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Power to the People: Rural Electrification in Uganda

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Spring 2009

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Acknowledgements

This project started from scratch. My own personal deficiencies—namely a lack of experience with electrical engineering and a simply fundamental understanding utility and energy policy—made things difficult. This project was also ambitious. In 6 weeks I traveled to 9 cities in the central, eastern, and western regions, allotting only a few days to conduct research in each place. Miraculously, I hit few snags. People were always welcoming, always informative, and, most importantly, always concerned with the completion of my research. "Did you get everything you needed? You're sure? Great! Will you join me for tea?" Things went smoothly, thanks entirely to the people of Uganda. I honestly do not believe I could have done it anywhere else, at least not with the same levels of comfort and clarity.

There are some people who must be thanked specifically. Martha Wandera and Dr. Charlotte Mafumbo of SIT Uganda: Development studies were a stellar resource throughout this independent study period (and throughout our time in Uganda). They organized homestays, advised me on transportation, clarified project proposals and networked like no one else. That they were able to do this for 28 students is truly amazing.

Three individuals at Uganda's Rural Electrification Agency also deserve special thanks. Executive Director Godfrey Turyahikayo for his willingness to take me on and assign me to a wonderful officer. That officer, Andrew Muguwa, for taking the time out of his busy schedule to reply to my inquiries, propose project visits and refer me to the proper people. And their colleague, Godfrey Werikhe for arranging Kalangala contacts.

Additionally, I would like to recognize all the individuals involved in this project in some capacity: Agaba Francis (who got me started), Dr. Professor John Kabogozza, Dan Mayanja and Musa Mukulu of UEGCL, Immaculate Mulindwa of UEAWU, Daniel Byentaka and Noah Guloba in Jinja, Opule David of Kamuli Police, Masahalya John of Umeme, Charles A. Okello of Kamuli LCV, Nelson Basaalidde, Bery Glaser, the Mirembe Resort Beach Staff, Augustine Kasirye, Oliver Hope Nakyanzi and Baliremwa Novato Mukajanga of Kalangala District Local Government, Michael Omara, Fred and Margaret Mpangana, Herbert Turyamureeba (for the help out West and the Bushera), Charles Swainson, The Scottish and Southern Kisiizi crew, Better Foundations Hostel, Medi, Miriam, Helen and the rest of the SIT staff.

Finally, the final draft of this paper is dedicated to the Ssegumba family of Ninta, Kampala, Uganda. Mzee, Mom, Peter, Vincent, Irene, Ben, Allen, Derek, Ivan, Sheila, Sylver, Angela, Michael, Thelma, Aaron, and everyone else: you all have been, and will remain, my family in Uganda. Thanks for everything.

Abstract

The absence of electrical utilities greatly impacts the lives of Ugandans. Without electricity many communities struggle to obtain the resources necessary to lift themselves out of a static state.

Rural communities have a genuine and justifiable need for electricity. These communities want to use electricity in relatively small quantities in order to: pump water, transport commodities, engage in income generating activities, practice modernized healthcare, and increase available light to extend work and leisure hours. Unfortunately, the road to achieving electrification is complex and costly.

Currently, Uganda's electricity sector is in flux: after the passage of the 1999 Electricity Act private enterprise was introduced into all aspects of the sector. Since that time, problems with power theft, insufficient supply, geographic isolation, and high infrastructure costs have inhibited rural communities from gaining access to electricity.

This paper attempts to uncover some of the major challenges of making electricity accessible in Uganda, a developing country with a large rural population. Information was obtained through site visits, area appraisals, interviews with key informants, and general observation. The subsequent sections provide a reasonably extensive overview of the electricity sector in Uganda; foundational information that is necessary if one is to truly understand the electricity situation. Three case studies—Kamuli, Kalangala, and Kisiizi—snapshot rural electrification and its challenges. The final section contains recommendations for making electricity more accessible to rural Ugandans, based on the information gathered during the research period.

