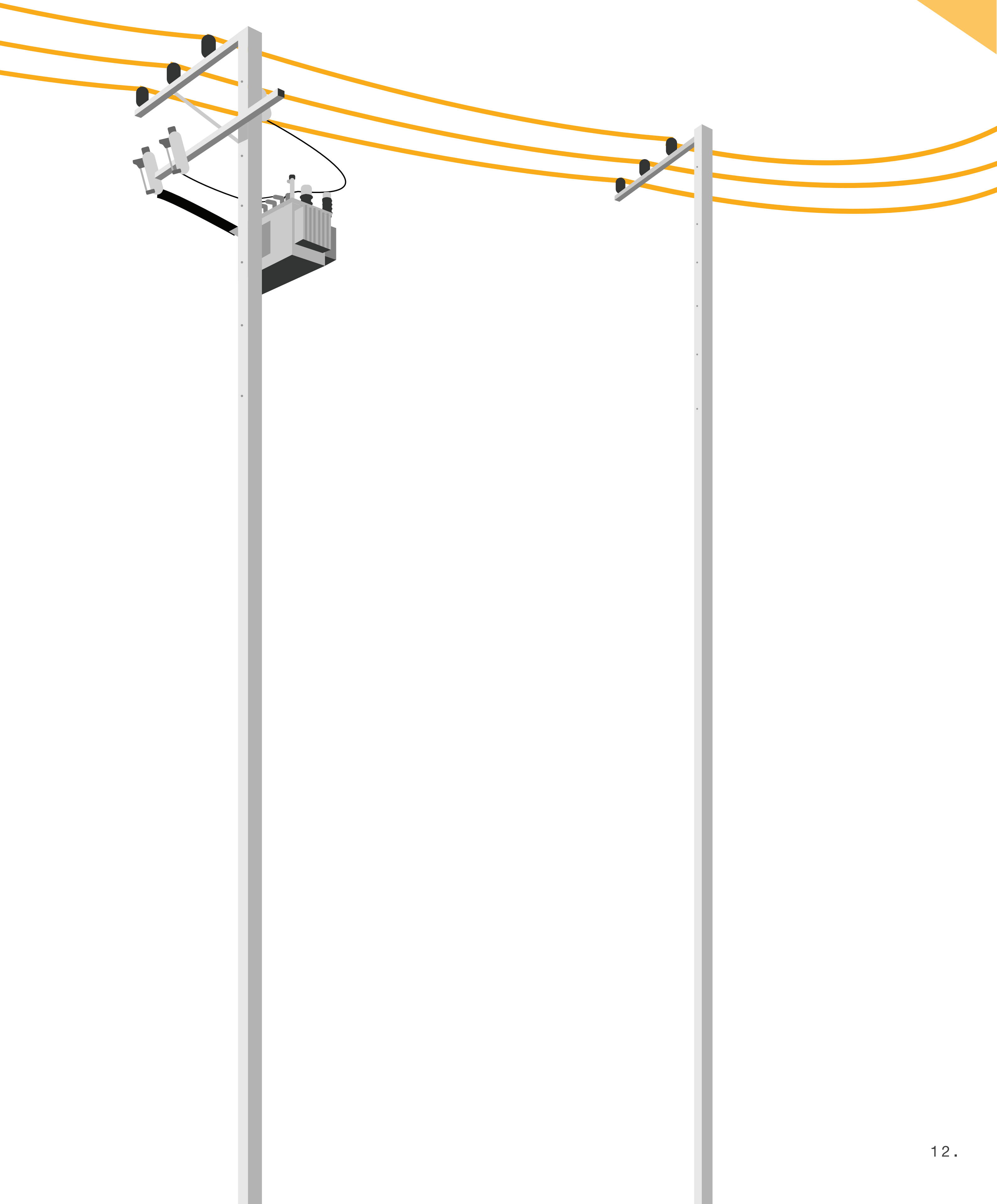

1. INTRODUCTION

Sustained global urbanization is a defining phenomenon of the 20th and early 21st centuries. Since 1950, the world's urban population has more than quadrupled from 800 million to 4.2 billion people, with an additional 2.5 billion set to become new urban dwellers by 2050 [1]. Yet, the scale and pace of this demographic movement — and importantly, the resources and capacity of governments to manage it effectively — is uneven across the world. In the Global South, where urbanization rates are highest and public resources are perhaps scarcest, low-income residents are increasingly concentrated in slums and informal settlements (see Box 1) that face overlapping deprivations of overcrowding, political and social marginalization, and a lack of access to basic infrastructure services like water, sanitation and electricity. Worldwide, these communities are home to about one billion (roughly one in eight people) today [2].

Sub-Saharan Africa in particular experienced an unprecedented urban boom in the late 20th century, as the end of colonial rule opened new opportunities for social and economic mobility in urban areas. However, historical underinvestment in public infrastructure and urban governance institutions during the colonial era left newly independent nations ill-prepared for such rapid urban expansion [3]. Informal settlements emerged rapidly during this time, as low-income populations who had been priced out of formal housing markets built communities in unused or underused urban spaces. Currently, an estimated 62% of Africa's urban population live informally, and these communities face various challenges including poverty, reliance on low-wage informal work, inadequate housing, vulnerability to climate change impacts, insecurity of land tenure, and limited access to public infrastructure [2]. Despite this, informal communities play a vital role in African cities, hosting diverse informal economic activities that employ a significant portion of the urban workforce and contribute significantly to the continent's gross domestic product.

Box 1. Terminology — slums and informal settlements

The terms ***slum and informal settlement*** are not universally defined, and their meanings vary depending on regional contexts and the official definitions used by different organizations and governments. An overview of both terms is given below.

Slum

In line with the United Nations Human Settlement Program's (UN-Habitat), a slum is defined as a household lacking one or more of the following [4]:

1. Durable housing structure
2. Access to clean water
3. Access to improved sanitation
4. Sufficient living space
5. Secure tenure

Informal settlement

An informal settlement is a broad term used to describe any unplanned or unauthorized housing area, typically established by individuals or communities without legal land tenure or formal urban planning.

These terms are not necessarily interchangeable. A community can be an informal settlement but not a slum, for example if a neighborhood is not formally planned but does not meet the criteria for a slum, and vice versa. It is also important to note there are negative connotations associated with the term slum [5]. However, organizations like the National Slum Dwellers Federation (NSDF) and Slum Dwellers International (SDI) have sought to reclaim this term as one of empowerment [6].

In the absence of a universally-accepted common terminology [7], this report opts for the term informal community to: 1) avoid the negative associations of the term slum, 2) highlight the importance of informal processes (such as in planning, tenancy agreements, conflict resolution, etc.) in the creation and management of these spaces, and 3) to emphasize the role of community in terms of a sense of belonging, cooperation, and mutual support. In this choice of language, the aim is to acknowledge the agency of communities in co-creating solutions, but not absolve duty-bearers of the responsibility to provide affordable, inclusive services for all.

Photo caption: *Hawkers selling fruit, clothing, and other goods to passersby on the highway alongside an informal community in Kampala. A number of businesses and electricity distribution infrastructure are visible in the background. Photo by Jess Kersey.*

Electricity is a critical input to the health, well-being, and livelihoods of informal communities and the urban economy more broadly. The many shops, salons, butcheries, restaurants, agricultural processors, video centers, bakeries and guesthouses that power the urban economy rely on electricity to run appliances, light workspaces, and extend their operating hours beyond sundown [8]. Unreliable, unaffordable, or low-quality electricity negatively impacts the income-generating potential of these enterprises and therefore the livelihoods of their owners, customers, and employees. At the household level, electricity enables a transition in cooking fuels away from polluting sources like charcoal and biomass — fuels that disproportionately harm the women and children responsible for food preparation through indoor air pollution [9]. Electricity also enables improved services in other sectors, like water, sanitation, street lighting (and hence public safety), health, and education [10].

Most research and policy action in support of Sustainable Development Goal (SDG) 7, to "ensure access to affordable, reliable, sustainable and modern energy for all" has focused on rural and remote communities [11]. However, this report shows that informal urban communities face persistent inequities in accessing reliable, high-quality, safe, and affordable electrical services [12], [13]. An electrical connection is not guaranteed for many informal community dwellers despite their proximity to distribution infrastructure [14]. In some countries and cities, governments have introduced laws prohibiting local utilities from providing electricity to households and businesses lacking proof of legal land tenure. In other settings, an expensive and bureaucratically complex connection process prevents residents of informal communities from connecting to the grid [15]. Even once connected, affordability of supply is an important barrier that prevents people from using electricity to the extent they need or want. Frequent and/or prolonged grid outages also discourage the use of grid electricity and ensure continued reliance on lower-quality fuel sources.

The past decade has seen a growing recognition of the importance of informal communities within the urban ecosystem and an acknowledgement of the rights of the poor to enjoy urban life. Accordingly, the emerging consensus is that sustainable and equitable urban development strategies must seek to address systemic urban inequality in part through incremental, in-situ upgrades to the built environment of these communities. Given its important links to livelihoods, health, education, and safety, electricity must be included as a basic public service within such efforts. By recognizing the specific needs and constraints of these communities in accessing electricity, development pathways can foster equal access for all individuals and communities to the advantages and possibilities that electricity offers. This approach promotes the creation of sustainable and inclusive cities, where everyone can benefit from the transformative power of electricity, regardless of their socio-spatial or economic background.

2. BACKGROUND

2.1 URBAN INFORMALITY AND INFRASTRUCTURE IN KAMPALA, UGANDA

Kampala, the capital of Uganda, has grappled with rapid population growth since the country's independence and its formal establishment as a city[1] in 1962 [16]. According to the Uganda Bureau of Statistics, between 1969 and 2021, Kampala's population increased by a factor of five from 331 thousand in 1.7 million [17]. Annual growth rates in Kampala now stand at around 6%, with an expected population of nearly 2 million by 2030 [18], [19]. The late 1980s in particular saw rapid expansion in Kampala as the conclusion of the Ugandan Bush War gave way to a period of political stability. During this time, soaring housing prices pressured a significant portion of the population to seek alternative settlements, leading to a proliferation of informal communities.

Table 1. Kampala's key socioeconomic statistics [20]

Size	189 square kilometers (176 square miles land and 13 square miles of water)
Population growth rate	3.9%
Total population	Daytime: 4,000,000; Nighttime: 1,650,000[2]
Households	414,406
Household size	3.8 people per household
Divisions	5
Economic sector	• The city contributes over 65% of national gross domestic product • 60% of the population employed in the informal sector

Today, nearly one million people are estimated to live in the approximately 60 informal communities, which take up an estimated 25% of the city's total land area [21]. In terms of employment, the informal economy (which is largely based in informal communities) employs over 60% of Kampala's total population. While informal sector enterprises are typically characterized by precarity, low productivity, low wages, and non-exportable goods and services, the sector provides livelihoods to the most vulnerable of the urban poor. Informal communities also disproportionately occupy low-lying areas prone to flooding which will only worsen as the impacts of climate change are more acutely felt [22].

Informal communities are home to Kampala's lowest-income and most vulnerable residents. The United Nations High Commissioner for Refugees estimates that as of 2023, around 142,000 refugees had settled in Kampala, mostly from South Sudan, the Democratic Republic of the Congo, Eritrea, Burundi, Rwanda, and Ethiopia [23].

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[1] Kampala's origin far predates British colonialism. The royal seat of the Kingdom of Buganda prior to colonization was located on several of the hilltops (and later moved permanently to Mengo hill), which are now incorporated within contemporary Kampala.

[2] The daytime and nighttime populations are different because of the large number of people who live outside of the city limits but who commute to the city to work.

It is important to note that the government considers refugees in Kampala as “self-settled”, and they do not receive any government or donor benefits. Many others are vulnerable simply because of their low and precarious incomes. A 2019 study that surveyed four informal communities in Kampala found that 73% of residents are below the national poverty line earning $1.90 per person per day [24]. In another study, 76% of informal respondents reported that their incomes are day-to-day [25]. Other sources found a high incidence of food insecurity and malnutrition [24], [25].

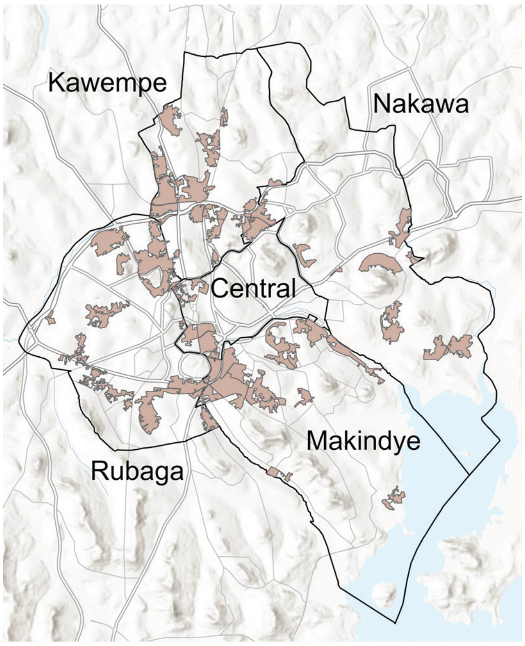

Figure 1. *Locations of informal communities within Kampala’s five divisions.*

The stock of housing in informal communities is mixed, but generally low-quality. An estimated 70% of the dwelling units are made of temporary materials [26].Tenements are the most common type of housing unit. These are most commonly constructed as standalone one room units (or groupings of units) which on average house 5-7 adults in nine square meters [26]. Many household and small business functions like cooking, eating, sleeping, and caring for children are often carried in a single space. Renting is the main method of accessing housing. Regarding their physical construction, housing units are often susceptible to flooding and have poor ventilation and other structural issues.

Access to infrastructure service in Kampala’s informal communities is uneven and limited. Most residents struggle to access clean water, sanitation facilities, and electricity, often paying more to access these services through landlords or private intermediaries [26]. Road networks are often poorly developed or nonexistent. These infrastructure gaps contribute to the perpetuation of underlying socioeconomic inequalities and hinder the overall development and well-being of these communities. Infrastructure improvements are further complicated by Kampala’s uniquely complex land tenure system[3] that makes urban development difficult and expensive [26].

These inequities in the city's infrastructure services date back to the early colonial period, when early planning approaches based infrastructure service delivery along explicitly racial lines [27].

At this time, the infrastructure in Kampala was designed to cater to the needs of European settlers, overlooking the growing indigenous population. These early urban plans have had a lasting impact on Kampala's urban fabric to the present day, resulting in infrastructure networks that provide inferior services to certain neighborhoods [28]. Even with the major infrastructure improvements over the years, the most vulnerable and poorest residents living in informal communities remain unserved and/or underserved, isolated, and fending for themselves in inadequate, costly, or environmentally degrading ways.

2.2 OVERVIEW OF THE UGANDAN ELECTRICITY SECTOR

Kampala was first commercially served by electricity in 1954, when Uganda's first power plant, the Owen Falls hydroelectric power station, was commissioned [29]. Situated near Jinja, about 80 kilometers east of Kampala, it utilized the power of the Owen Falls (now known as the Nalubaale) dam on the Victoria Nile to serve electricity to a rapidly-growing Kampala. Preparations for the dam had begun in 1933, when the Government of Uganda passed an electricity ordinance that allowed commercial generation, distribution and supply in Uganda. The Uganda Electricity Board (UEB), which had been established in 1948, oversaw its construction.

Prior to the commissioning of Owen Falls dam, only 3,263 customers were connected to electricity through diesel generators that almost exclusively served European households and institutions [30]. Though the dam, which had increased installed capacity from 1 mega-watts (MW) to 150 MW, was expected to spark rapid growth in new connections, this never materialized [29]. Somewhere between one-half and one-third of the generation was exported to Kenya [29]. By 1961, one year prior to Uganda's independence, the system had only expanded to 32,000 users across Kampala, Junja, Masaka, Kasese, and Soroti.

Accordingly, after several decades of lackluster financial and technical performance, an inability to attract private investment, slow system expansion, charges of corruption, and pressure from multilateral lenders like the World Bank, the 1999 Electricity Act was passed [31]. This allowed for the unbundling of the electricity sector into three separate entities, the Uganda Electricity Generation Company Limited (UEGCL), the Uganda Electricity Transmission Company Limited (UETCL), and the Uganda Electricity Distribution Company Limited (UEDCL).

The Electricity Act also allowed for the privatization of UEB, which resulted in the Government of Uganda granting a 20-year license to Umeme Limited in 2005. At the time the concession was granted Umeme was majority owned by a UK-based firm Globeleq and minority-owned by South African firm Eskom Enterprises, though ownership stakes have now changed [31]. As the licensed distributor in Uganda, Umeme has been responsible for all aspects of distribution including operations, maintenance, retail, and system upgrades including expansion of the distribution grid. While Umeme operates the distribution grid, UEDCL retains ownership of the infrastructure assets.

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[3] Uganda uses four parallel systems of land tenure (mailo, customary, freehold and leasehold), each of which has its own characteristics and legal frameworks. While these four systems coexist, they can sometimes overlap or lead to conflicts regarding land ownership and rights [26].

The Electricity Regulatory Authority (ERA) is the sector regulator established in 2000 to "regulate the generation, transmission, distribution, sale, export and import of electrical energy in Uganda" [32]. ERA is responsible for overseeing Umeme's performance, which it does by setting, monitoring, and periodically reviewing the performance parameters of its license. These metrics are focused on reducing electricity losses, improving revenue collection, and overall operational efficiency, and, more recently, increasing the number of new customers connected each year [33]. The latter was added to incentivize new connections after progress in electrification was initially sluggish. ERA reports to the Ministry of Energy and Mineral Development (MEMD), which is tasked with issuing policy guidance, creating a sound enabling environment, and regulating private sector activities to support the sustainable development of energy and mineral resources in Uganda.

The reforms implemented after the Electricity Act have been relatively successful. Distribution losses have reduced, revenue collections have increased, and a significant amount of infrastructure has been rehabilitated or newly built. ERA has also been effective in its role, and Uganda is widely lauded as one of the only countries in sub-Saharan Africa to sustain cost-reflective tariffs [34]. However, this has come at the expense of affordability (Figure 2). Tariffs have been drastically increased over the past 20 years, beginning with increases of 41% and 35% in 2006, 46% in 2012, and 16% in 2016 [34]. This has disproportionately impacted low-income groups. A 2019 report from the Word Bank found that the poorest 40% of the population spend over 7% of their household income to meet basic electricity needs, compared to just over 3% in Kenya and 2% in Tanzania [35].