Important Acronyms

UEB – Uganda Electricity Board
ERA – Electricity Regulatory Authority
REA – Rural Electrification Agency
REB – Rural Electrification Board
REF – Rural Electrification Fund
UEGCL – Uganda Electricity Generation Company Ltd.
UETCL – Uganda Electricity Transmission Company Ltd.
UEDCL – Uganda Electricity Distribution Company Ltd.
UEAWU – Uganda Electrical and Allied Workers Union
K.I.S. – Kalangala Infrastructure Services
MW – Megawatts
GWh – Gigawatt Hours
kV – Kilovolts
kW – Kilowatts
PV – Photovoltaic Cells
Ush. – Ugandan Shillings

Justification

Ten years after the passage of the reformative 1999 Electricity Act Uganda is still struggling to find a proper balance between public- and private-led electrification initiatives for its citizens. In the great scheme of things, this time period is relatively short. Nevertheless, frequent examinations of the energy sector and rural electrification projects are necessary to highlight failures, successes, and areas in need of improvement. The challenges of expanding access to electricity are many. Given the economic and social benefits of electrification, however, efforts must continue as part of Uganda's path to development.

Objectives

The study of rural electrification in Uganda requires investigation into generation, transmission and distribution after decentralization of the energy sector, utility decision making, power-theft, project funding and the like. Basic questions to be explored include, but at not limited to: How do rural communities gain access to electricity? What is the government doing to assist rural communities in these efforts? What role does electrification play in the larger realm of national development?

In an effort to answer these questions, and learn more about the electricity sector in Uganda generally, I pursued research with specific objectives in mind. My independent research project objectives were:

1) Live and conduct research in specific rural communities that are looking to implement electricity on improve upon the existing power structure.
2) Collect information about rural electrification, energy policy, and potential improvements to the system from individuals working in the electricity sector.
3) Utilize the obtained knowledge to make recommendations for the improvement of the rural electrification process and electricity usage in Uganda.

Methods

Throughout the research period several different techniques were used to gather information. Whenever possible, methods utilized kept in line with Participatory Rural Appraisal Methodology—research methods that solicit information directly from individuals in the community, without making any assumptions or suggesting exogenous

solutions to problems. The methods used most extensively were interviewing—both formal and informal—of key informants, general observation, and site appraisal/mapping. Each of these methods can produce (and did produce) valuable information, though they are not without their deficiencies. Alone, they would have proven to be insufficient, but together, they were enlightening.

Site Visits and Appraisals

Site visits were conducted to determine, first-hand, the state and availability of electricity in different parts of Uganda. On average 2-5 days were spent gathering information in each of the following places: Generation was studied in and around Jinja at the Nalubaale and Kiira hydroelectric facilities on Lake Victoria. Site visits to the villages of Busembatya and Bakono provided prime examples of life without electricity, especially in contrast to urban Kampala. Case studies were conducted on power theft in Kamuli District, electrification in isolated areas in Kalangala (Ssese Islands), and successful project implementation in Kisiizi. The concept of prepaid power was examined in Kanungu District.

Visiting these sites helped to bring statistics and figures to life. The deficit created by insufficient access to electricity only became apparent after living and working in an area alongside its residents. Furthermore, visits to generation, transmission and distribution facilities augmented my own knowledge of the mechanics behind electrification, knowledge that proved to be necessary in order to understand the true state of the electricity sector.

Interviewing

Formal and informal interviews yielded the most substantive information throughout the research period. Interviews were conducted with local government officials in nearly all areas (typically chief administrative officers and district engineers), employees of UEGCL, REA, and Umeme, community residents, and police officers. All citations from interviews are used with the consent of the interviewees.

As the experts in the field, professional, formally interviewed individuals were able to provide insight into broad and localized issues related to electricity in Uganda. Because they deal with problems on a day-to-day basis (and often take flack when things aren’t running smoothly), these people spoke with credibility and an enthusiasm for the

subject. Often our formal conversations would unintentionally devolve into discussions about the government's role in providing utilities or the difficulties of living without consistent power. Many people were quick to provide an anecdote about an inconvenience or hardship they endured related to the supply of electricity.

Similarly, informal interviews revealed local perspectives on power that humanized the statistical information. Almost everyone in the visited areas had something to say about electricity in Uganda, and their comments were duly noted.