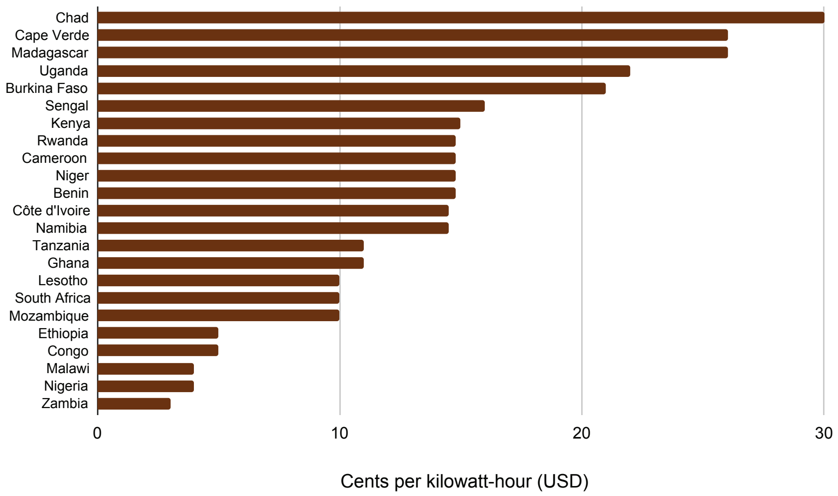

Figure 2.
Comparison of tariffs in 23 countries in sub-Saharan Africa [9]. These are levelized residential tariffs which include all items in the electricity bill, including the various energy and distribution costs, service fees, and taxes.

At present, the high electricity tariffs, in addition to persistent slow growth in electrification, motivated the Government of Uganda in 2022 to officially notify Umeme that its concession would not be renewed at its conclusion in March of 2025. ERA is currently conducting a cost assessment to determine the total cost of the buyout [36]. The expectation is that distribution responsibilities will revert to UEDCL [37].

2.3 GLOBAL ACADEMIC AND PRACTITIONER EXPERIENCE WITH ELECTRIFICATION IN INFORMAL COMMUNITIES

Human societies rely on energy as a productive input to satisfy basic human needs and support broader macroeconomic growth [38]. Though these energy needs have historically been met with biomass sources or fossil fuels, electricity delivered via a centralized grid has become an essential public service in the modern era. However, as of 2021, 567 million people in sub-Saharan Africa had no electricity access [39]. And, as the SDG 7 community increasingly embraces a multidimensional understanding of energy poverty [40], the emerging picture is that billions, rather than millions, face complex access barriers related to reliability, affordability, power quality, and safety.

To date, the community of practice surrounding SDG 7 has largely focused on rural and remote areas [41], [42]. The seeming cause of this focus is an underlying assumption that urban areas are either already well-electrified, or can easily be electrified [12]. However, Africa's urban population has grown by 2,000% in the 65-year period between 1950 and 2015, and this rapid growth has not been accompanied by an equitable distribution of energy services [43]. There is a growing concentration of energy poverty in urban areas that has not been well-recognized in existing discourse and practice [15], [44], [45]. Informal communities, in particular, have been all but absent from the global agenda on electricity access.

The body of knowledge on how informal communities access and use grid electricity, and the barriers to their access, is limited relative to the scale of the challenge. In most cities, there is a lack of baseline data on even basic indicators like connection rates and consumption levels. This being said, researchers have provided some insight into electricity access in diverse geographies including Yangon, Myanmar [15], Bangkok, Thailand [46], Rio de Janeiro, Brazil [47], Dakar, Senegal [44], and Nairobi, Kenya [48]. This work reveals that there are some barriers, like legal status (or lack thereof) and affordability gaps, that are relatively universal across informal urban settings.

The findings also show tremendous diversity in terms of connection rates, alternative fuel sources used, and consumption habits, among other indicators of access. This means that electricity access is place-specific and existing studies are difficult to generalize across regions, countries, and even cities. Another key limitation of this body of work is the simplistic indicators of energy access used. In most cases, energy access is defined along binaries of connected or unconnected and legal or illegal. As such, much of this work struggles to link findings to the broader socio-political context of these communities, and/or overlooks other important dimensions of access like reliability, safety, or quality.

In contrast, the work of researchers from human geography and other social science disciplines have provided an understanding of the social and political aspects of electricity access. These studies cover the politics of grid connections from various perspectives [49]–[51] and provide insights into the day-to-day struggles of informal communities with electricity access [52], [53]. The main constraint of these works, however, are methodological. The small sample sizes and qualitative approaches do not allow for findings to be easily generalized for the purposes of designing programs, policies or other interventions.

Past experiences with programs and policies to improve electrification in informal communities are instructive but limited. One notable example is the Kenya Slum Electrification Program (KSEP), which was a joint initiative of the Kenya Power and Lighting Company and the World Bank launched in 2012. KSEP aimed to improve safety and curb electricity theft in informal communities by offering subsidized connections. Examples of similar programs exist in South Africa [54], Brazil [12], and India [55][4]. Appendix A provides an overview of these programs.

In reviewing these programs, community engagement is an important ingredient of success. For example, expert interviewees involved in KSEP noted that the program struggled to attract participants in the first two years due to the communities' mistrust of the utility, and that some project activities were met with hostility or threats of violence from the community. After later pivoting to a strategy based on engagement with community leaders and informal electricity resellers, the program flourished [56].

Other best practices which have emerged from these cumulative experiences, which are paraphrased from a 2004 report by USAID, include partnering with community-based organizations to gain community acceptance and buy-in, competing effectively (or partnering with) informal service providers, addressing affordability barriers through well-targeted subsidies and convenient payment methods, implementing technology-based anti-theft measures to reduce losses, addressing barriers in the enabling environment related to land tenure and right-of-way issues, mainstreaming gender across activities, and actively promoting community participation, education and awareness-building within program design [57].

Within Kampala, the local utility Umeme has begun taking steps to improve electricity access in informal communities. In 2020, Umeme launched Pamoja, meaning together in Swahili, which aims to work with communities to improve their relationship with the utility, address safety challenges, and ease the process of obtaining legal connections. Project activities include training programs for entrepreneurs whose businesses are based on electric appliances. Further, through a collaboration with the Directorate of Industrial Training, Pamoja offers opportunities for informal electricians to undergo training as a pathway toward formal certification. The project is currently operating in five areas, including Nakulabye parish, with plans to scale in the future.

An exhaustive accounting of the global evidence base on the barriers and solutions to electricity access in urban informal communities is outside the scope of this report. The studies and experiences mentioned here serve to demonstrate that there is a niche but robust body of knowledge which can serve as a starting point to guide future efforts. However, there are also clear knowledge gaps in terms of understanding electricity access beyond simplistic binaries of connected or non-connected or legal versus illegal, and in tying such metrics to the actual lived experiences of the urban poor.

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[4] It should be noted that many countries including Uganda have electrification policies that benefit informal communities despite not directly targeting them.

2.4 SPOTLIGHT KAMPALA'S OBJECTIVES

This research initiative, Spotlight Kampala, seeks to understand and describe the electricity access challenges faced by informal communities in Kampala. It leverages the perspectives of a multidisciplinary and diverse team of engineers, geographers, community organizers, and urban planners from both universities and advocacy groups. The team partnered with 25 informal communities in Kampala, which participated in surveys, interviews, digital measurement of power, infrastructure mapping, and community forums. Combined, these mixed quantitative and qualitative methods are intended to create a comprehensive picture of the barriers to electricity access.

Our data provides important baseline statistics on metrics of access like access rates, affordability, reliability, and power quality as well as a qualitative understanding of how community members perceive and navigate barriers to access. The aim is not only to provide summary statistics, as much existing research has already done, but to ground these learnings in the daily lived experience of Kampala's informal residents. Community participation is a core objective of the work, with community members involved in each step of research design, execution and dissemination.

Spotlight Kampala's main objective is to straddle the gap between researchers and policymakers by providing data that is action-oriented, and can catalyze further action by duty-bearers to find solutions to alleviate urban energy poverty for Kampala's informal communities. Beyond Kampala, this work aims to advance a larger dialogue within the SDG 7 community of practice on the unique energy needs and challenges of the world's growing population of urban poor living in informal communities.

What follows is a description of the approach, findings and recommendations stemming from eight months of data collection in partnership with 25 informal communities in all five divisions of Kampala. It is important to note that this report does not reveal the identities of the participating communities to protect their privacy.

3. METHODS

The following sections provide an overview of the research methods, which include the following five activities:

1. **Surveys** of 500 households and businesses on connection status, type of connection, energy expenditures, appliance ownership, and other metrics
2. **Interviews** of 45 community members and 19 expert stakeholders
3. **Remote** monitoring of power quality and outages, using a comparative approach across 150 participants in both informal and adjacent formal communities
4. **Mapping** to capture the location of electrical infrastructure like utility poles, streetlights, and transformers
5. **Forums** to share the findings with the participating communities and solicit feedback

This section also describes the process of selecting, engaging, and facilitating the work in partnership with community leadership and advocates.

3.1 COMMUNITY SELECTION FOR STUDY SITES

A sample of 25 communities was chosen at random from approximately 60 informal settlements in Kampala using probability-proportional-to-size sampling based on each settlement's population. Population data was provided by ACTogether Uganda. The 25 communities span all five of Kampala's districts, and are diverse in terms of geographic location, quality of the built environment, and socioeconomic status of residents, among other dimensions. To ensure willingness to participate, ACTogether Uganda reviewed the selected communities, which resulted in the substitution of three communities with alternatives of comparable population sizes. Geospatial datasets, encompassing the boundaries of the chosen settlements, were obtained from the Kampala Capital City Authority and ACTogether Uganda. A third set of boundaries, which were used in the study, was manually delineated through visual inspection of these available data sources.

3.2 COMMUNITY ENGAGEMENT AND FACILITATION

In order to ensure buy-in, build trust, and establish active participation with communities, the team undertook a series of pre-field work activities including identifying and establishing contacts with local council (LC) leaders both at parish level (LC II) and village level (LC I)[5]. The initial meetings served to: i) introduce the team, the purpose of the study and its objectives, and solicit feedback, ii) explain the potential benefits to the communities, and iii) seek input and involvement.

[5] In Uganda, there are five levels of political administrative units which are led by elected local council leaders. The village level, usually containing between 250 to 1,000 people, is led by an LC I. A parish, which is a collection of several villages, is led by an LC II Chairperson, and nine other executive committee members including the Vice Chairperson, the General Secretary, the Treasurer, and 6 other secretaries for-Youth affairs, Women affairs, People with Disabilities, Information and Mobilization, Project and Development, and Defence.

These initial contacts were key in securing LC leadership commitment throughout the project period. LCs were notified in advance of any fieldwork occurring in the zone, and in some cases availed community guides to facilitate the project activities. The team also worked with National Slum Dweller Federation of Uganda (NSDFU) leadership throughout the project in coordination with ACTogether.

In addition to liaising with LCs and Federation leadership, the team took deliberate steps to integrate community voices and participation throughout the project including employing community members during the project. Enumerators from the communities were hired to carry out household and business surveys. Youth from the communities were hired to map infrastructure in collaboration with Makerere University YouthMappers. Through the collaborations, students and youth were able to share knowledge and build skills.

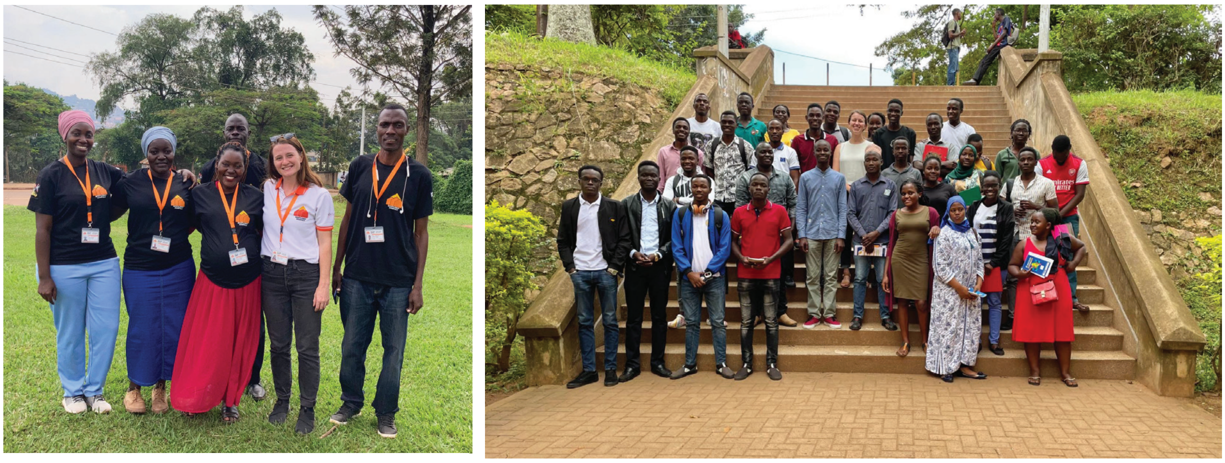


Photo caption: *The enumeration team on the final day of surveying (left). First day of training for the infrastructure mapping team including Makerere University YouthMappers and community youth (right). Photos provided by Jess Kersey and Elena van Hove.*

3.3 INTERVIEWS

A purposive sampling approach was employed to select interview participants for this study. The selection criteria were based on two categories: expertise in the energy policy landscape in Uganda or lived experiences as informal community dwellers. The participants were divided into expert and community interviewees. For the expert interviews, a total of 19 individuals were selected, including policymakers and practitioners representing organizations such as the utility company, Umeme, MEMD, ERA, other development partners and donor agencies, and academia. These experts provided valuable insights, knowledge, and nuanced perspectives on the intricate challenges of energy access to the existing policy frameworks in both the city and the country as a whole. The team also presented the research outcomes to these expert interviews for feedback, dissemination, and validation. These interactions significantly contributed to the development of the practical recommendations to address energy access challenges proposed in this report.

For community interviews, the team engaged tenants and landlords, institutions like schools and health centers, and local businesses. The interview questionnaire sought to understand their lived experiences and their unique energy needs, access barriers, connection types, rates and payment structures, concerns regarding quality, reliability and safety, and the impact of inadequate or unreliable access to their livelihoods. In addition, interviews were intended to surface the innovative strategies communities have developed to cope with their energy needs.

Table 2. Interview participants by type and affiliation.

Type	Number of interviews	Organizations represented
National and municipal government	6	Kampala Capital City Authority Ministry of Energy and Mineral Development Uganda Electricity Distribution Company Limited Electricity Regulatory Authority
NGO, aid or development partner	6	Cities Alliance National Slum Dwellers Federation of Uganda World Bank Modern Energy Cooking Services Raising Gabdho Foundation Energy 4 Impact
Academic	4	Urban Action Lab, Makerere University University of Bristol
Utility	5	Umeme management Umeme subcontractors
Community members	32	Renters Landlords Homeowners Informal wiremen (*kamyufus*) Entrepreneurs
Community institutions	6	Health clinics Primary and secondary schools Community centers Vocational schools
Community leadership	5	Local council I, II and III

Each interview took from 15 to 90 minutes to complete and were conducted in a location chosen by the participant. Non-expert interviewees provided written consent and were compensated 20,000 UGX for their participation.

3.4 SURVEYS

20 surveys were conducted in November 2022 in each of the 25 participating communities for a total of 500. A team of five experienced enumerators from NSDFU performed the enumeration following one day of training, hosted at Makerere University, and one day of practice enumeration. The only constraint introduced to participant selection was a requirement for three in four respondents to represent households. The remaining one quarter of respondents was reserved for entrepreneurs whose place of business could either be separate from or co-located with their home. Though there was no explicit requirement for the gender composition of respondents, women were overrepresented (76% of respondents) because surveys were conducted from 9 am to 3 pm when male family members were likely to be away from the home.

Photo caption: *Harry, an enumerator from NSDFU, surveying a study participant. Photo taken with consent of those pictured by Jess Kersey.*

Surveys were conducted on tablets using SurveyCTO software. The survey had eight separate sections whose contents are described in Table 3. The full Open Data Kit survey is available at the following repository in .xlsx format: https://doi.org/10.7910/DVN/P1SIME.

Table 3. Survey sections and description of questions.		
No	**Section name**	**Description**
1.	Demographics	Captures gender, whether the respondent is a renter or homeowner, how long they have lived in the community, and their refugee status.
2.	Energy sources	Determines whether the respondent is connected to the electricity grid, and if not, why. Captures use of non-electrical energy sources like solar and batteries, and preferred cooking fuels.
3.	Connection type	Records how the respondent is connected to the electricity grid, whether they have a prepaid (Yaka) meter, whether the meter is shared, and, if yes, how many others it is shared with.
4.	Affordability	Captures average monthly income and expenditures on electricity and other energy sources. Also asks whether the respondent knows the per kilowatt-hour (per unit) price of electricity, if that is affordable, and what they think an affordable tariff would be.
5.	Autonomy of use	Asks about agency in electricity usage, such as who makes the decision on when and how electricity can be used or whether anyone regularly cuts power supply.
6.	Appliance ownership	Collects inventory of the electrical appliances owned by the respondent. Also captures which of these appliances are broken or not regularly used, and the reasons for this.
7.	Safety and enforcement	Asks about the respondent's knowledge of people in the community who have died, been injured, or experienced fires as a result of the electrical system. Also asks about the frequency of illegal connection enforcement visits from the utility, and what actions are taken during these visits.
8.	Reliability	Captures the respondent's perception on the duration and frequency of outages on a weekly basis, and which months of the year reliability is the worst.

To ensure that the survey respondents were geographically dispersed, the geospatial boundary of each community was divided into five equal areas. Each enumerator was randomly assigned to one area. The assigned areas were downloaded onto each enumerator's tablet through the Google Earth mobile application. During surveying, each enumerator could see their own GPS location relative to their enumeration boundary, and as such could space their surveys randomly across their enumeration area. Each survey took on average nine minutes to complete, and each respondent provided written consent and were compensated 10,000 UGX for their participation.

3.5 REMOTE MONITORING

Using proprietary utility data shared through a collaboration with Umeme, for each of the 25 communities the team identified two transformers. One transformer served the target informal community and the second served its neighboring formal area. The two transformers selected at each site were on the same medium-voltage electrical feeder to allow the research team to isolate outages that took place at the grid level versus outages at the transformer level.

For each of the 25 participating informal communities, the team selected four participants (homes or businesses) who were connected to the transformer of interest in the informal area and two participants connected to the transformer in the nearby formal area through purposive sampling. The purpose of selecting participants in both formal and informal settlements was to compare the quality of power between the two settlement types. The deployment took place in two rounds, each of which lasted two months. The first round of sensors was deployed in 12 communities from October to December 2022 and the second round of sensors was deployed in 13 communities from January to March 2023. In total, the sensors were deployed at 150 total sites.

The sensors used are part of the nLine GridWatch technology suite which combines PowerWatch sensors with cloud data storage and processing. The PowerWatch sensor measures voltage magnitude, AC frequency, and power state at two minute intervals. With an integrated SIM card, the sensor reports measurements over the cellular network, and has local storage to support a data backlog in case of network failure. The sensors are plugged into a wall outlet and capture power quality and reliability as directly experienced by the customer.

Photo caption: *An nLine PowerWatch sensor deployed in an extension cable in a participant's home. Photo by Jess Kersey.*

After being briefed on project goals, risks and benefits, each participant provided written consent. They then completed a brief pre-deployment survey capturing connection type, appliance ownership, reliability, and energy expenditures. Each participant received a free extension cable, 10,000 UGX at the beginning of the deployment, and an additional 10,000 UGX at the end of the deployment when the sensor was recovered. During the two-month deployment, the research team reviewed the status of the sensors daily, and called participants if there were outages greater than eight hours in duration. Participants could also call the research team to report any outages or other issues. The reasons for the outages were recorded, producing a unique qualitative dataset to complement the qualitative data on power quality and reliability.

3.6 INFRASTRUCTURE MAPPING

Electrical and other critical community infrastructure were mapped in each of the 25 participating communities between February and March 2023. Mappers were divided into two groups that worked on alternate days. On each day, the group would divide into four teams which each covered one separate quadrant of a community. Each team consisted of three people, including two students from the GeoYouthMappers chapter of Makerere University and one youth member from the community. The teams were arranged this way to ensure safety and efficient navigation within the informal settlements. Prior to the start of mapping activities, the mapping teams received training on the tools, mapping workflow and data validation. They worked with three tools: KoboToolBox, FieldPapers and OSMTracker.

Photo caption: *Youth mapping a utility pole using Kobo collect and youth referring to the printed fieldpapers. Photos provided by YouthMappers.*

Photo caption: *Example of mapped utility pole with white boxes which are prepaid meters on the pole and service lines dropping from the pole to houses. Photo provided by YouthMappers.*

Photo caption: *Examples of mapped streetlights. Photos provided by YouthMappers*

Photo caption: *Three types of mapped transformers. Two high capacity and one low capacity transformers. Photos provided by YouthMappers and Elena van Hove.*

The survey form was deployed with KoboToolBox and included questions on the condition of the mapped infrastructure and attributes of the infrastructure, such as the number of prepaid meters on a pole or the power source of a streetlight. Teams mapped electricity infrastructure, including utility poles, power lines, streetlights, and transformers. Critical facilities including schools, health centers, water collection points, and commercial areas were also mapped.

Table 4. Count of mapped infrastructure across all communities.

Community critical infrastructure	118 schools 55 water collection points 55 commercial areas 23 health centers
Power system infrastructure	5,404 utility poles 277 streetlights 221 transformers

FieldPapers were used to map the electricity utility information shown in Table 5, including the connections between utility poles. OSMTracker was used for locational information during the data validation stage. Teams then cross-checked and validated data before uploading data onto OSM. Data was downloaded from KoboToolBox and checked to ensure that all fields were captured accurately.

Table 5. Tags for electrical infrastructure data uploaded onto OSM.

Feature	Tags
1. Utility pole	Power = pole, operational_status = operational
2. Streetlight	Power = pole, lit = yes, operational_status = operational
3. Transformer	Power = transformer
4. Power line	Power = minor_line

3.7 COMMUNITY FORUMS

To disseminate and validate the study's findings, the research team hosted community forums in each of the 25 communities between June and July 2023. Each forum lasted roughly 90 minutes and were attended by 15 to 45 participants who were a mix of previous study participants, LC leadership, and interested community members. At the start of each forum, the team presented the challenges that were observed during the study, presented early recommendations, and took questions and comments. Banners and flyers in both English and Luganda were available as visual aids.

Photo caption: *Attendees voting on challenges during a community forum. Photo by Jess Kersey.*

The team then led two structured brainstorming and voting sessions, one focused on challenges to electricity access and the second focused on potential solutions. During a comment period, participants had the opportunity to add challenges and solutions to the initial lists presented by the team. Each attendee was given two sets of five stickers, which were labeled with a unique identification number and a priority number. The identification number was used to match votes to basic socioeconomic data which was captured on a registration sheet filled out by each participant. The priority number was used to represent preference, where 1 indicated the most important challenge or solution, and 5 represented the least. During voting, participants physically placed their stickers on a banner to indicate their choices. These votes were then recorded by the research team at the conclusion of each session.

3.8 CONSENT AND ETHICAL REVIEW

This research is approved by the Institutional Review Board of the University of California, Berkeley under protocol 2022-07-15500 and the AIDS Support Organization under reference number TASO-2022-141. It is also registered with the Uganda National Council for Science and Technology under registration number SS1437ES. Prior to participating in the research, all human subjects received information on the risks, benefits and voluntary nature of their participation. They then provided signed consent in the language of their choice (Luganda or English).

Photo caption: *Research assistant Paul Kyoma going through the consent process with a business owner to install a power quality sensor. Photo by Jess Kersey.*

4. FINDINGS

Access to electricity is crucial in alleviating poverty as it enhances productivity, livelihoods, health, nutrition, well-being, and overall quality of life. It is important to note, however, that it is the use of electricity in terms of kilowatt-hours (kWh) consumed that drives these positive impacts. In informal communities, the findings show that residents struggle to translate a connection to the grid into access to electricity, which is taken here to mean the ability of consumers to use electricity for desired services and end uses. Ultimately, this means that the positive benefits of electricity use cannot be realized.

The findings show that obtaining a connection is not the main barrier to electricity access. The coverage of electrical infrastructure in informal communities is relatively high, and 95% of households and businesses have a grid connection (Figure 3). Yet, a large number of respondents choose to stack energy sources like charcoal, candles, gas, and firewood (Figure 4). Cooking end uses, in particular, remain biomass-based, with 92% of respondents reporting using charcoal as their primary cooking fuel (Figure 5).

Furthermore, there are a number of other dynamics, including the extreme rationing of electricity consumption, daily power shut-offs by landlords, and restrictions on the types of appliances that can be used which point to a more complex and socially-embedded landscape of electricity access than this high access rate might suggest. Electricity access in informal settings is profoundly gendered, and a disproportionate amount of the burden of these challenges is borne by women.

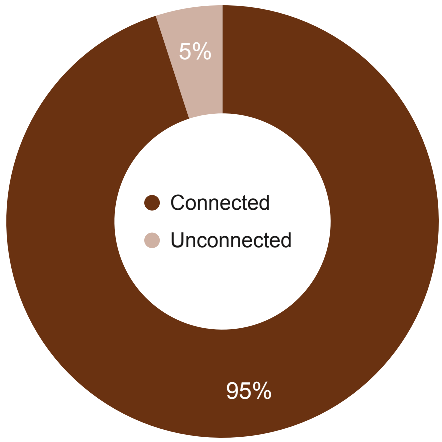


Figure 3. *Grid connection rates basedzz on surveys with 500 households and businesses.*

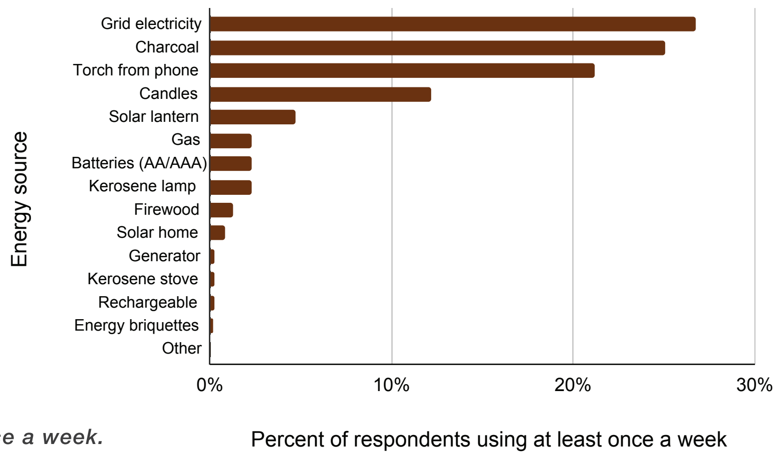


Figure 4. *Energy sources used at least once a week.*

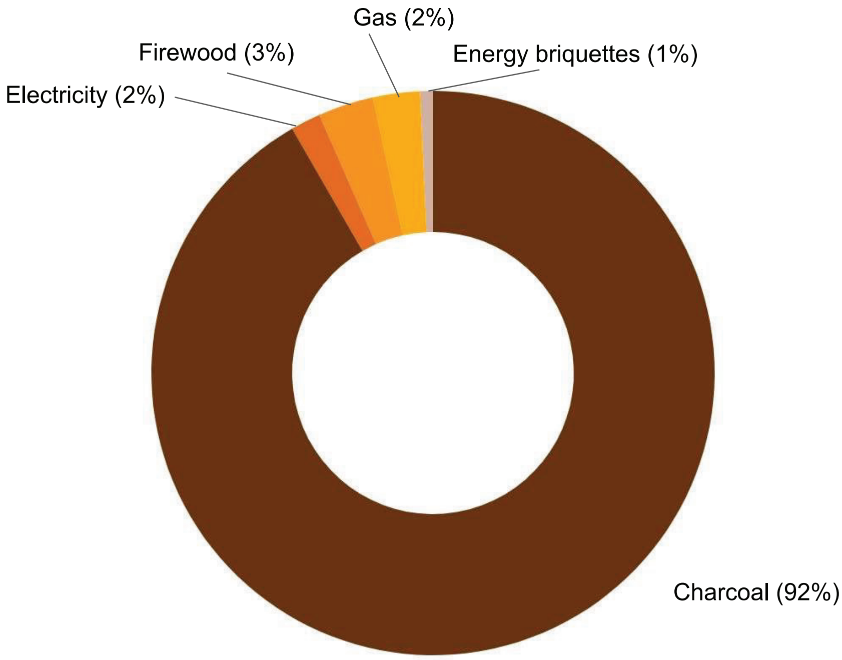


Figure 5. *Preferred fuel source for cooking.*

Although communities are almost universally connected, all grid connections are not equal. Given acute financial constraints and the large number of renters, the ideal model of one individual meter per customer simply is not a reality for most. Instead, there are diverse ways in which households and businesses in informal communities connect to the grid that have evolved to better cater to each user's particular constraints and circumstances. The way in which a user is connected, and their relationship with the supplier, is intertwined with experiences of affordability, reliability, quality, and safety, which in turn impact the ability to use and benefit from electricity.

This chapter summarizes the main findings of eight months of data collection and over a year of engagement with residents, leaders and advocates from 25 of Kampala's 60 informal communities. Section 4.1 describes the type of connections that users in informal communities make and why. Section 4.2 outlines the ways in which a connection type may limit a user's autonomy in deciding how and when to use electricity. Affordability, which in such resource-constrained contexts is uniquely interwoven with nearly every aspect of electricity use, is discussed in Section 4.3.

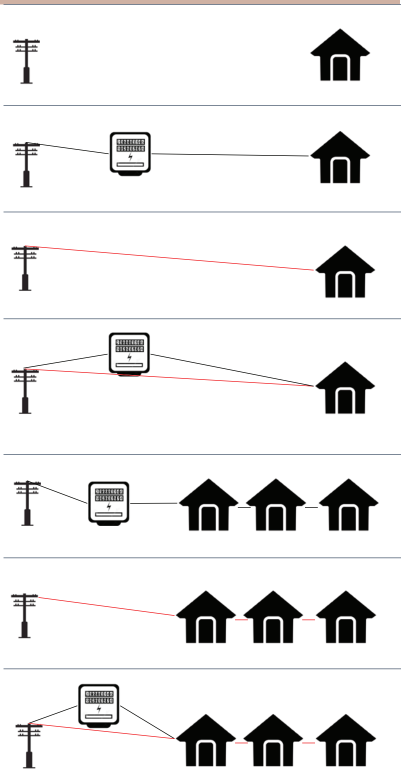
Section 4.4 describes the professional life of Kampala's informal wiremen, known locally as *kamyufus*, who act as de facto last-mile service providers in providing access to electricity whose needs fall through the gaps of formal channels. Section 4.5 highlights the ways in which the quality of power supply impacts its use, and Section 4.6 outlines the causes of electrical safety risks, and their consequences in terms of human life and livelihoods. Section 4.7 narrates the experiences and burdens women face in navigating electricity access. Section 4.8 describes the infrastructure mapped, its physical distribution across communities, and the impacts of poor infrastructure coverage. Section 4.9 concludes by examining how a lack of trust and poor communication between the utility and informal communities undermine efforts to improve service provision.

4.1 BEYOND LEGAL VS. ILLEGAL: CONNECTION TYPES ARE DIVERSE TO MATCH PEOPLE'S NEEDS, CONSTRAINTS AND CIRCUMSTANCES

Evidence collected through expert interviews suggests that stakeholders associate informal communities with high levels of electricity theft. Policymakers and practitioners articulated perceptions that communities are mainly connected to the grid illegally, that they contribute the largest percentage of electricity losses to the government, and that they cannot afford to sustainably finance legal connections given their low incomes and illegitimacy of their communities.

"Because of the low income levels and the manner in which the people live in these places, there is a lot of theft. Actually if it were possible, people...would cut off these slums. If they had their way, they would stop serving." - Expert interviewee[6]

However, the evidence from surveys and community interviews shows that the rates of illegal connections, in terms of the number of unmetered connections, are relatively low. This challenges binary assumptions of connections as legal or illegal, instead revealing a diversity of ways in which people in informal communities connect to the grid. The survey data revealed seven prevalent connection types (including non-connection) (Figure 6). Interviews further contextualized that these connection types respond to people's circumstances, needs, and constraints including purpose or use, tenancy agreements, income levels, gender and household demographics, level of education, and relationship to electricity suppliers, among other factors.



Physical configuration of connection	Connection type	Electricity payment to
	Unelectrified	N/A
	Individual metered	Umeme
	Individual unmetered	Neighbor Landlord *Kamyufu* No one
	Individual dual	Umeme Neighbor Landlord *Kamyufu* No one
	Collective metered	Umeme Neighbor Landlord
	Collective unmetered	Landlord Neighbor *Kamyufu* No one
	Collective dual	Umeme Landlord *Kamyufu* No one

Figure 6. *Overview of the seven primary connection types. Note that this list is not exhaustive, and other configurations do exist.*

[6] Readers should note that this is the perspective of a single interviewee, though it is emblematic of a larger trend observed in interactions with stakeholders. As discussed in Section 2.3, Umeme has been progressive in its approaches to addressing electricity theft through community engagement, such as in the Pamoja program.

Grid connection types can be categorized as: collective vs. individual and metered vs. unmetered. It is possible to have two separate connections, one metered and one unmetered, leading to a third category of connections here referred to as dual. Of the 95% of survey respondents who are connected to the grid, a majority of 69% are connected in ways that are fully metered, and 26% of connections are informally made through unmetered connections (Figure 7). Interestingly, the most prevalent type of connection, at 45% of all respondents, is collective metered connections where a single prepaid meter is shared among multiple households and businesses.

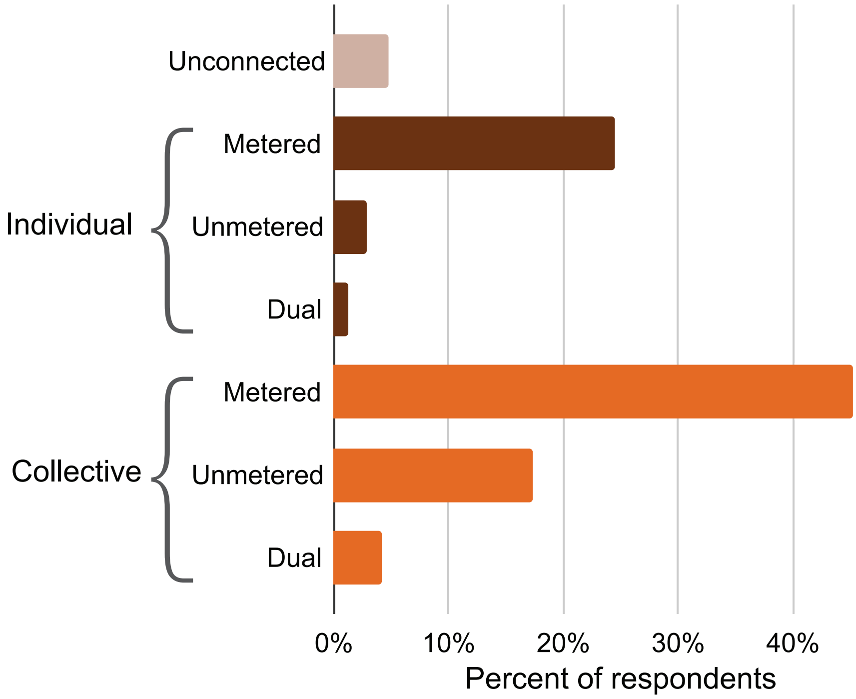


Figure 7. ***Frequency of seven connection types among 500 survey respondents.***

In a collective metering connection type, a user, often a landlord, applies to Umeme and obtains a prepaid meter. They then extend electricity to secondary beneficiaries, usually tenants or neighbors in a daisy chain. Electricity rates are usually determined by the meter-holder and are based on estimated consumption which accounts for the type of appliances owned and the time of day in which electricity is used. Though the rates are decided at the discretion of the meter-holder, rates were somewhat uniform across communities.[7] A normal tariff can be as low as 10,000 UGX per month for someone who uses only lighting and TV, or as high as 50,000 UGX for users (particularly businesses) requiring electricity for more intensive uses like refrigeration.

[7] Clear exceptions were observed where the meter-holder was unfairly inflating the rates, particularly for elderly or other vulnerable users.

Photo caption: *A cable extending into a household to provide electricity, likely as part of a collective metered connection. Photo by Jess Kersey.*

In unmetered connections, it is important to note that electricity is not free.[8] Users pay a monthly charge to the *kamyufu* providing the supply, which in some cases may exceed what a user would pay through a metered connection.[9] The payment depends on various factors, but like collective metered connections often depends on the types of appliances owned and the time of day when they are used. It is interesting that *kamyufus* charge based on estimated consumption because, unlike Umeme, a *kamyufu's* costs of service are not based on the kWhs supplied. An average household spends between 10,000–15,000 UGX on electricity per month, while a business whose activities are sustained by electricity such as saloons, betting centers, local restaurants, pay between 30,000–40,000 UGX a month in electricity bills.

Interviews revealed that users with dual connection modalities are served by both metered and unmetered connections, and use involves switching modes during different hours of the day, metered in the day, and unmetered in the night. In this type of connection, users limit metered connections for services like house lighting, radio, and televisions, and unmetered connections for heavier energy consuming services like cooking and all associated appliances. Monthly payments for electricity are mainly made to both Umeme, and the supplier of the unmetered connection, who can be either the landlord or the *kamyufu.*

[8] When discussing unmetered connections, it must be noted that high-income users are often an important source of electricity theft [58], [59]. Across many contexts, a substantial amount of losses are attributable to high-income residential, commercial users, and government institutions who have the ability to pay for unmetered connections which are more sophisticated and more difficult for the utility to detect.

[9] The number of unmetered users who do not pay at all for electricity is extremely small, and is usually the *kamyufu* themselves or their family and close friends.

Tenancy arrangements were found to be perhaps the most determining driver of connection types. Most survey respondents (76%) were renters, and renter interviewees reported that most units are offered on take-it-or-leave it terms. Disproportionately low-income tenants had little to no power to negotiate how electricity was accessed. For example, 83% of survey respondents connected through a collective metered connection reported that they did not have their own prepaid meter because they did not have the power or required documents to apply for one.