Observation

General observation should not be overlooked as an important research technique. Much of the research period was spent traveling. During this time the extent of local distribution grids, the number of visible lights, and industrial processes requiring electricity were observed. As a research method, observation on its own is often insufficient to produce accurate, complete results. Used in conjunction with other methods however, it can be a wonderful tool.

Challenges

Several challenges were encountered that prevented the complete implementation of the aforementioned methodology. Unfamiliarity with travel in Uganda often created time management conflicts. Since only a few days were spent in each place, a setback of several hours might have meant missing an interview. Unfamiliarity with the sites visited caused similar problems. Most times offices and facilities were sought out through verbal instruction from local residents. Although this process leant itself well to the 'general observation' aspect of the methodology, it created unforeseen scheduling issues.

The business of electricity workers also contained inherent difficulties. The individuals who were sought out for interviews were typically the ones dealing with problems in communities. Hence, tracking informants down without an appointment (or even with one) was sometimes impossible.

Language barriers made some information obtained during informal interviews indecipherable. Feelings about electricity, which could be very emotionally charged, may have lost some content in translation.

Finally, my own insufficient understanding of technical terminology and (at the outset) necessary background information inhibited a thorough comprehension of the generation and distribution capacities of Ugandan facilities.

Introduction

Residents of developed countries have come to take utilities for granted. The occasional power outage may aggravate us temporarily, but, in the end, will prove to be little more than a nuisance. Conversely, the absence of electrical utilities greatly impacts the lives of residents in the developing world. Without electricity many communities struggle to obtain the resources necessary to lift themselves out of a static state.

Rural communities have a genuine and justifiable need for electricity. These communities want to use electricity in relatively small quantities in order to: pump water, transport commodities, engage in income generating activities, practice modernized healthcare, and increase available light to extend work and leisure hours. Unfortunately, the road to achieving electrification is complex and costly.

A typical scenario in a developing country may look like this: Large power companies are supported by government—either through state ownership or by obtaining government-issued bids—and are typically integrated vertically. Power theft accounts for huge losses and collection rates are low. Market failure—a scenario in which a desirable commodity (here, electricity) is not supplied at a level that meets demand—exists prevalently, as demand for electricity exceeds production capacity. The burden is placed both on the consumer, who must cope with frequent outages and increased tariffs, and the providers, who face difficult financial and infrastructural challenges.

In Uganda, the situation is not much different. Both government and the private sector are grappling with getting power to the people. Western worlders, wondering why rural electrification is moving at a crawl, may be quick to forget that the developed world took multiple decades to make electricity accessible in rural areas. Uganda is in that phase now, moving, but moving slowly.

This paper attempts to uncover some of the major challenges of making electricity accessible in Uganda, a developing country with a large rural population. The subsequent sections provide a reasonably extensive overview of the electricity sector in

Uganda; foundational information that is necessary if one is to truly understand the electricity situation. Following this portion, three case studies—Kamuli, Kalangala, and Kisiizi—snapshot rural electrification and its challenges. The final section contains recommendations for making electricity more accessible to rural Ugandans, based on the information gathered during the research period.

Electricity in Uganda, Historically and Today

Generation and Consumption

Some may be surprised to know that Uganda has been generating electricity for over half a century. Situated at the source of the Nile River, the potential for hydroelectric power in Uganda is immense. The British colonial authorities noted this potential and commissioned the construction of the Owen Falls Dam—later to be renamed Nalubaale Power Station—in 1954. Since that time, the power sector has been slowly growing. Consumption has increased from 11,432 customers in 1954, to 95,773 in 1989, to nearly 300,000 in 2008.[1] Similarly, the number of units generated has increased from 13 GWh in 1954, to 660.90 in 1989, to 1,756 in 2003.

Any overview of the power sector in Uganda must be framed in economic terms. It is crucial to note that although generation has increased alongside consumption, demand still exceeds available supply. The World Bank estimates that the country has a practical generation capacity (what can feasibly be produced at any given time) of 340 MW at its major generating facilities while peak grid demand is nearly 380 MW.[2] Even if the power sector incurred no losses in transmission and distribution—an impossible feat—a market failure would still exist. That being said, Uganda's policy makers will inevitably face tough choices in the near future, deciding where and how to obtain an adequate supply of power.

Today, power is generated primarily at major hydroelectric plants near the city of Jinja on Lake Victoria. These stations generate 99.3% of all electricity produced in Uganda, dwarfing all other power sources.[3] At full capacity the plants can supposedly

[1] Statistics obtained from ERA
[2] http://af.reuters.com/article/ugandaNews/idAFLQ72753420090326
[3] www.reeep.org

generate 380 MW of power—180 MW at Nalubaale and 200 MW at the sister plant, Kiira. It should be noted, however, that these plants have never operated at full capacity due to technical and hydrological difficulties. The remaining power generation in Uganda occurs at 100 MW diesel plants, 50 MW heavy fuel oil plants, thermal generation facilities, solar PV stations, and small-scale hydroelectric projects. There exists an untapped resource in geothermal energy, though the government has yet to explore it.

Because Uganda relies so heavily on hydroelectric power, which is subject to natural and man-made fluctuations, the flow of electricity has become, at times, inconsistent and unpredictable. The hydrology of Lake Victoria depends primarily on rainfall and significant tributaries that originate in Tanzania. Periods of drought, in conjunction with upstream diversions of water for agricultural purposes, have caused water levels to drop far below normal levels. Consequently, the Jinja power plants have operated at less than half of full capacity since the 2005-2006 calendar year due to low water levels. The Government of Uganda, recognizing that demand is outpacing supply, has commissioned a variety of new power stations to be built in the coming years.[4]

One of these projects, a large-scale, privately funded hydroelectric plant to be built downstream from the current dams, came under much scrutiny in late 2008 after a World Bank Inspection Panel report found great associated economic and environmental risks. The project, known as Bujagali, was found to place an unnecessarily high burden of risk on power consumers, while leaving investors and operators virtually unaccountable. Concerns were also raised over the proposed dam's impacts on Lake Victoria, which is already affected by the Nalubaale and Kiira plants. To the Panel, the construction of another major hydroelectric facility in Uganda seemed like an improper way to address the current market-failure: "In a country where only 5% of the population is connected to the grid and there is widespread poverty, it would be reasonable to expect attention be paid to small and/or distributed generation options (not only hydro) which might in theory more directly address local and rural poverty."[5]

In spite of these concerns, the Bujagali project will be commissioned (as expected) in 2010, with construction beginning in phases shortly thereafter. Dan

[4] Interview with Musa Mukulu of UEGCL
[5] "Uganda Dam Slammed By World Bank Appeals Body"

Mayanja, the UEGCL technical director at the Jinja plants worries that environmental concerns about new projects don't consider the broader picture. When asked about the opposition to Bujagali, he questioned "if demand for electricity was there (and it was), then environmentalists should have been asking themselves: 'which is better for the environment, hydro or thermal?' because as soon as the project was stalled, the first 50 MW thermal generator came online." He believes that hydroelectricity is both better for the environment and easier on consumers' wallets, as the costs are fixed.

In the face of conflicting opinions and scattered episodes of public outcry, Uganda has made electricity a priority and will continue to pursue generation options in the future.

Structure and Composition

The structural composition of the electricity sector in Uganda has undergone great fluctuations in the last 10 years. Prior to the passage 1999 Electricity Act, electricity was generated, transmitted, distributed, and regulated by a single, state-owned, vertically integrated entity, the Uganda Electricity Board (UEB). As demand for electricity grew, UEB proved to be cumbersome, unaccountable, and inefficient. In concordance with government-led economic reforms, the monopoly was dissolved, leading to a decentralized structure geared toward private investment. Policymakers hoped that this structural realignment would force the power sector to become financially viable, reliable, and capable of meeting increases in demand.