For their part, landlords varied in their approach to providing electricity services. Some were apathetic, preferring not to get involved and leaving the tenants to self-organize to obtain a connection. In these cases, tenants could not apply for a meter without the landlord's consent, and often turned to neighbors to extend a cable, or, more commonly, to a *kamyufu* to provide a connection. As one *kamyufu* commented, *"The requirements needed are too many. For example, a letter from the landlord, land title, national identity, among others, hence making it hard to acquire electricity."*

Electricity connection not included in rental agreement	Per kWh cost of electricity too high	The utility is slow to make repairs	The connection process is lengthy and complex
"Tenants are difficult when it comes to issues with electricity, so I agree to rent them the house and they find their own ways of getting electricity." — Landlord	*"You can find someone with one fridge and they pay almost 20,000 UGX everyday. But when that 20,000 UGX cannot fit in the business, they're bound to get interest in stealing electricity because it would be a lot money yet they need the fridge."* — *Kamyufu*	*"If your meter gets spoilt, you don't pay anything but when [Umeme] comes and take it to the lab, it can almost take two years without giving you another one and imagine if that's you and you have a business, do you just abandon your business or get someone to connect you?"* — *Kamyufu*	*"When you go through the kamyufu that offer illegal connection, you get Yaka fast though you have to pay them something. When you use the right procedure of requesting Umeme, it takes three years and I personally have experience. I requested for electricity at my home but till now I've never received."* — LC II

Figure 8. *Four key drivers of unmetered connections as communicated by interviewees*

More proactive landlords tended to offer a connection through collective arrangements. In such cases, the landlord would procure one prepaid meter, and extend the cable to serve all rental units. While this connection type has the benefit of quickly and affordably providing an electricity connection to tenants, it creates issues around how costs are allocated to individual tenants. These dynamics are discussed in the following Section 4.2.

Landlords prefer for each unit to have a separate meter, but were discouraged by the high cost. As one landlady said, "*We wanted every tenant to have their own meters but it's also very expensive. A tenant pays 150,000 UGX rent a month, when will the 600,000 UGX for the meter for everyone ever get completed?*" Other landlords noted that they had tried to procure prepaid meters for each unit, but their efforts had been frustrated by long wait times, high costs of wiring and poles, and the bureaucratic complexity of the process. Interestingly, there were several examples of landlords who had installed submeters for their tenants.

"The tenants disturb me, they always want you to read the meter, add, subtract, I'm old now, it's too tiresome. Yaka [would be] better but they don't give you as many as you want, I want every room to have its Yaka meter but [Umeme] can't give me." — Landlady

A need or desire to use energy-intensive appliances for productive purposes or for cooking was also a strong driver of unmetered or dual connections. In particular, businesses that are based on refrigeration, electric motors, or resistive heating reported using unmetered connections because they could not afford their consumption otherwise. This was particularly true for users who desired to cook with electricity.

Box 2. Dynamism in connection status.

In the context of informal communities, it is also important to note that the status of a grid connection is dynamic. Connection can be (and often are) lost. Examples of disconnection scenarios observed during the research or reported by interviewees include:

- The confiscation of an unmetered connection during an enforcement raid by the utility
- The landlord turns off the circuit breaker due to rent or electricity bill non-payment
- The meter is removed for repair by the utility due to a technical issue
- A neighbor removes the connection due to a dispute over electricity use

Of the 5% of total respondents who did not have an electricity connection at the time of the survey, 70% had had an electricity connection previously (Figure 9). Respondents cited malfunctioning of the prepaid meter, disconnection by landlords, and confiscation of unmetered connections as the reasons for losing their connection. All respondents who had never been connected cited affordability as the primary barrier.

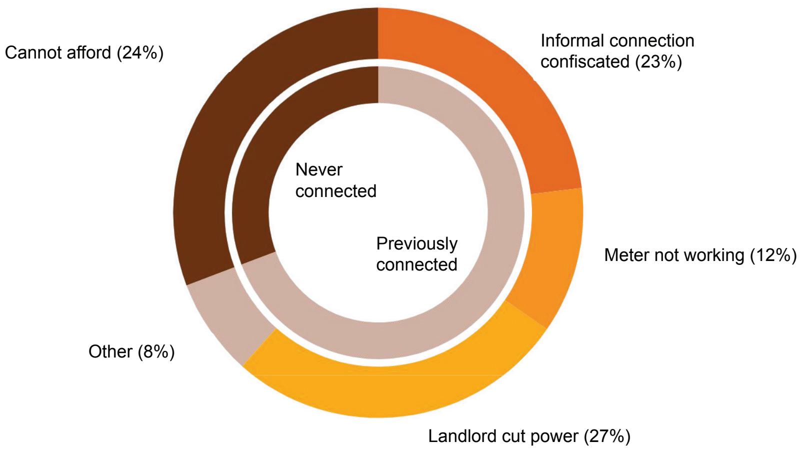


Figure 9. *Reasons for not being connected given by survey respondents.*

4.2 CERTAIN PREVALENT CONNECTION TYPES LIMIT USERS' AUTONOMY TO DECIDE HOW AND WHEN TO USE ELECTRICITY

The autonomy of a user — meaning their ability to decide how, when, and how much electricity can be used — varies widely depending on the connection type. Individually metered users who pay their bills directly to the utility enjoyed the most autonomy, but faced a different set of barriers related to affordability, which are discussed in more detail in Section 5.3. In contrast, two specific user groups reported navigating complex social dynamics around electricity use that limited autonomy. These are: customers on collective metered connections, particularly tenants paying to landlords, and users on unmetered connection types who pay to a *kamyufu*. As are detailed in the following paragraphs, these dynamics were observed to disadvantage low-income and other vulnerable end users.

In collective metered connection types, the person managing the meter is faced with the challenge of assigning financial responsibility for electricity consumption without any way to determine the actual kWh use of each user on the meter. Given this, the most common arrangement is for electricity tariffs to be assessed as a flat monthly rate based on the types of appliances owned by each user. When asked how much they paid for electricity, it was common for interviewees to report their monthly payment along with the services included in it (e.g., "I pay 15,000 UGX a month for lighting and TV"). Sometimes, the payment amount is also based on the time of electricity use. This is common in the case of people who worked outside the home, who would pay a lower "nighttime only" rate. Interestingly, similar conditions applied to unmetered users who paid the *kamyufu* monthly for service.

"Those [cooking] coils, we discourage them. [The tenants] don't use them…We allow them to iron. Okay, you iron, we're fine with it. The radio and TV, fine. But when you have any gadgets which are using [more electricity], you have to pay a little more." — Landlord

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These types of agreements are sustained by a certain level of trust and transparency between the supplier and end user, as the supplier requires the user to honestly state the intended purpose including the number and type of appliances. However, the power dynamics of this relationship between landlord and tenant or *kamyufu* and customer are asymmetrical and sometimes fragile. Disagreements over rent and electricity payments, or other unrelated matters, can result in temporary or permanent disconnection from the grid. As one landlady said, "If you don't pay me, I just cut you off." The terms of electricity connections then depend on the user's personal relationship with the supplier, which can disadvantage some users from more socially marginal groups like refugees.

Limitations on appliance use and time of electricity use were observed to be enforced in various technological and social ways. For example, some interviewees reported that the meter-holder would install a circuit breaker specifically sized to ensure that high-draw appliances, such as for cooking, could not be used. To enforce when electricity is used, it is also common to physically switch off and de-energize the circuit during certain hours. 18% of respondents on a collective meter reported that someone turned off their power supply at least once a week.

“[They] charge you according to how you use it. So if he gets to know that you have an appliance that consumes a lot of energy and tell him I have lights he will put on a circuit breaker. If you put on a strong appliance it will go off.” — Renter

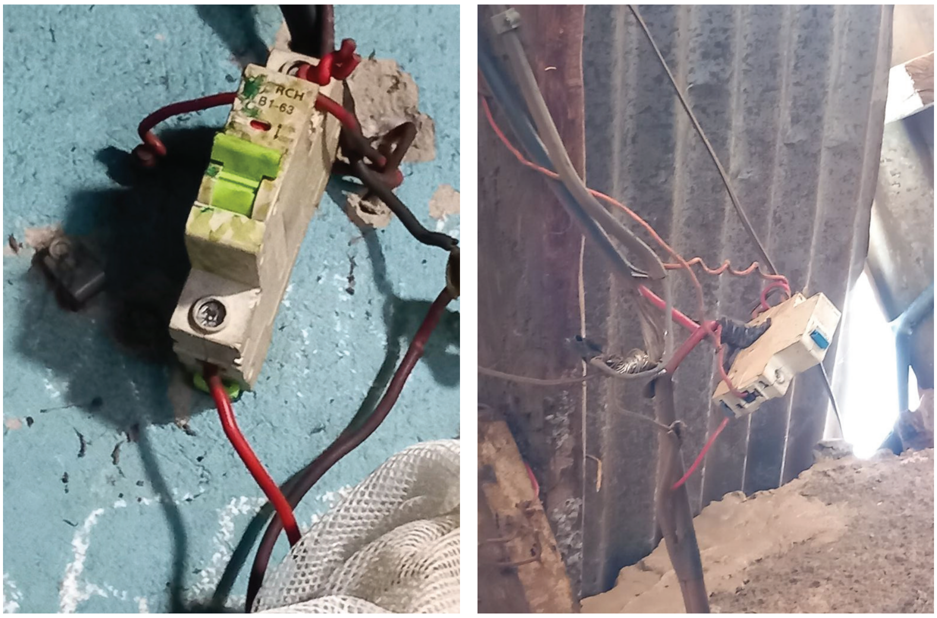

Photo caption: ***Examples of circuit breakers installed to limit electricity draw. Photos by Paul Kyoma.***

In terms of social enforcement, tenants and neighbors were observed to police each other’s appliance use. As one *kamyufu* put it, *“When say one person tells me they only use electricity for lighting, and they are paying 5,000 UGX, tomorrow when they buy a TV, even before I know, the neighbor who pays 10,000 UGX will tell me and I will come and increase the price, lest I disconnect them.”* In this way electricity becomes a social project, with access being contingent on ongoing negotiations with both the supplier and other third parties.

4.3 AFFORDABILITY IS A KEY CHALLENGE FOR CONNECTING TO THE GRID AND USING ELECTRICITY

Discussions with community members and experts underscored that affordability is perhaps the most significant deterrent to electricity access in informal communities. Concerns with affordability can be divided into two separate categories: the cost of connecting through a prepaid meter and the per unit cost of electricity.

As of December 2020, new connection fees in Uganda stood at 720,883 UGX for a no-pole connection (and 2,300,000 UGX for a single pole) compared to 178,200 UGX and 393,500 UGX for no-pole connections in Rwanda and Kenya, respectively [60]–[62][10]. This was reported to be unaffordable to residents in informal communities, who reported an average monthly income of 680,000 UGX for households and 730,000 UGX for businesses. For households, this implies the connection fee is 1.2 times their monthly income for a no-pole connection and 3.4 times their monthly income for a single pole connection.

In addition to being low, incomes are unpredictable. As income is earned through a day, week or month, it is allocated to high-priority expenses like food, rent, water, toilet use, replenishing business inventories, and school fees, making it difficult to save for large expenses like a connection. Making this point in a focus group, one woman noted, *"You wake up and you don't have money in your bag. The moment you get it you plan [what] you eat that day."*

Box 3. Successes and challenges of past and present connection subsidy programs.

In 2018 the Electricity Connections Policy (ECP) was launched by MEMD with support from the World Bank to increase the number of new connections made annually to 300,000 [64]. Under ECP, meters were given free of charge if participants bore the cost of internal wiring and inspection. Though the intended beneficiaries of the program were mainly rural Ugandans, informal communities also benefited.

A substantial number of interviewees mentioned knowing about or participating in the ECP, and the general sense is that the program was successful in overcoming the affordability barrier to acquiring a prepaid meter. However, the program was discontinued at the onset of the COVID-19 pandemic, resulting in several hundreds of thousands of applications being frozen. Community members expressed frustration at this delay (which in some cases was 2-3 years) and the lack of communication on the status of applications.

In late 2021, Umeme launched the Hybrid Connections Credit Scheme for the No-Pole Electricity connections program in partnership with the Government of Uganda, ERA, Uganda Development Bank, and the Rockefeller Foundation. The credit scheme reduced no-pole connection costs to 470,000 UGX, with an option to pay an initial deposit of 200,000 UGX and get a loan of 270,000 UGX. The utility recovers this loan by deducting a minimum of 15% from every transaction made by the customer over the period of eight years or until the loan is paid off.

While some are likely to take advantage of the program, 470,000 UGX is still out of reach for many lowest-income households or businesses in informal settlements which struggle with irregular and unpredictable incomes. The program also does not address the population who require a pole to get connected because their homes and businesses are too far from existing poles, or because the available meter slots on existing poles are full.

[10] A pole is sometimes needed if the applicant's premises are greater than 35 meters from an existing pole, or if existing poles no longer have space to install additional meters [63]. In these cases, the customer is responsible for purchasing a pole to facilitate the connection.

"I bought my electric pole and mounted it, then they connected other people on it. By the time I need to use it [to connect more tenants], they ask me to buy another one….they gave out my pole to other customers." — Landlady

Furthermore, there is no existing structure that ensures information flow to informal communities, such that they are made aware of such financing schemes. When asked, no respondents reported being aware of this credit financing program in the first four months of its operation.

Table 6. Connection fees and requirements for a typical household or small business [60]

Connection requirements	
1) Copy of national ID or passport	
2) Electrician's license number (input into digital application process)	
3) Way-leave permission from landowner through which the line will pass (if applicable)	
4) Company seal and certificate of incorporation (for companies)	
5) Loan application form for applicants applying to the customer credit financing scheme	
Inspection fees	
a) Domestic/residential	UGX 41,300
b) Ordinary commercial (e.g. shops and kiosks)	UGX 41,300
New connection fees (Single phase)	
1) Wireless split meter – no pole	UGX 470,000
2) Bare conductor wireless split meter – one pole	UGX 2,387,472
3) ABC conductor wireless split meter – one pole	UGX 2,741,188

At a levelized average of roughly 850 UGX per kWh[11] [65], electricity in Uganda is the highest in the region and among the highest on the continent (see Figure 2). This high cost per kWh of electricity was found to be a significant burden on users in informal communities. 85% of survey respondents reported that the electricity tariff is unaffordable.

More broadly, the affordability of electricity and energy is commonly measured in terms of its expense as a percentage of income, and 5% is commonly used as a threshold for "affordable" electricity [40]. Across all survey respondents, the average electricity burden was 5.3%, meaning that electricity could, on average, be considered affordable.

"You find a person who sleeps in darkness, has nothing to eat, and [then someone] requests for an electricity fee! Some only earn 2,000 UGX which caters only for food. What then should they do? They resort to illegal electricity and just call a kamyufu to connect them." — LC II

However, this overlooks two key underlying factors which suggest that challenges with affordability manifest more acutely for certain demographics of users. First, informal communities are socioeconomically diverse both within and across communities. Community members include low-income residents alongside those who have accumulated wealth over several generations. Developers also increasingly encroach into informal communities to redevelop land for higher-income tenants. Therefore, affordability indicators must be disaggregated to account for this diversity. Table 7 shows the average monthly incomes reported by survey respondents disaggregated into four income quartiles.

Table 7. Income quartiles of respondents in terms of average monthly income.

Income quartile	Lower value (UGX/mo)	Upper value (UGX/mo)	Average (UGX/mo)	Percent of respondents
Lowest	35,000	370,000	202,000	30%
Middle-low	371,000	600,000	486,000	29%
Middle-high	601,000	800,000	700,000	16%
Highest	801,000	4,600,000	2,700,000	26%

When disaggregated by income quartile it becomes clear that electricity burdens are disproportionately higher among lower-income user groups (Figure 10). The lowest income quartile, with an average monthly income of 202,000 UGX, reported an average electricity burden of 7.8% compared to 4.5% for the highest income group. Electricity burden also differed based on who the bill was paid to, which is an indicator of the connection type. Across all income quartiles, users that paid to Umeme through metered connection types had a higher electricity burden.

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[11] This was calculated by the report authors as the levelized cost including all taxes and the monthly service fee for a customer using less than 50 kWh per month.

Importantly, metered connections which are paid to Umeme became increasingly unaffordable for lower-income respondents. Respondents in the highest income tier who paid to Umeme reported spending 4% of their monthly income on electricity, compared to nearly 14% for those in the lowest income tier. The difference in electricity burden was much smaller between income tiers for those who paid to a *kamyufu,* landlord, or neighbor. For those paying to a landlord, for example, respondents in the highest income tier spent 2% of their monthly income on electricity, compared to just over 4% for the lowest income group. This clearly shows that connections through the landlord or *kamyufu* are better able to cater to low-income users' ability to pay.

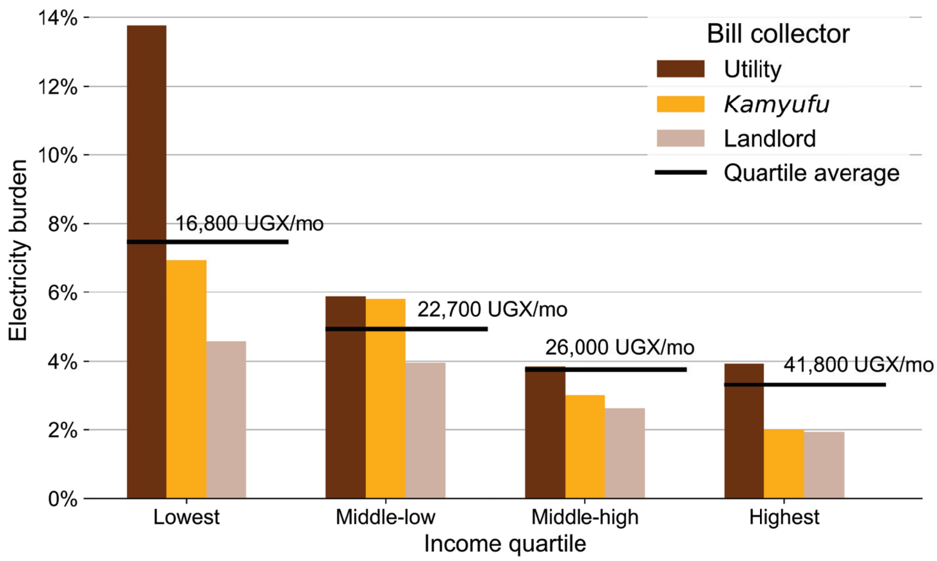

Figure 10. *Electricity burden reported by respondents across four income quartiles*

Box 4. Cooking fuel burden.

The cost of cooking fuels emerged as an important theme among discussions of affordability. Compared to an average electricity burden of 5.3%, survey respondents reported spending 12.3% of monthly incomes on cooking fuels (almost exclusively charcoal). Interviewees reported that their irregular incomes motivated them to buy charcoal frequently in small quantities, which resulted in higher prices than if purchased in bulk.