The 1999 Electricity Act legalized the privatization of UEB and initiated the formation of numerous successor companies. Three main independent companies, Eskom Uganda (now leasing use of the Nalubaale and Kiira stations from Uganda Electricity Generation Company Ltd. (UEGCL)), Kilembe, and Kasese Cobalt, began to deal with generation. Transmission is handled by the Uganda Electricity Transmission Co. Ltd. (UETCL) above 33 kV and the Uganda Electricity Distribution Co. Ltd. (UEDCL) at and below 33kV. Distribution rights lie under Umeme, which is wholly owned by the Commonwealth Development Corporation (CDC) of the United Kingdom, and, to a lesser extent, Ferdsult Engineering Service Ltd. Though several companies are operating

in the power sector, the average consumer interacts solely with the distributors, to whom they pay their electricity bills and issue any complaints.[6] [7]

These companies interact on a regular basis to discuss problems in the electricity sector. Even after unbundling, the various components of the sector operate cooperatively under a system of shared incentives. Hence, the chain is only as strong as its weakest link.

The Act also established the Electricity Regulatory Authority (ERA) to provide licenses and create tariffs.[8] The ERA operates as an autonomous regulatory body headed by 5 board members. By law, the ERA is required to remain open and objective in its licensing practices, promote continuity in the electricity sector, and approve or modify tariffs as it sees fit. Because stakeholder and public consultations are supposed to take place before any tariff modifications are implemented the ERA has come under criticism from public advocacy groups when it fails to make its dealings widely known.[9]

Legal and financial disputes involving consumers, power companies, or regulatory agencies are heard by the Electricity Disputes Tribunal.[10]

Rural Electrification in Uganda: REA and REB

Finally, the Act established the Rural Electrification Board (REB) and the Rural Electrification Agency (REA) to "promote, support, and provide rural electrification programmes through public and private sector participation."[11] The REB is a supervisory board comprised of the Permanent Secretaries of the Ministries of Energy and Mineral Development, Finance, Planning and Economic Development, Local Government, and donor and public representatives. The REA reports to the REB and is responsible for analyzing policy issues related to rural electrification. Practically, these two bodies, operating semi-autonomously under the Ministry of Energy and Mineral Development, distinguish areas well suited for rural electrification, solicit funding from parliament,

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[6] Presentation on Power Sector Reform by Hon. Eng. Simon D'Ujanga

[7] For a visual depiction of this somewhat complicated structure, see the appended diagram A.

[8] 1999 Electricity Act, Part II, Sections 11-18

[9] NAPE Petition, 2006

[10] 1999 Electricity Act, Part VIII

[11] 1999 Electricity Act, Part VII, Section 63

donors, and related agency surpluses through a Rural Electrification Fund (REF), and recommend the appropriate types of projects for selected areas.

The Rural Electrification Strategy and Plan for the period between 2001 and 2010 set forth the goal of achieving a rural electrification rate of 10%, a net increase of 400,000 households, by 2010 (later changed to 2012).[12] This goal, determined by a consortium of energy suppliers, consumers, academics, policy makers, environmentalists, foreign and domestic donors, contractors, developers and manufacturers, is ambitious. The timetable has already been extended once: to achieve the pursued rate will take a dynamic combination of government, private, and donor-funded efforts.

Rural Electrification: Benefits and Challenges

Why rural electrification should be a priority

There is no magic bullet. Development will only occur when a confluence of important social and economic factors arises in concordance with a people's unique, indigenous circumstance. Access to electricity is likely one of these important factors. Electricity serves as a catalyst, making the other pillars of development—education, modern healthcare, income generating activities, etc.—possible. Abu-baker S. Wandera, an official at the United Nations Development Programme in Uganda, puts it well: "Conventional energy is a prerequisite if a society has to move out of subsistence…Therefore access to electricity is not an end in itself, but constitutes an important tool for development when we consider its linkages to [*sic*] agriculture, education and health."[13] For nations seeking to develop—at least in traditional terms—providing accessible electricity to the entire population must be a priority.

Many researchers have sought to highlight the tangible benefits of electrification. Nigel Smith finds that high quality and reliable lighting "[generally] facilitates a wide variety of socially and economically beneficial activities."[14] Electric lighting, he finds, allows children to study after dark and families to convert to modern, efficient cooking methods (as they no longer need an open fire for lighting). Smith also notes that electric

[12] Rural Electrification Strategy and Plan Covering the Period 2001 to 2010
[13] "The Private Sector Role in Rural Electrification of Uganda"
[14] "Low-Cost Electrification: Affordable electricity installation for low-income households in developing countries"

lighting can produce indirect financial benefits, as it serves as a replacement for expensive kerosene lanterns. Though the costs of implementation are high, the positive yield of a small quantity of electricity—enough to run a single light bulb—is significant to rural communities.