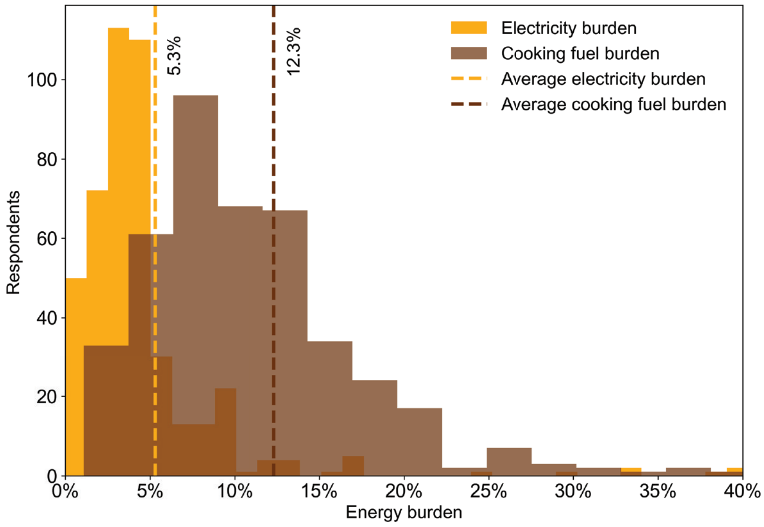

Figure 11. *Cooking burden versus electricity burden reported by survey respondents.*

Though cooking is not the main focus of this report [12] , these early findings indicate that promoting electricity as a cooking fuel, as the government is currently seeking to do, may be a fruitful area of future efforts to reduce the overall financial burden of cooking energy in informal communities [66].

Second, residents in informal communities tended to ration power as a strategy to keep bills low. Metered users forgo the use of certain appliances, or use them only sparingly or for special occasions as a way to limit their consumption. 56% of survey respondents who reported having an appliance that they did not use cited affordability as the reason. Cooking coils, electric kettles, refrigerators, blenders, and electric irons were the appliances that most respondents reported not using as a way to save money. For example, one woman explained that she keeps her electric kettle in her bedroom, away from her children, and only brings it out occasionally to boil water for tea. Others narrated how they often switch off their fridges most of the time, and only power them on fur a few hours a week to ensure they are not broken.

It is relevant to note that there is a lifeline tariff in place that provides a 70% subsidy on the first 15 kWh of usage [65]. However, to qualify for the lifeline tariff, the six-month average of consumption must not exceed 100 kWh monthly. In collective metered connections the cumulative consumption of all users on the meter often exceeds this amount, meaning that the subsidy is not applied. Furthermore, as mentioned in Section 5.2, in collective metered connections the meter holder usually charges a flat monthly rate based on the number and type of appliances used, irrespective of the lifeline subsidy. Even in arrangements where the landlord used submeters to individually bill tenants, the norm is to set a per kWh rate that is independent of the official tariff. For example, as one landlady said of her billing practices, *"Each person has their own submeter, when it's time to pay for electricity I read their meter reading and multiply by 1,000 UGX. That's how I do it."* The end result of these dynamics is that the lifeline subsidy reaches very few end users in informal communities.

[12] Barriers to clean cooking will be explored in subsequent work through a partnership with the Modern Energy Cooking Services.

Affordability also intersected with issues of autonomy and reliability in ways that were difficult to isolate. In collective connection types, reducing costs was the main rationale for the meter holder to cut power. This was usually done at the discretion of the meter-holder, and other users had little to no recourse. As one renter said in an interview, *"[The landlord] claims Yaka was depleting so fast, now he limits the hours electricity is on, he switches it off at 8 am and on at 6 pm."* Individual users also reported cutting their own power supply at the circuit breaker during daytime hours, or when children were left in the house alone, as a cost-saving measure.

Through the data from the remote power quality sensors, and follow-ups by phone, there were numerous recorded instances of affordability outages lasting from several hours to several days. Affordability outages refers to outages that happen not as a result of the grid supply, but rather because the user runs out of credit on their prepaid meter and does not have the funds to purchase more tokens. In the words of one *kamyufu* interviewee, *"Someone can go months when they've not paid [their meter] because they can't afford it. Yet Yaka doesn't wait for when you have, if you don't load, you won't have power."* And, the findings show that affordability outages are far more frequent than grid-level outages.

4.4 *KAMYUFUS* ARE LAST-MILE PROVIDERS WHO FILL SERVICE GAPS LEFT BY THE UTILITY

Kamyufu is a local name for informal electricity suppliers. They are uncertified, unregistered wiremen of variable levels of training and knowledge who operate outside the formal utility grid systems (and often in informal arrangements with formal grid system providers). This study finds that *kamyufus* significantly contribute to last-mile access in urban informal communities in Kampala by navigating electricity regulations and financial constraints to provide inclusive electricity access [51]. This section describes the identities, backgrounds, livelihoods, and operations of *kamyufus*, and highlights both the risks and benefits of their role in providing electricity services to low-income users who are unable to navigate formal channels to access.

Interviewees reported that *kamyufu* is a contested and elusive term, but is mostly understood to describe one that supplies electricity illegally. When asked, many *kamyufus* disliked the negative connotations of this word, and preferred to refer to themselves as local electricians, subcontractors, or wiremen. Others are in fact subcontractors officially employed with Umeme, or certified domestic wiremen, but occasionally facilitate unmetered connections or moonlight as *kamyufus.* The division between *kamyufus* and formal electricians was thus ambiguous, with one LC chairman noting that *"Umeme guys and these guys who do illegal connections for people are one and the same, the difference is the uniform."*

A misconception voiced by several expert interviewees is that *kamyufus* are completely untrained. The findings show, however, that most *kamyufus* have considerable levels of training and expertise but that their education is primarily informal and applied. Many *kamyufus*, in narrating the story of their career development, shared that they started out as errand boys for certified electricians or were sent to work with electricians after expressing an interest in electricity. What they described was an informal system of apprenticeship, where most worked with former utility employees, certified wiremen, or more experienced *kamyufus*, gradually developing their own electrical skills over a period of as much as six to ten years.

"I was trained by a former Uganda Electricity Board electrician who had several customers in my neighborhood. Whenever he came by, I used to follow him everywhere and one day he started to send me around to pass him stuff here and there. With time, I started to help him dig walls for wiring installations while he monitored. Gradually I learnt every step and he became comfortable sending me to his customers unattended. From then, he started to give me my own customers, and that is how I started. Now I also have over 15 kamyufus that are under me." — Kamyufu

During this time, they build their skills slowly, advancing from simple tasks like installing conduit pipe, to wiring sockets, to wiring entire homes, and, for some but not all, learning to climb poles to tap meters. They establish their own networks and territories, building independent customer bases mainly through referral systems. And, as their workload grows, they take on the responsibility of recruiting, training, and graduating additional *kamyufus* through the same system. Some *kamyufus* would even go on to eventually gain a certification from the regulator, though many reported not seeking certification because of associated financial or literacy barriers. Others reported turning to *kamyufu* work after being employed with the utility, either because they could not renew their contracts or because they were unsatisfied with the low pay and short contract periods.

Kamyufus operate territorially, with each in charge of a well-defined boundary that is known and observed by both fellow *kamyufus* and also customers. No one *kamyufu* can cross into the other's territory without permission, or connect a customer in another's territory, regardless of any relations or situation. As one *kamyufu* explained, *"We gave ourselves territories. You don't interfere with my work and I don't interfere with yours too. In cases where a person fails to pay my money, I disconnect them and no one is allowed to reconnect them back."* They often also work in concert with the utility. Several *kamyufus* reported having active informants within Umeme who would warn them of impending enforcement raids so that they could disconnect any visible illegal connections.

"We have those that we connect with…[they are] big people that we give money to monthly and they are very fast to warn us in case the officers are coming [to enforce illegal connections. There are times when an officer with higher authority plans to come, our Umeme friends call at night to tell us to disconnect everything." — Kamyufu

In terms of the services they offer, *kamyufus* are best known for providing unmetered connections. They do so by illegally tapping into existing electricity infrastructure, and may use a variety of methods including directly hooking a nearby uninsulated line, tampering with Yaka meters to enable consumers to use electricity without preloading tokens, or slowing down the consumption rate. However, many *kamyufus* reported offering various other services like fixing sockets, installing internal wiring, and other standard electrical work. Interestingly, it was also common for them to assist customers in navigating the formal connection process.

Kamyufus also provide local maintenance and operations services to ensure electricity continues flowing to their customers, and are generally proactive about communicating and addressing safety hazards with customers to mitigate risks and prevent harm. For instance, during an interview with one *kamyufu,* he explained that his daily tasks primarily involve inspecting wiring and connections within his territory, maintaining a record of necessary repairs or reconnections, setting timelines for these tasks, and communicating with his customers. These maintenance activities sometimes extend to infrastructure that serves the whole community. Several *kamyufus*, for example, shared that they will sometimes rebalance the loads on a transformer to improve reliability, or that they would manually cool transformers when they overheated to keep them from failing.

The *kamyufu's* competitive advantage, relative to the formal connection process, is the ability to fill existing service gaps and meet customers' needs and constraints in flexible and negotiable ways (Figure 12). This includes a lower upfront connection cost, as a *kamyufu* can procure lower-cost, used materials. It also includes a lower monthly rate, which is normally based on the number and type of appliances used, and which can also be negotiated depending on a customer's unique circumstances. Payment terms could also be adapted to smooth over periods of irregular incomes, which was a key obstacle for many. A woman who had recently lost her husband, for example, shared that the *kamyufu* had not made her pay since her husband's passing because he knew she could not afford it.

"The kamyufu will connect you regardless of how much money you have. They will advise you and meet you at your lowest or minimum energy requirement, you can also talk to them and they understand you." — Community interviewee

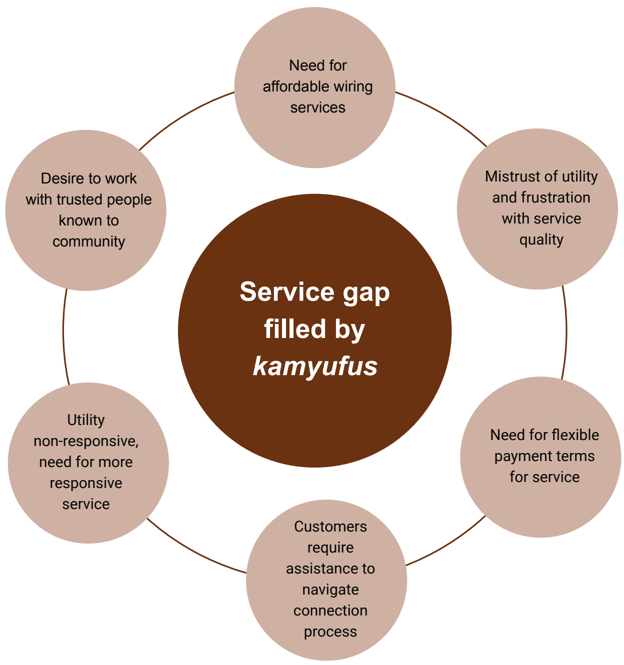

Figure 12. *Contributing factors to the service gap which is filled by kamyufus.*

There are certain risks and inequities related to the services provided by *kamyufus* which must be recognized. An important one is related to *kamyufu's* level of expertise and knowledge, particularly as it relates to safety. Although most *kamyufus* have undergone years of training, because they exist outside of the formal certification system, there is no way to ensure that they maintain a certain standard of safety in their work. For example, in providing affordable services to their customers, they sometimes jeopardize safety through cost-saving practices like using secondhand or low-capacity wiring. These dynamics are discussed in more depth in Section 4.6.

There are also significant power asymmetries which exist between *kamyufus* as electricity providers and their clients. These dynamics were similar to those reported by tenants and landlords. *Kamyufus* at their discretion may choose to disconnect clients for non-payment or as a result of a conflict which could be unrelated to electricity. Of course, there is no formal process to file a complaint against a *kamyufu*. In one situation discussed in Section 4.7, one woman's grievance against a *kamyufu* was met with aggression and violence. Nonetheless, there does appear to be a strong local acceptance of *kamyufus* and their operations as last-mile connection providers and facilitators.

4.5 POOR QUALITY AND RELIABILITY OF POWER SUPPLY SUPPRESSES ELECTRICITY CONSUMPTION

Data from the power quality sensors revealed chronic low voltage, episodes of high voltage surges, and frequent voltage fluctuations which led to the premature breakage of appliances and disruptions to daily activities. The power quality sensors were deployed across both informal and formal communities, providing a unique opportunity to compare the quality of power between the two.

The findings show that informal communities bear a greater burden of low voltage than formal communities. On average, informal communities experience approximately 3.2 hours of low voltage during the daytime period between 7 am and 4 pm while formal communities experience only 1 hour during the same time period. During the hours of peak demand between 4 pm and 9 pm, informal communities experienced an average of 2 hours of low voltage compared to formal communities who in the same period experienced only 0.7 hours of low voltage. These differences in power quality between formal and informal communities reflect inequalities in the condition of local distribution infrastructure and overall quality of service.

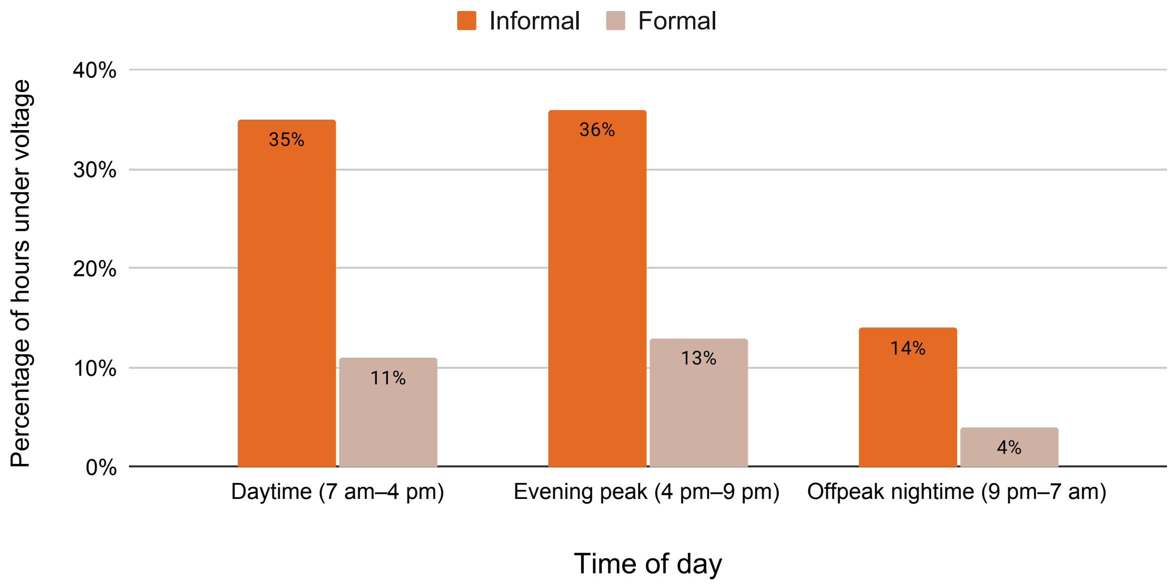

Figure 13*. Percentage of time spent under voltage at different times of day by community type.*

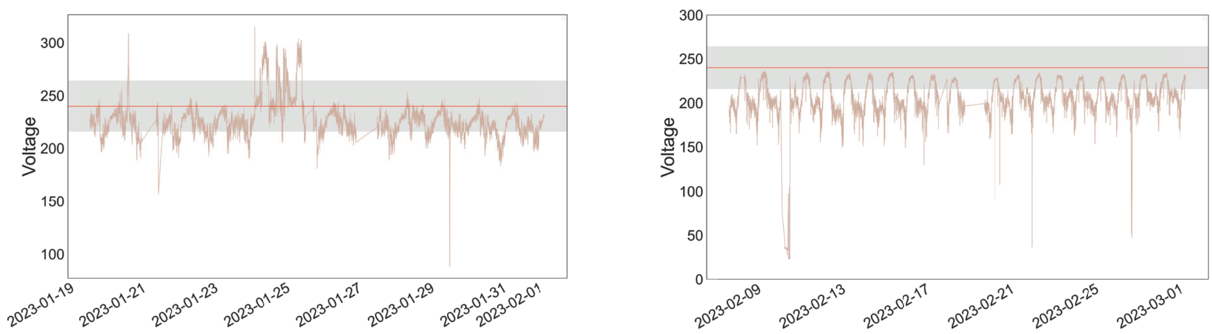

Figure 14*. Examples of fluctuating and chronic low voltage under 240 V (right) and high voltage surges (left) taken measured for two participants. The line in red indicates nominal voltage in Uganda of 240 V.*

The connection type was found to also influence voltage quality, with unmetered connections experiencing lower voltage than metered connection types. For participants with unmetered connections, approximately 55% of all voltage readings measured were low. In contrast, for those with individual and collective metered connections, 20% and 21% of voltage readings were low, respectively. In addition, though it was less common relative to under voltage, the sensors also captured instances of frequent voltages surges, some in excess of 300 V.

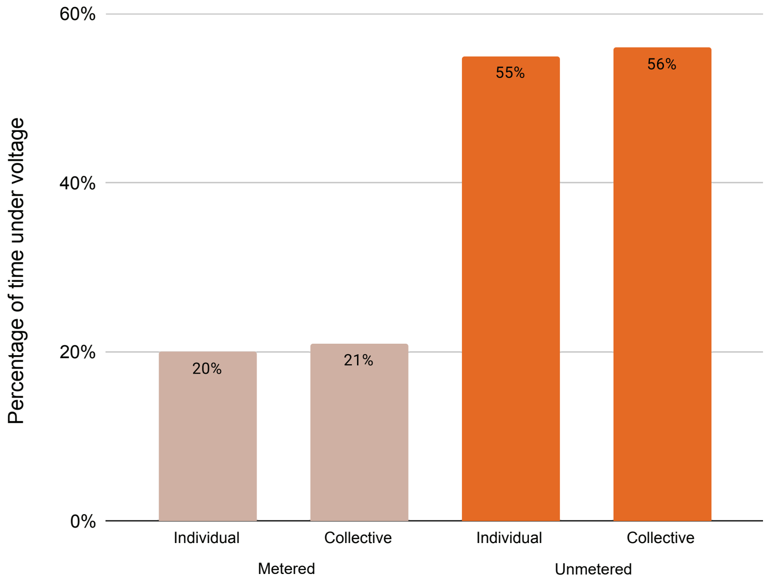

Figure 15. *Percentage of time spent under voltage across connection types.*

In terms of reliability, the sensors recorded an average of four outages per participant per week in informal communities, which lasted on average five hours. This translates to an average of 208 sustained interruptions per participant per year and an average outage duration of about 78 hours per participant per year. The outage frequency and outage duration surpasses published values of 28 sustained outages per customer per year and 50 hours outage duration per customer per year in Uganda [67]. By most metrics, electricity service in informal communities is highly unreliable.

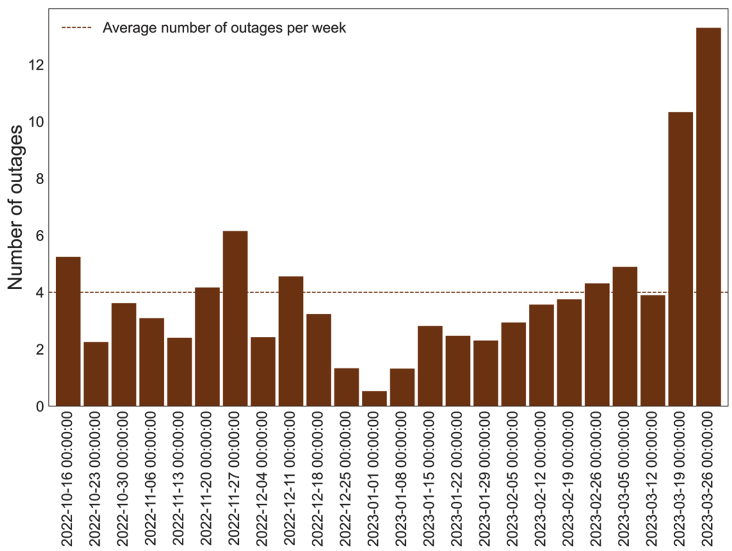

Figure 16. *Time series showing the average number of outages per week in informal communities. The dotted line indicates the average of four outages per week. The figure shows outages recorded between October 2022 and March 2023.*

One important consequence of these power quality challenges are appliances that prematurely break. It is likely that this most often happens during power surges, where the voltage spikes for a relatively short period of time but can burn wiring and internal circuitry. As one renter noted, *"[electricity] can come with very high voltage and destroy bulbs and TVs. Last time it came with a very high voltage and destroyed a lot of things…I heard people saying their appliances got spoiled."* A number of appliance repairmen who were interviewed also pointed to low voltage as a main reason for appliance breakage. During periods of under voltage, current increases. This can produce heat which damages appliances by burning or melting cables and internal parts. Broken appliances impose a significant financial burden on customers who are forced to pay for repairs or new appliances, particularly if they depend on that appliance to generate income.

Findings from the survey reveal that electric kettles, irons, and TVs were the consumer appliances that were the most commonly broken (Figure 17). For example, 27% of respondents owning an electric kettle reported that it was broken at the time of the survey. In the "other" category, respondents reported a number of diverse appliance types, almost all of which related to small businesses activities. While the study design cannot demonstrate causality between power quality and appliance breakage, 54% of survey participants responded that they thought the appliance breakage was due to voltage deviations.

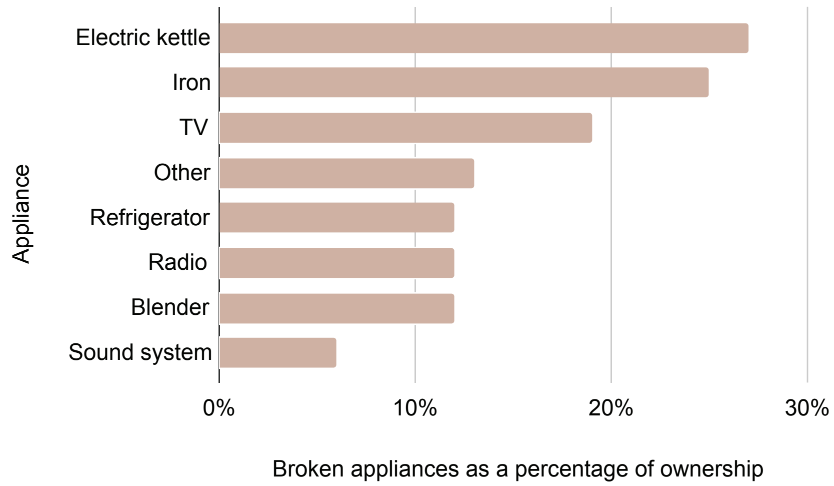

Figure 17. ***Broken appliances (n=108) reported by survey respondents. The percentage represents the number of respondents who reported owning a particular appliance who also reported it was broken at the time of the survey.***

"The electricity supply is unstable. Voltage increases and decreases, and it spoils whatever it finds plugged into a connection." — Appliance repair man

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Another outcome of unstable voltage and poor reliability is that some appliances cannot be used during times of day when the voltage is too low or power is not available. During periods of extremely low voltage, electricity can become unusable for most day-to-day activities that require electricity, including basic uses like lighting and phone charging. Interviews showed that community members were quite aware of these fluctuations and sometimes planned their schedule around them. When asked about voltage quality, one female focus group participant said, *"Current flow is low. I have a radio but at around 7, 8 and 9 pm it can't work…Sometimes you can't even charge a phone."* Many reported that this "weak" voltage impacted their work days, for example if lights became too dim for them to sew or read. Small businesses based on services like printing or phone charging reported that they could not operate during outages. Others pointed to the safety risks, especially for women, of homes and public spaces being unlit or dimly lit.

4.6 POOR QUALITY WIRING COMPROMISES SAFETY

Internal wiring in homes and businesses is often improvised. Given residents' low and unpredictable income levels, people wire their homes and businesses incrementally as they can. Many renters even reported that the landlord does not provide internal wiring, and are accustomed to taking their outlets, lightbulbs, switches, and wiring with them when they move. As a result, the overall poor quality of wiring is characterized by low-quality material, wiring which could not safely support required loads, and lack of adherence to safety standards like grounding. These present significant safety risks to people living in informal communities.

Photo caption: ***Wires which are improperly spliced and bare, which are at risk of transferring current into materials or people who come into contact with them. Photos by Paul Kyoma.***

These electrical safety hazards can lead to injury, property damage, and loss of life. Respondents narrated having normalized frequent electrical shocks through daily appliance usage, laundry hanging lines, wet floors and iron roofing. In the survey, 10% of survey respondents knew of at least one person who had been injured, and another 10% knew of property damage that had occurred due to electricity-related fires.

15% of respondents reported knowing of at least one person who had died in their community in the past two years due to electricity. And, respondents often reported knowing of more than one fatality — respondents reported on average knowing of 1.4 deaths, 23% of which were children. As one interviewee contextualized, *"Children die a lot due to [electrocution]. Recently someone lost a child. There's a period where we lost three* *children in one month just last year in 2022. One was a three year old."* Community members also noted that deaths were not always reported to the authorities, particularly when they resulted from unmetered connections.

"[When someone dies of electrocution] they hush it down and quietly bury the dead. Even the bereaved would keep it quiet because they are afraid if Umeme finds out they can make them pay for all the years they've used stolen electricity." — Kamyufu

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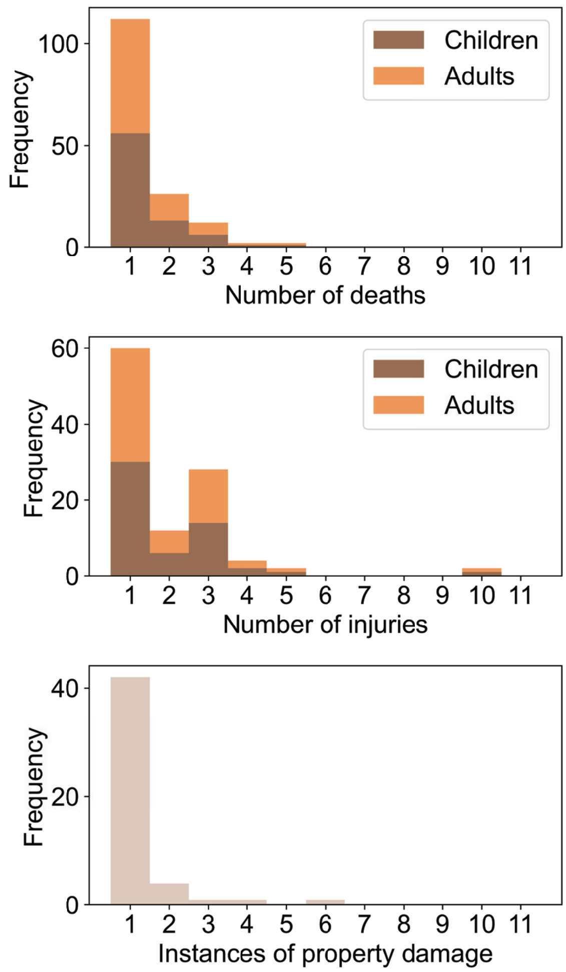

Figure 18. ***Number of survey respondents reporting knowing of a death, injury, or property damage which had occurred in their community in the past two years.***[13]

Safety risks were tied to connection types in complex ways which go well beyond a simplistic association of metered connections as safe and unmetered connections as unsafe.

[13] The frequency of responses cannot necessarily be equated to the actual number of incidents because more than one respondent may have reported on the same event.

In general, unmetered connections, which are not subject to any type of regulation or inspection, were perceived by respondents as higher risk. However, metered connections were not without any risk. To provide a metered connection, the utility requires a wiring certificate and inspection as part of the application process. However, after receiving a meter, extending internal wiring to additional rooms in the same building or to neighboring residences is common. Thus, though the wiring is safe at the time that the meter is installed, there is no way to ensure that future modifications meet these same standards.

While expert interviewees tended to assign culpability for unsafe practices to *kamyufus*, the findings showed a less straightforward relationship. As discussed in Section 4.4, many *kamyufus* are well-trained and are knowledgeable of electrical safety practices. However, there are exceptions to this. There were cases reported of *kamyufus* who are poorly-trained or apathetic to the safety of their clients. Also, wiring is sometimes done by amateur handymen whose expertise does not rise to the level of a *kamyufu*. For example, some interviewees spoke of boys and young men who had not been trained but who would do small tasks like wiring an outlet or splicing a cable as a favor for neighbors and family members.

In most cases, however safety challenges stem from underlying financial constraints which translate into an inability to pay for high-quality materials in sufficient quantities. *Kamyufus'* livelihoods depend on their ability to adapt their services to customers' financial needs. This means that, at their discretion, they implement cost-saving measures like installing wiring of insufficient capacity, using secondhand or damaged materials, or omitting grounding. Aware of these limitations, *kamyufus* give instructions to their clients on how to safely use electricity. When asked about his safety practices, one *kamyufu* said, *"I warn them about overloading it and tell them to get better wires [when they have the money]. I explain that I have connected them just because they don't have money but they should not overload the wires."* However, they have little control over whether their instructions are adhered to, and respondents recounted that it was common for wiring to spark or melt.

Electric cooking emerged clearly within discussions of safety. According to *kamyufus*, a desire to use electricity for cooking was an important factor in how the wiring was done. One *kamyufu* told us, *"We make research about who is cooking on it…we connect it in a way that even if they cook with it the wires wouldn't weaken easily."* In some cases, *kamyufus* even reported choosing not to provide wiring capable of supporting e-cooking to households with young children out of fear for their safety. The implication of this is that internal wiring will be a limiting factor in the uptake of e-cooking in informal communities.

A general poor awareness of safe electrical practices on the part of community members was another contributing factor to poor safety conditions. The research team often observed extension cables which were burned, damaged, overloaded, or used in lieu of wiring. Appliances with broken cords or plugs would often be wired directly into a socket. As one appliance repairman commented on general electrical safety, *"People don't know these things. They just use whatever they find. Some peel off the insulation when the charger is faulty and connect live wires into the sockets and the phone burns."* Similarly, several interviewees communicated misconceptions about the safety of electrical use, such as believing that food prepared with electricity could cause cancer.

Photo caption: *An extension cable in use, burnt in several places from overcurrent (left). A charging block with missing prongs is wired directly into an extension cable (right). Photos by Paul Kyoma.*

4.7 THE BURDEN OF ACCESS CHALLENGES IS DISPROPORTIONATELY BORNE BY WOMEN

As female respondents shared their lived experiences, they revealed the ways in which gender roles, norms, values and inequities influence energy access in informal communities. There is a complex interplay between gender, safety, and electricity access in informal communities. Women, because they are most often at home, were more likely to report safety incidents related to electricity. These risks are usually related to their responsibilities in the household. For example, one of the most common ways in which electrocution happens is through metal laundry lines that come into contact with bare wires. Women reported numerous accounts of themselves or others being shocked this way, sometimes even fatally.

Photo caption: *Laundry lines in close proximity to electrical wires and metal roofing. Photo by Elena van Hove.*

“I fear electricity. I was once electrocuted while I was seven months pregnant, I almost died! You see that wire over that roof, it fell on top of the roof and spilled over to the hanging line, it happened while I was hanging clothes.”* — Female renter

Cooking emerged as a clear theme related to electricity access and gender. Women and girls in most cases bear the burden of meal preparation within the household. Survey results show that 70% of women in the household have responsibilities related to cooking, compared to 20% of men. Many women reported wishing to use electricity to cook instead of charcoal or firewood, acknowledging the time savings, reduced smoke, cleanliness, and other benefits of electric cooking. Most, however, found electricity too expensive to cook with. As one woman in a focus group put it, *“The problem is when you use electric appliances, they use up your units faster. If you use a blender or [cooking] coil, you'll realize the 11 units you'd planned on lasting you for two weeks get done before then. That's why we fear using these appliances.”* Accordingly, women who were connected via unmetered connection types reported using electricity to cook with much more frequency.

“I use charcoal, but I have health issues with too much smoke. So I like electricity, but when I cook with electricity, I don't even want to check the meter reading because then I'll be forced to reduce my usage because it depletes so fast.” — Female interviewee

Photo caption: *A damaged electric stove which a woman had stopped using because it was shocking her and her children (left). An example of electric cooking with cooking coils (right). Photos by Jess Kersey and Judith Mbabazi.*

Women also bear the impacts of electricity rationing and often go without indoor lighting or TV or radio as entertainment during the daytime as they go about daily activities of cleaning, caring for small children, cooking, and running small businesses from their homes. They also tend to avoid using electricity due to concerns regarding potential risks and harm to the household. Moreover, *kamyufus* and other suppliers tend to restrict services such as cooking and appliance usage more in households headed by women and/or those with young children, citing safety and security reasons.

"If a mother has young children, even if they have how much money, I cannot allow them to cook on electricity. Because some women are careless, they might forget to switch off the coil and before you know it, a crawling child is dead." — Kamyufu

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However, despite these constraints, women in informal communities are resourceful in navigating the risks associated with unsafe electricity connections. In interviews, many women acknowledged only utilizing electricity for cooking when their children were not present or when they were physically present to monitor the cooking area until the cooking was completed. They took extra precautions to ensure that the cooking appliances were safely switched off after use.

Gendered energy access disparities were also evident in livelihood options and economic activities within informal communities. Women in these communities are predominantly involved in small businesses, mainly home-based enterprises and in the food business. They prepare (steam, boil, fry) and sell food and snacks within their local neighborhoods. Limited access to electricity significantly hampers their productivity, restricts their ability to expand or diversify their enterprises and increases their workload.

Female users are significantly more exposed to gender-based harassment than men during electricity access processes and arrangements. Multiple interviews revealed anecdotal evidence that women are charged substantially higher charges than their male counterparts and frequently experience bullying from electricity suppliers. A case from one particular community illustrates the extent of this issue: a female landlord shared her ordeal of a *kamyufu* connecting multiple houses on a cable that came into contact with her toilet roof, resulting in electrical shocks for her and her tenants whenever they used the restrooms. When she confronted the supplier and requested the removal of the wires, she was met with aggression and the threat of physical violence. She narrated that it was only through the intervention of LC leaders that her request to have the cables removed was eventually granted, but even then, she continued to live in fear both of electricity and the *kamyufu.*

4.8 PHYSICAL INFRASTRUCTURE IS OVERBURDENED AND COVERAGE IS VARIABLE

In the infrastructure mapping activities, teams physically mapping the electrical distribution system, including utility poles, transformers, meters, and the layout of distribution lines. Within informal communities much of the existing infrastructure is overburdened in terms of the number of people it serves. This is evidenced by a sparse distribution of streetlights and transformers (Figure 19), and many service lines on each pole. However, in most communities there are much fewer service lines than the estimated number of households. [14]

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[14] Estimates for the number of households per community was provided by ACTogether Uganda

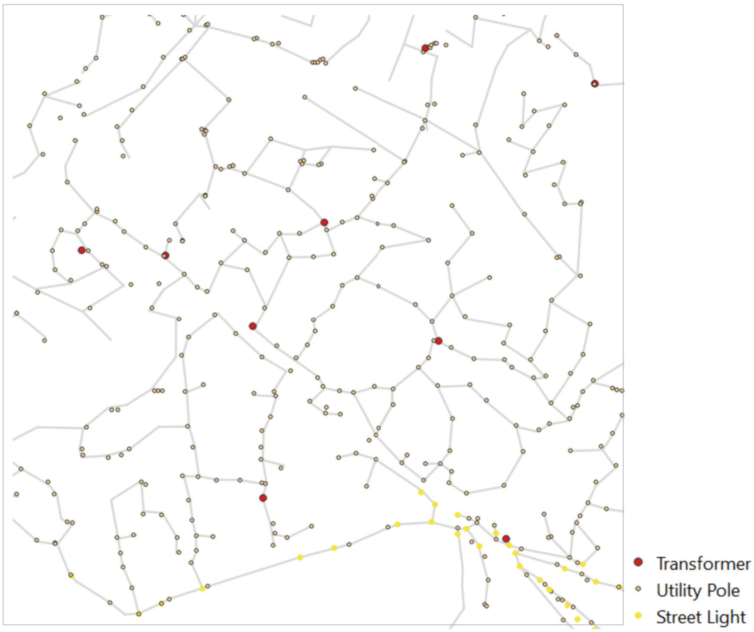

Figure 19. *Electricity distribution network, showing transformers, utility poles and streetlights.*

There are two types of meters, the prepaid meters where a white box containing the receiver is located on the utility pole and the postpaid meters for which the meter box is inside the customer's building. For each utility pole, whether prepaid or postpaid, a wire drops down from the pole to the customer's building. It follows then, that counting the number of service lines and comparing them with the number of meters on the pole provides insights into the state of repair of the network and instances of unmetered connections. On average, there were eight service lines per each utility pole, with a maximum of 37 service lines per pole.

Photo caption: *Comparison of the number of prepaid meters and wires dropping down from a utility pole. One pole shows the ideal of two prepaid meters and two service lines (left) while the other features few meters but many service lines originating from the same pole (right). Photos provided by YouthMappers.*

Whereas there is in general a large burden on existing infrastructure in terms of the number of service connections to electricity poles, the distribution of connections varies for each settlement (Figure 20). In 23 of 25 settlements, the number of service lines are less than 50% the estimated number of households living in that community. Similarly, the count of prepaid meters is less than 30% the estimated number of households. This indicates that there are many households with collective meters or unmetered connections and it confirms statistics from the surveys and interviews. The remaining two communities have service lines exceeding the estimated number of households in the community.