Chaieb and Ounali found that community perceptions of rural electrification in parts of Tunisia were extremely positive.[15] These researchers conducted participatory rural appraisals (community interviews and investigations) to discover the perceived benefits of introduced access to electricity in Tunisian communities. Linkages were discovered between rural electrification and the areas of education, basic health, family planning, and women's reproductive health. Many families had purchased (and now consistently watch) televisions, which prompt intellectual expansion, expose women to political happenings, and introduce families to messages concerning personal hygiene and health. Furthermore, participants perceived increased economic opportunities for women, who were choosing to sew or open hair-salons at home rather than travel to urban areas in search of work.

Difficulties

Electrifying rural areas is not easy business. Nor is it good business, which is part of the problem. Private utility providers, now officially leading the way in Uganda, face major constraints when aiming to make electricity accessible to rural populations.

First and foremost, the costs of implementing and maintaining generation, transmission, and distribution facilities in rural areas are high, while revenue collection is low. It often does not make sense financially for a company with limited supply to transport and distribute that supply to rural areas when urban areas—with large industries and (relatively) reliable customers—are still without. Furthermore, Smith finds that "utilities tend to find that for low-income households, which only consume a small amount of electricity, the costs of meter reading, billing, revenue, collection and administration outweigh the revenue collected." Simply stated, without government assistance or subsidy rural electrification is commercially undesirable to private utility companies.

Low generation capacity also poses a problem. Electricity providers in

[15] "Rural Electrification Benefits Women's Health, Income and Status in Tunisia"

developing countries often struggle with an insufficient supply of generation that does not match demand. This market failure forces distribution companies to engage in load-shedding, a process used to account for shortages by selectively cutting off power to certain consumers. As load-shedding is a major inconvenience to customers, power companies almost always target small, unreliable customers for load-shedding. Uganda is no exception: residential areas, particularly rural residential areas, have their power cut much more frequently than urban industries.

Companies also face the problem of theft. While theft in Uganda will be detailed in a following section (Kamuli: A Case Study in Power Theft), suffice it to say that power theft spurs increased revenue loss, making it even more difficult for power providers to justify rural electrification efforts.

There are also inherent public sector problems that prevent rapid and successful rural electrification. Lack of knowledge about necessary technology on the part of consumers and policy makers slows the development of alternative power sources. Service personnel in the region may be inadequately trained to handle repairs. Insufficient support infrastructure slows the transportation of spare parts when equipment is broken or stolen. Electricity, in unique cases, may not be socially accepted or feared by potential users. And it should be noted that these problems are particularly severe when it comes to alternative energy sources, such as solar power, which may hold the key to electrification in an isolated area.[16]

These factors, in conjunction with political and economic factors unique to Uganda, make rural electrification a slow and tedious process. In order to combat these deficiencies the government, with the help of international private donors, has had to facilitate most rural electrification efforts in one way or another.

Kamuli: A Case Study in Power Theft

In July of 2008 *The New Vision* reported that Uganda's power losses were the highest in the Nile Basin.[17] While other nations in the region are experiencing typical losses of 20-25%, Uganda's total losses average around 40%. This constitutes a

[16] "Case Study of a Successful National Energy Programme/Strategy"
[17] http://www.newvision.co.ug/D/8/220/640723

monetary loss of around $50 million annually (about USh. 100 billion) and greatly diminishes both state- and private sector-led initiatives to provide accessible power to Ugandans.[18]

The causes of these losses are both technical/endogenous—losses due to inherent thermodynamic deficiencies in the system—and exogenous. Among those causes foreign to the system, power theft has gained the most notoriety as of late. Power theft exists in two forms. The first, and most common, is the theft of power through an electrical "bridge" which either evades meters or routes numerous connections to a single meter. Power that is consumed in these situations may not be accounted for or detected by meter readers, resulting in significant revenue loss for the distributor. Unfortunately, this process is self-perpetuating, as lower revenue collection rates spawn higher tariffs, which persuade more individuals to engage in theft. The second form of theft involves the literal abduction of transmission and distribution equipment. Thieves will scrap materials from the grid and sell them for hefty market values. This form of theft typically hits the consumer hardest, as power lines may become inoperable until repairs and replacements can be completed.