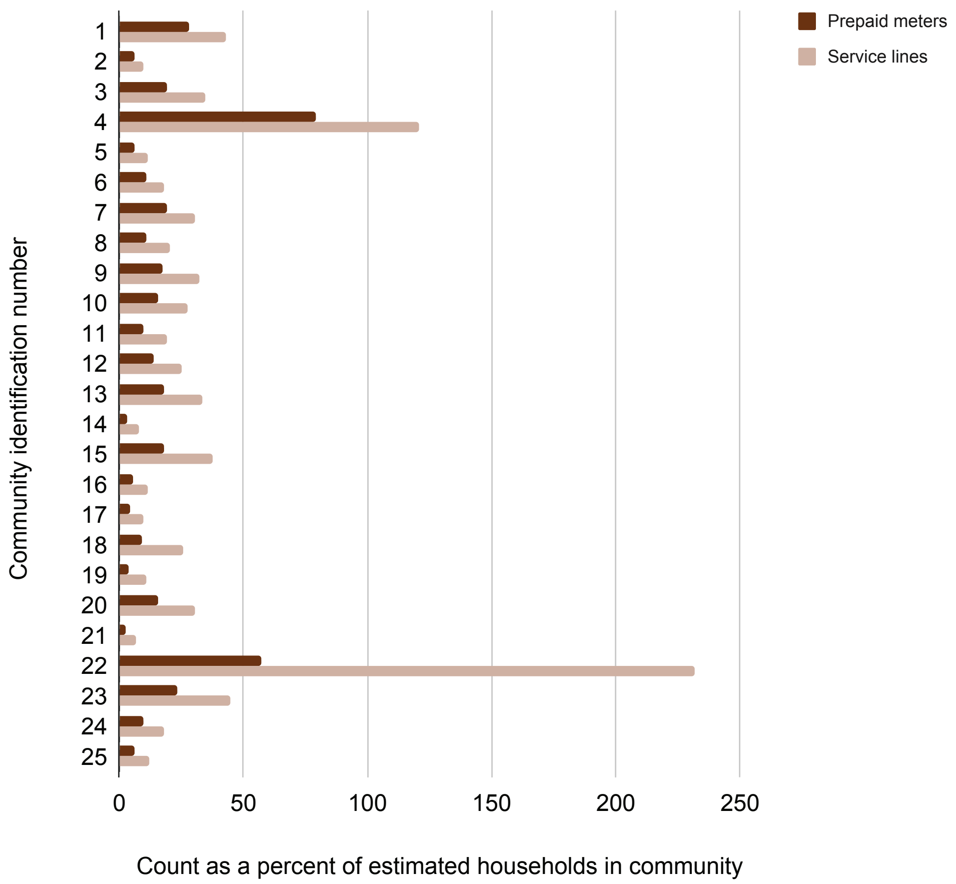

Figure 20. ***Ratio of prepaid meters and service lines counted in relation to the estimated number of households in each community.***

Whereas there are many utility poles within the informal settlements, there is especially poor coverage of street lighting and most areas remain dark in the night. Most of the streetlights were captured on the main roads bordering the communities with very few identified within (Figure 21). 95% (263 streetlights) of the mapped streetlights were operational. 60% of the communities had three or fewer streetlights, of which four settlements had none. The low availability of streetlights causes security issues, particularly for women. As one interviewee noted, *"Security issues are on the rise because there are no streetlights. Women can no longer go to the market early because the crime rate is alarming."*

Figure 21. ***Street lights distributed along a road. Map identifiers are intentionally omitted to protect the identity and privacy of the participating communities.***

Transformers are designed based on a particular load expected from a specific number of customers. Since informal communities are densely populated and continuing to grow, there should be a proportional increase in transformer capacity to reliably meet the load. In most communities, transformers were sparsely distributed and served a very high number of users (Figure 22), meaning transformer-level outages tended to impact a large number of customers. This point was underscored by a number of interviewees, who readily identified an overloaded transformer as the main cause of outages and poor power quality in their communities. Interviewees even shared stories and videos of transformers smoking or catching fire, an indicator of a transformer being overloaded. It must be noted, however, that this mapping does not capture transformers that feed the community but are located outside of its boundaries.

"This transformer of ours…it can't take a month without causing fire…At times you just see smoke, it bursts like a bomb, then you see smoke coming out, then the power goes off. There's a day we discussed with [Umeme engineers] and they were saying the transformer is overloaded because we are many in this community. Being a slum people are many…Now we said, "What can we do?" They said we need a stronger transformer probably, or to add another one, but they haven't achieved it. So, we use that one." — Health clinic worker

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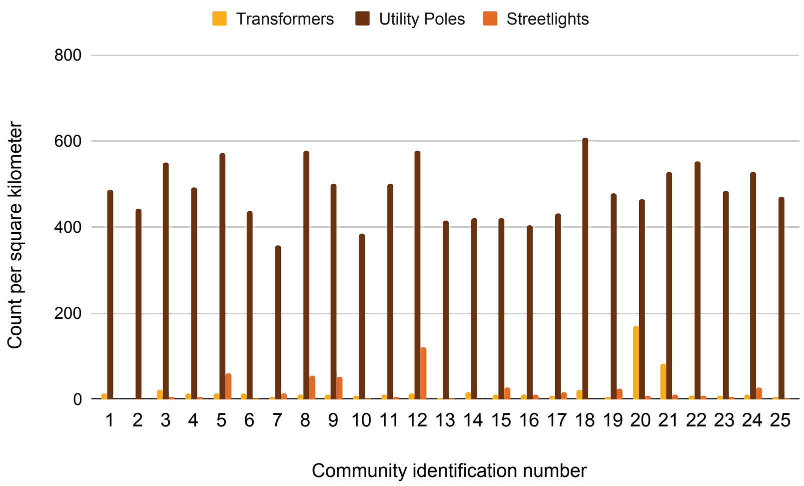

Figure 22. *Density of utility poles, transformers, and streetlights per settlement.*

4.9 POOR COMMUNICATION AND MISTRUST CREATE A NEGATIVE FEEDBACK LOOP IN UTILITY-COMMUNITY RELATIONS

A lack of trust between the utility and informal communities is a well-recognized challenge to electricity service provision across many geographies, and this was certainly found to be the case in Kampala [49], [57]. Interviews with community members and experts in the electricity sector revealed divergent narratives. From the community's perspective, a lack of consistent communication, enforcement actions, and poor experiences with customer service create mistrust, feelings of discrimination and marginalization, and misperceptions which motivate the continued use of unmetered connections. From the utility's side, the high amounts of losses in these communities lead to a perception of informal communities as being difficult and expensive to serve, and ultimately loss-making. This creates a feedback loop where the utility sees little value in moving beyond the status quo to improve infrastructure or customer service, and users in turn see little motivation to change their behavior (Figure 23).

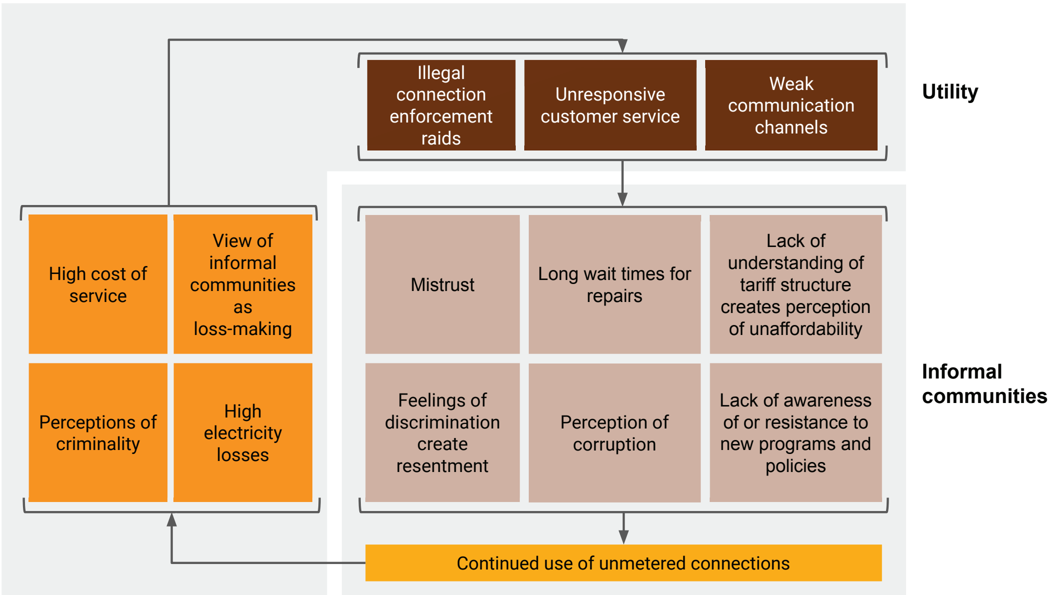

Figure 23. *Feedback loop of interactions between the utility and community*

“When you go into those informal settlements, the propensity for theft is very high, the consumption is extremely low so the cost benefit supplying such a place is very poor.” — Former regulator and utility manager

In many informal communities, residents’ perceptions of the utility personnel are based on their conduct during enforcement raids. These are carried out by a special unit within Umeme in partnership with local police. During such visits, teams check the integrity of meters, confiscate any cables providing unmetered connections, and issue fines or make arrests. Across all communities surveyed, enforcement raids took place on average over three times a year (Figure 24). Since this is often the only contact that community members have with Umeme personnel, it creates feelings of marginalization and discrimination. This being said, from the utility’s perspective, enforcement actions are an essential part of revenue protection which is a standard practice of many utilities. In some communities, Umeme has estimated that as much as 40-45% of supplied electricity is lost through unmetered connections.

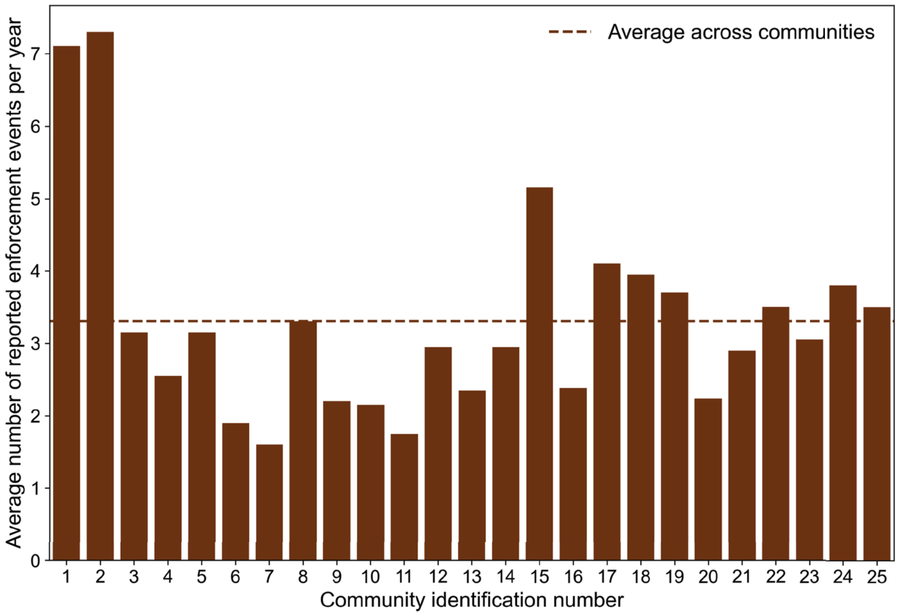

Figure 24. *Frequency of illegal connection enforcement visits reported by survey respondents across the 25 communities.*

Another challenge which contributes to mistrust and misperceptions is poor experiences with customer service. Many interviewees reported response times ranging from weeks, to months, to even years for Umeme personnel to fix meters, fallen poles, blown transformers, and other critical pieces of distribution infrastructure. Others reported discriminatory experiences with call centers, recounting stories of being hung up on once the respondent learned that they were calling from a “slum” neighborhood, or of staff refusing to speak in English even if the caller was not a Luganda-speaker. However, Umeme’s customer satisfaction index has risen steadily in the past few years, which brings into question whether such experiences are unique to informal communities [68].

“This pole caught fire almost three months ago, the whole community was disconnected. I called Umeme immediately, but up to now they have never come to even check it out or communicate what’s next or when it would be fixed. Imagine if we had no other way of being connected, how would we be living right now?”
— Local council leader

Despite substantial efforts by Umeme to improve their customer communication (notably through social media like Twitter), it appears that these communication channels struggle to reach end consumers in informal communities. Instead, inaccurate information and misconceptions spread easily that either motivate consumers to connect to the grid in unsafe ways or ensure that they remain ignorant of programs that could benefit them. For example, very few community members were aware of the recently-launched Hybrid Connections Credit Scheme despite significant outreach efforts by the government and utility.

This communication vacuum also creates a lack of awareness or mistrust of new technologies and programs which could benefit communities. Numerous interviews revealed high degrees of skepticism and resistance from the community to government or utility programs. ECP was commonly cited. A number of participants in the study narrated that, despite their doubts, they had decided to enroll in ECP, which offered free connections. However, their concerns and doubts were validated when the program was stalled, with many not receiving any benefits from the program or any notifications regarding its progress or cessation. This left an entrenched sentiment of frustration and dissatisfaction which deters future participation in similar programs like the Hybrid Connections Credit Scheme.

The most prevalent and damaging misconception is community members’ lack of understanding of the tariff structure and the lifeline tariff. 54% of survey respondents did not know (or could not guess) the prevailing unit cost of electricity, while others provided highly inflated figures. The lifeline tariff was particularly poorly understood, with most people believing it was a “bonus” or a “premium” they received for buying electricity early in the month. This led many to turn to unmetered connections based on the perception, rather than the reality, that electricity was unaffordable. In some cases, this allows users to be exploited — some are charged significantly more than what they actually use and what they would ordinarily spend in metered connection arrangements.

5. PRIORITY ACTIONS TO IMPROVE ELECTRICITY SERVICE DELIVERY IN INFORMAL COMMUNITIES

In all interactions, residents of informal communities conveyed a strong desire to see improvements in their access to electricity, and to be active agents, rather than passive recipients, of this change. This section provides a set of recommendations that were either communicated directly by community members or inferred through the research team's findings and discussions with stakeholders. These recommendations are oriented towards government policymakers, utilities, aid agencies, city planners, community advocates, and other people and organizations with a role to play in providing equitable electricity services. They are intended to provide ideas for strategies, programs, policies, and other interventions, informed by both this work and experiences in other geographies, which can be implemented to address the access challenges observed in this study.

5.1 DEVELOP MORE TARGETED AND INNOVATIVE SUBSIDY PROGRAMS TO REDUCE ELECTRICITY COSTS FOR LOW-INCOME CUSTOMERS

Reducing the burden of the high cost of electricity emerged as a clear priority for community members. Though a lifeline tariff is in place to reduce the cost of the first 15 kWh of electricity each month to 250 UGX per unit, it is applied evenly across all residential meters consuming less than 100 kWh monthly. This means that some relatively wealthy users can access the subsidy, while the 45% of users in informal communities who are collectively metered cannot. Tariff reforms, like a more progressive inclining block tariff structure or targeted subsidy programs, could be based on socioeconomic status. In other geographies like South Africa and Colombia, tariff targeting has been done effectively by geospatially identifying low-income areas, through government-maintained income statistics, or through other proxies like property value [57]. This approach, though more administratively demanding than the current uniform subsidy, could enable different consumer groups to cross-subsidize and ensure that subsidies only reach those who truly need them.

5.2 CONTINUE BUT IMPROVE CONNECTION SUBSIDY PROGRAMS

Connection subsidy programs, like ECP and the Hybrid Connections Credit Scheme, will be an important element in improving electricity access and mitigating non-technical losses in informal communities. These programs should continue but require improvements to increase their impact for this specific demographic. Where loans and on-bill repayment structures are used, they should have provisions to ensure that landlords cannot transfer these costs to tenants without their consent. Programs should emphasize wider outreach to informal communities and LC leadership for awareness-building, increase the efficiency of the process and decrease wait times, and expand programs to at least partially subsidize the cost of the pole for those requiring single-pole connections. Ensuring timely and clear communication with program participants is also essential.

5.3 CREATE SPECIAL PROVISIONS FOR FAIR AND SAFE ACCESS BY RENTERS

Given that most residents in informal communities rent rather than own, efforts should be made to address the challenges tenants face in accessing electricity on fair and safe terms. A key issue for renters is that they cannot apply for individual meters without the landlord's approval and instead must rely on unmetered or collective connections or forgo a connection altogether. Utilities could create provisions for renters in informal communities to apply for an electricity connection without requiring documents from the landlord. Further, programs could seek to provide a free or discounted meter for renters that relocate and can prove that they had purchased a meter at their old premises. Specialized metering programs could be developed to register users who are collectively metered, and to provide subsidized sub-meters, to enable low-income customers to take advantage of lifeline tariffs and ensure that landlords bill based on actual, rather than estimated, consumption.

5.4 DENSIFY AND UPGRADE DISTRIBUTION INFRASTRUCTURE AND STREET LIGHTING

Overloaded distribution infrastructure was the likely cause of many of the power supply challenges observed, which include frequent voltage fluctuations, chronic under voltage, and regular outages. Community members reported that their willingness to pay for electricity would be higher if the supply was reliable and of higher quality. Stakeholders should consider making capital investments in these communities to improve the coverage, capacity, and condition of the low voltage distribution system to alleviate the burden of broken appliances and corresponding impacts on livelihoods. Supporting additional data collection efforts and low-cost sensing of the distribution grid could guide targeted investments in distribution infrastructure upgrades. Such investments could also be a show of goodwill by the utility, which would help interrupt the negative feedback loop that encourages the continued use of unmetered connections. Street lighting is also an important area of investment that would have especially positive impacts for women. Efforts undertaken in Jinja, for example, where community youth were trained to install and operate the street lights, can instruct ongoing efforts by the Kampala Capital City Authority to expand street lighting coverage in informal communities [69], [70].

5.5 DEVELOP PROGRAMS AIMED AT IMPROVING INTERNAL WIRING CONDITIONS

Community members reported an alarming number of deaths and injuries caused by unsafe wiring conditions. To address this pressing safety risk, governments and development partners could develop assistance programs for replacing existing wiring with correctly dimensioned and safe wiring, as well as standard electrical ducts, circuit breakers, fuse boxes, and outlets. Improved wiring is also likely to significantly improve power quality. For example, good quality and properly sized circuit breakers can eliminate unnecessary outages that are caused by low amperage fuses. Cost reductions in this equipment could be achieved through bulk purchasing or the easing of import taxes. In tandem, innovative financing schemes could be created to make upgrades in internal wiring affordable for low-income customers. The utility and relevant stakeholders could also offer subsidized innovative technology such as "ready boards" that eliminate the need for internal wiring, such as those successfully implemented as part of Cape Town's electrification project [57]. Within these solutions, there is significant potential to leverage private sector involvement.

5.6 MOVE BEYOND "REGULARIZATION" AND EXPLORE ALTERNATIVE SERVICE DELIVERY SCHEMES

An overall conclusion from the study is that a one-size-fits-all approach to electricity delivery disadvantages informal communities who have significantly lower ability to pay for services. Instead of seeking to "regularize" informal customers, service providers should explore alternative ways to safely and cost-effectively provide electricity access. Utilities could pioneer new technologies and delivery models to meet the needs of extremely low-income users at a lower cost, for example leveraging solar home systems or meshgrids as an alternative electricity source. This could also help address financing barriers by providing an entry point for the private sector. New delivery models involving the community in electricity service delivery and operations may also prove fruitful. In Cape Town, for example, a community-based distribution company was established which dramatically improved the quality and reliability of service [57].

5.7 PROVIDE MORE RESPONSIVE CUSTOMER SERVICE THROUGH LOCAL AGENTS

A need to improve the responsiveness of the utility's customer service was a consensus across communities. Community members were frustrated by long wait times for repairs and the lack of local personnel to answer questions, and these are service gaps that are currently being partially filled by *kamyufus* (informal wiremen). Utility providers could establish community-based agent networks consisting of trained representatives, possibly even *kamyufus*, embedded within these communities. These local agents should be known to and trusted by the community and empowered such that they can effectively communicate and address residents' concerns. A local agent model could also offer a pathway for women to enter the technical workforce. By offering prompt assistance and response to inquiries, local agents can improve customer satisfaction, decrease the number of unmetered connections, and ultimately provide safer, more inclusive access.

5.8 RECOGNIZE *KAMYUFUS* AS VALUABLE SOURCES OF HUMAN CAPITAL AND SEEK OPPORTUNITIES TO UTILIZE THEM

It is clear from this study that *kamyufus* are a crucial link in the electricity supply chain within informal communities. Most are relatively well-trained and experienced and are trusted figures in their communities. They can provide flexible and responsible services to populations that the utility is simply poorly equipped or not designed to serve given their low income levels. It is important that *kamyufus* be viewed as part of potential solutions rather than as a cause of the problems. Though some type of certification or training will be needed to ensure a minimum safety standard, as Umeme's *Pamoja* project has done, policymakers should seek to empower *kamyufus* and tap into their knowledge and

[15] Meshgrids are standalone solar and battery systems which are interconnected with low-capacity wires to allow for small amounts of power sharing between nearby users. Interested readers can visit Okra Solar for more information on this emerging technology [71].

relationships to provide inclusive access to informal communities. Innovative approaches could, for example, seek to train *kamyufus* as local utility representatives or use them as communication channels for information related to electricity services.

5.9 SHIFT AWAY FROM PUNITIVE APPROACHES TO CURB ELECTRICITY THEFT AND TOWARD COMMUNITY ENGAGEMENT

In most cities, efforts to curb electricity theft in informal communities have focused primarily on punitive approaches to enforcement. In Kampala, an Electricity Amendment Act was passed in 2022, which increased the penalties for those found to be stealing electricity to 15 years of jail time or a one billion UGX fine [72]. This is a steep punishment for low-income residents of Kampala, who resort to unmetered connections because of affordability and service barriers and who generally communicated a desire to access electricity legally. While these types of enforcement mechanisms will continue to be an important tool to deter theft from certain user groups, a greater focus should be placed on identifying the main drivers of unmetered connections and addressing those directly in partnership with communities. The *Pamoja* project, which Umeme implemented, has sought to do just this by assigning utility representatives to engage directly and regularly with community members. *Pamoja* was talked about positively by study participants, and efforts to scale elements of the program to a larger number of communities would likely be fruitful.

5.10 BUILD STRONGER COMMUNICATION CHANNELS BETWEEN SECTOR STAKEHOLDERS AND COMMUNITIES

The study showed that a lack of information contributes to the proliferation of mistrust and misconceptions regarding electricity services in informal communities. Stakeholders like the government and service providers should seek to improve communication to engage and inform communities, rebuild trust, establish more positive relationships, and to sensitize users on important topics like tariff structures and electrical safety. Central to these efforts is identifying appropriate communication channels. Digital mediums may have a limited reach, as not all residents own smartphones and computers, but community radios, dissemination through LC leadership, community-based organizations like savings groups, and locally-held events are likely to be effective. These communication efforts should not be seen as a one-way channel, but as an opportunity for stakeholders to also solicit feedback from community members and ultimately improve the quality and safety of service.

5.11 EMPHASIZE PARTICIPATORY APPROACHES TO TRANSFORMING ELECTRICITY SERVICE DELIVERY

Efforts to improve the quality of electricity services should place a strong emphasis on promoting participatory approaches that empower communities to actively engage in the planning and implementation of upgrades and initiatives. This could, as examples, involve hosting community feedback sessions as part of tariff-setting activities, engaging community members in the process of siting streetlights, or working with *kamyufus* to identify priority areas for upgrading of distribution infrastructure. In such activities it will be crucial to adequately resource community counterparts in terms of financial support, capacity building, and technical assistance. Such approaches can help ensure that the community's needs and aspirations are voiced and considered and in doing so cultivate a sense of empowerment and collective responsibility which can enable community members to take an active role in shaping their energy futures.

5.12 RECOGNIZE THE UNIQUE CHALLENGES OF INFORMAL COMMUNITIES WITHIN THE BROADER SDG 7 AGENDA

An implicit and unexamined assumption within the Sustainable Development Goal (SDG) 7 community of practice is that urban areas are well-electrified, or easily electrifiable given their proximity to grid infrastructure [12], [42]. This has manifested as a focus on addressing the access challenges of rural and remote communities to the exclusion of other energy-vulnerable groups like refugees and, as this report argues, the urban poor in informal communities. As urbanization continues in the coming decades, and the global population living in informal communities swells to over three billion people by 2030, energy poverty will become an increasingly urban phenomenon [2], [45]. Efforts to understand and address the unique challenges of vulnerable urban populations must be mainstreamed into the SDG 7 agenda to ensure a just and inclusive urban future.

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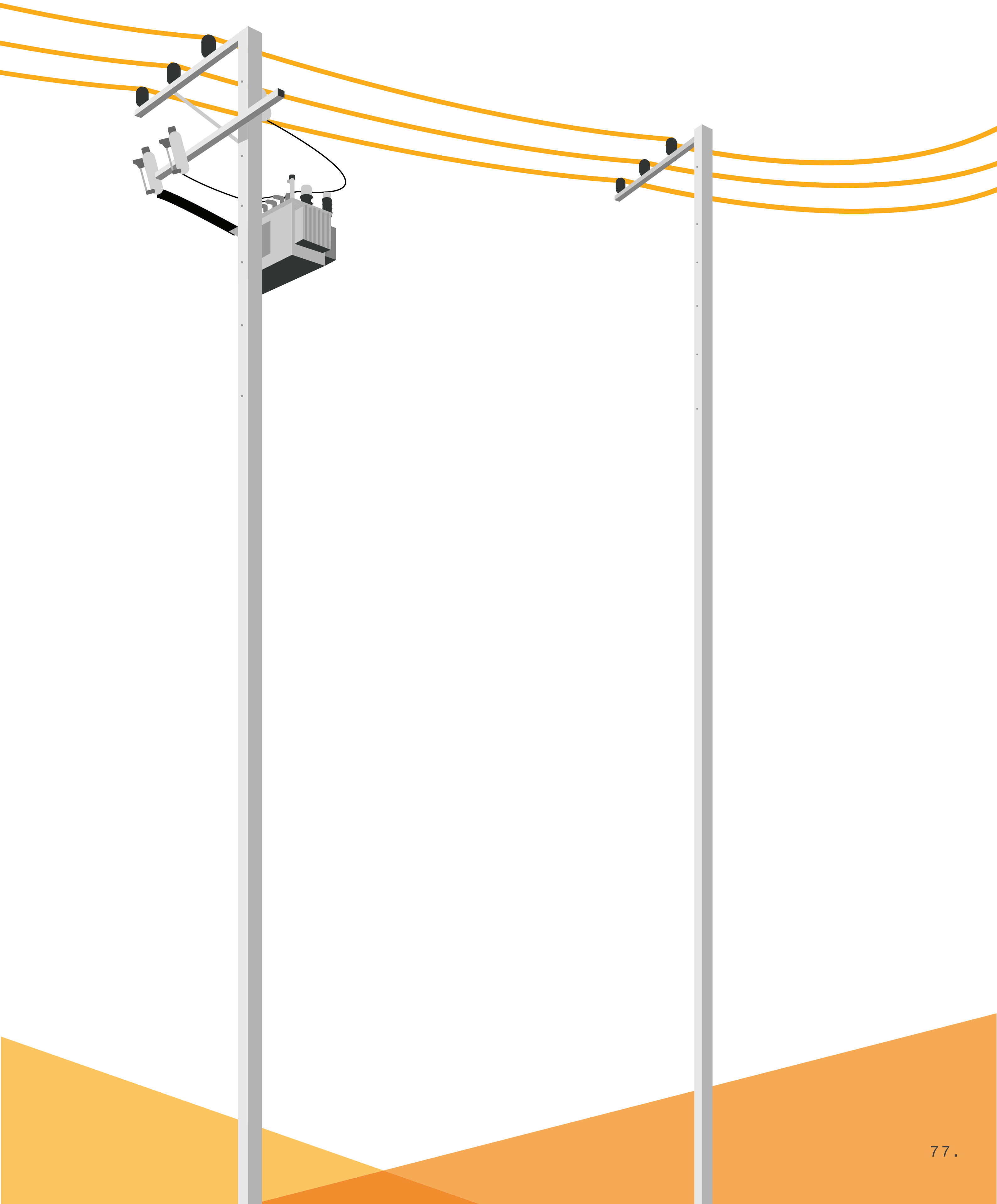


7. PROJECT CONTRIBUTORS

Alexandra Wall

Alexandra helps lead nLine's operations, business development, implementation of in-country sensor deployments, and global partnership engagement. Prior to nLine, she worked in research and program implementation roles spanning financial inclusion, economic empowerment, community development, and wildlife conservation. She is passionate about human development and the application of technology and data science for advancing global development, reducing poverty, and protecting, maintaining and restoring our natural resources and wildlife. Alexandra holds a Master of Development Practice from the University of California, Berkeley and a BA in Economics and International Studies from the University of Wisconsin, Madison.

Bulenza Sirezi Mulezi

Bulenza is a community engagement officer at ACTogether Uganda who works with NSDFU and he is also an Act Program Manager for the department of Profiling, Enumeration, and Mapping (Community Led Data). With expertise in community mobilization and participation as well as G.I.S software, he is passionate about a people-centered approach to slum upgrading programs. From Makerere University in Kampala, Uganda, Bulenza earned a bachelor's degree in urban and regional planning. With these abilities, he has helped inhabitants, primarily those living in informal settlements under the auspices of NSDFU, alter their life in a variety of ways by equipping them with skills such as data gathering, mapping, and other related tasks. He is passionate about people-centered approaches to problem solving.

Civian (Kiki) Massa

Civian is a PhD student in the Systems Towards Infrastructure Measurement and Analytics (STIMA) lab at UMass Amherst. Her research interests lay at the intersection of data mining and developing low cost power quality monitoring systems to improve power quality and reliability in Sub-Saharan Africa. Civian holds a BS in electrical power systems engineering from the African Leadership University and Glasgow Caledonian University. She has experience in temporal and spatial energy analytics, statistical analysis with R and Python as well as load flow analysis.

Elena van Hove

Elena is the Director of Global Energy Access within Arizona State University's Laboratory for Energy And Power Solutions where she manages a ten person team on numerous energy access and electrification projects. She has a variety of experiences working on energy projects around the globe, including in Europe, Africa, the Pacific, Latin America, and North America. Elena holds a BS in Electrical Engineering from Purdue University and MS in Sustainability from Arizona State University.

Jess Kersey

Jess is a PhD candidate in the Energy and Resources Group at UC Berkeley and a National Science Foundation Graduate Research Fellow. She has broad research and practitioner interests focused on technology, regulation, and policy to address inequalities in energy access. She has experience in energy, construction and disaster relief across multiple geographies including Uganda, Haiti, Panama, the US Virgin Islands, and Iraq. Jess holds dual bachelor's degrees in chemical engineering and political science from Virginia Tech and an MS in Energy and Resources from UC Berkeley. Currently, she is a research affiliate at Lawrence Berkeley National Lab and a consultant with ESMAP and the Global Energy Alliance for People and Planet.

Judith Mbabazi

Judith is a Graduate Fellow and facilitator at the Urban Action Lab, Makerere University where she collaborates on research projects between the research lab and its partners, including community organizations, civil society organizations, and government agencies. She is passionate about informality and inequality, and researches issues that affect the quality of life in terms of livability, economic growth and development, inclusion and equity, with a keen interest on policy and planning and how the two shape urban environments. Judith holds a bachelor's degree in urban planning and a masters of land use and regional development planning from Makerere University.

June Lukuyu

Dr. June Lukuyu is an Assistant Professor of Electrical and Computer Engineering at the University of Washington (UW). Her research focuses on multi-disciplinary approaches to developing inclusive and sustainable energy systems and end-use technology adoption for underserved communities, centering on promoting social development and human empowerment. She is also a Fellow of the Energy for Growth Hub. She received her PhD in electrical and computer engineering at the University of Massachusetts Amherst where she focused on strategies for stimulating electricity demand to enhance sustainable human development in sub-Saharan Africa, collaborating with mini-grid developers, utilities, and other academic partners. Before that, she spent five years as an engineer at Aspen Technology, developing design-based cost estimation software for power projects. She earned her MS in renewable energy systems technologies from Loughborough University in the UK and her BS in engineering science from Smith College.

Junior Alves Sebbanja

Junior is an urban design enthusiast who grew up in a Kampala City slum, which fueled his passion for community-based planning. After earning a bachelor's degree in urban and regional planning from Makerere University, he gained practical experience with urban planning consultancies. For the past six years, Junior has provided technical support for community mobilization and data collection in Uganda's informal settlements. He has expanded his skills in project management, gender transformative programming, and land governance. Currently, he leads the African Cities Research Consortium Research project and works as the acting project manager for the Kampala Jinja Expressway – No One Worse Off Project. Junior aims to enhance his professional capacity in urban planning for large-scale infrastructure projects to contribute to Uganda's city planning and development.

Lydia Letaru

Lydia is a geospatial analyst, graduate research assistant in the Department of Geomatics and Land Management, and the chapter supervisor of the Geo-YouthMappers chapter of Makerere University. She oversees all chapter activities and is responsible for student capacity development. Lydia is passionate about using open geospatial tools and technology in solving environmental and social issues and has overseen multiple GIS and remote sensing projects. She has an MS in geo-informatics and geo-visualization from the University of Salzburg and Palacky University, Olomouc. Her graduate research was on usability assessment of web maps depicting electricity utilities. Prior to this, she earned an MS in geo-information science and technology and a BS in land surveying and geomatics, both from Makerere University.

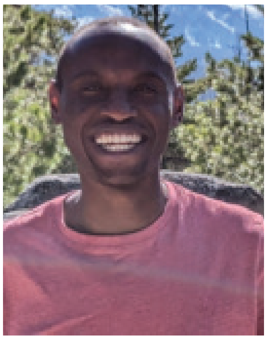
Margaret Odero

Margaret is a Data Analyst at nLine working to reveal and communicate actionable insights on power quality and reliability metrics from sensor data. She is passionate about using technology for positive impact. She especially loves to use her knowledge and skills in optimizing systems on the African continent. Her background is in electrical engineering and data science and is continually improving her tech knowledge to be able to solve energy quality and reliability issues. At nLine, she writes and improves data analysis algorithms for revealing and communicating insights into the key performance metrics of power grids. Margaret holds an MS in Electrical and Computer Engineering from Carnegie Mellon University and a BS in Electrical and Electronics Engineering from Ashesi University.

Michael Jurua

Michael is a final year geomatics student at Makerere University and the immediate Vice President of the Geo YouthMappers chapter. He is dedicated to using geospatial data to support disaster-prone communities in accessing the resources they need to adapt to environmental challenges. His research focuses on developing innovative solutions that promote sustainable natural resource management and advance principles of environmental justice. Michael has successfully overseen numerous humanitarian projects that target societal challenges within his local community in Uganda. Michael's dedication to making a positive impact in his community through geospatial technology is a testament to his commitment to social responsibility and using his skills for the betterment of society.

Paul Kyoma



Paul currently works as a research assistant at Spotlight Kampala, where he primarily focuses on remote sensor monitoring for power systems quality, reliability, and energy usage. He is interested in the synergistic relationship between energy systems and data science, specifically in how data can be harnessed to forecast and achieve sustainable energy goals, particularly pertaining to Sustainable Development Goal 7. Paul's academic qualifications include a BS in electrical engineering from Makerere University and an MS in electrical and computer engineering from Carnegie Mellon University.

Stellamaris Wavamunno Nakacwa

Stellamaris is a geographer and geospatial data engineer with interest in governance, data and urban development. She holds a Master's degree in Geography from West Virginia University. She is currently a Program Director for Everywhere She Maps program, YouthMappers network. Stellamaris has applied her skills to the Spotlightlight Kampala Project by guiding overall Geo YouthMappers engagement. She has built a wealth of knowledge in managing projects focused on improving geospatial strategies for organizations and groups like OpenStreetMap Uganda. In addition to her professional roles, Stellamaris holds positions of influence within the geospatial community. She actively contributes as a board member for OpenStreetMap, a voting member for Humanitarian OpenStreetMap, and also chairs the IGAD Youth & Land Stakeholder working group.

APPENDIX A — EXAMPLES OF PAST ELECTRIFICATION PROGRAMS IN INFORMAL COMMUNITIES

Program name	Geography	Year	Description	Impact	Source
MERALCO's Depressed Area Electrification Program	Manila, Philippines	Launched 1990-92	Electrification efforts focused on extending distribution lines to the outskirts of slums. Households were equipped with individual meters. Financial assistance was provided to support internal wiring	300,000 households connected or regularized	[57]
PN Energy's Khayelitsha electrification project	Cape Town, South Africa	1994 – 2003	A community-based distribution company dramatically improved the quality and reliability of service. Prepaid meters were installed to assist households to stay within their budgetary means, subsidy and finance for the connection fee were provided, and ready-boards were provided to eliminate the need for internal wiring.	60,000 connections	[73]
Brazil LIGHT's Program for Normalization of Informal Areas	Rio de Janeiro, Brazil	2000 – 2003	Community agents served as intermediaries between the electricity company and the local residents. Community events were organized to promote acceptance and understanding of the program. Debt relief and subsidized connection fees were implemented to facilitate easier enrollment for households.	120,000 households	[57], [74]
COELBA's Community Agent Program	Salvador, Bahia. Brazil	1999 – 2011	In collaboration with an NGO, the electricity company recruited local agents to act as liaisons between the company and the community. The electricity company took steps to enhance energy efficiency by replacing inefficient lighting, refrigerator seals, and unsafe internal wiring in homes. They also facilitated the process by offering subsidies and financial assistance for connection fees, and established convenient bill payment outlets in accessible locations.	400,000 households	[57], [74]

Program name	Geography	Year	Description	Impact	Source
Ahmedabad Electric Company's Slum Electrification Program	Ahmedabad, India	2005 – ongoing	The program was integrated with ongoing slum upgrading initiatives, forming a partnership between NGOs, local government, and residents to collaboratively design and implement the program. Initial financing for the subsidized connection fee was provided, ensuring affordability for participants. Additionally, local residents were employed to handle meter reading tasks.	200,000 households projected	[55]
Safe and Legal Electricity Connections in Slum Communities	New Delhi, India	2004	A community-based program to provide safe and legal electricity in New Delhi. A local NGO collaborated with microfinance institutions to provide capacity building for the community and to finance the costs of connecting households to the grid. An outreach and advocacy campaign raised awareness in the community about the risks of illegal electrical access.	850 households	[73]
Electricity for Pavement Dwellers	Mumbai, India	1997 – present	Example of a community-based initiative in which urban poor communities organized themselves in a structured manner to demand and acquire access to electricity. This approach is now being replicated in other slum areas within the city as well as amongst pavement dwellers in cities outside of Mumbai.	25,000 households	[73]