Kamuli, a central region district in Uganda, has recently experienced numerous episodes of power theft. The small district, which is located about 2 ½ hours away from Kampala by taxi, has a population numbering 690,000. The people engage primarily in subsistence agriculture, and while some commercial activity occurs in Kamuli Town, the region lacks any significant industry. Although only 1% of domestic households have an authentic connection to the electrical grid, power is highly desired and is used in healthcare centers, small-scale mills, schools, government offices, and, perhaps most importantly, to pump water.

Electricity Distribution and Problems with Theft

In Kamuli, two Umeme technical staffs are responsible for any electrical breakdowns and surveys of new potential connections. The small office staff handles all customer concerns, 24/7. If they are incapable of handling a situation, they refer the problem to the Iganga office, which has a larger staff and greater resources. For new connections, an individual consumer first contacts the main office in Jinja. Once they get

[18] http://af.reuters.com/article/ugandaNews/idAFLQ72753420090326

the go-ahead, the local office surveys the area, assesses costs, and approves or disapproves of the connection. Even when projects are approved, however, manpower is insufficient. New connections may lie dormant for some time before finally being electrified. When asked about the district office staff's goals, Masahalya John, a technician with Umeme in Kamuli, responded: "For our [small] office, achieving a 'goal' is…difficult."[19] Power theft has been difficult for this small office to tackle, though it greatly effects their operations and reputation.

There are several theories as to why exogenous power theft occurs. Firstly, there is the financial incentive. The UEDCL transmission wires that connect Kamuli to the power plants in Jinja provide a tantalizing opportunity for thieves. The wires, which are made of copper, can sell for Ush. 20,000 (about $10) per kilo at the scrap yard. In some raids, thieves will collect over Ush. 6 million worth of wire, cutting poles at night and focusing on isolated areas.[20] Secondly, owners of competitive local grain mills that run on gasoline may be cutting wires to sabotage their competitors who are using electric generators. Thirdly, it's possible that former UEB electricians—who lost their jobs when Umeme took over—assist thieves or engage in sabotage in an attempt to enact revenge. And finally, there is suspicion that some Umeme and UEDCL workers are cutting lines to create work for themselves. Many of these workers are paid on commission, so they have an incentive to create repair situations. The latter two theories are supported by the notion that whoever is cutting transmission wires must have some advanced technical knowledge, otherwise they might risk electrocution.

While Umeme and UEDCL share the costs of replacing the wires—and usually replace them with aluminum, which is less desirable to thieves—consumers of electricity in Kamuli suffer greatly. Masahalya John's team is responsible for some of the repairs. He says that it takes, on average, 36-48 hours to replace wiring; sometimes even longer. When a transmission wire is cut, all downstream components of the grid become disconnected from the generation source. Therefore, power in an area where theft is occurring becomes inconsistent and unreliable.

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[19] Interview with Masahalya John of Umeme Kamuli
[20] Interview with Opule David, O/C UD of Kamuli Police

Consumer access to power in Kamuli is limited not just by high installation and user costs but also by the added inconvenience of unreliability. Hospitals and businesses are forced to resort to expensive thermal generators to maintain a consistent flow of power. Under these conditions, healthcare facilities become "unable to perform simple surgical operations or treat patients properly"[21] Households choose to steal power on an individual level rather than go through the hassle of installing and maintaining a connection that may go out at any time. On the whole, theft of electrical equipment is bad for citizens and the power companies alike.

Reasoning and Responses

Kamuli's Umeme staff, police forces, and local government are all working to devise solutions to the problem of theft. From the technical side, Umeme is pushing for UEDCL to install aluminum wiring and poles that may be difficult to demolish (either because of magnitude or material composition). By removing the financial incentives behind theft Umeme and UEDCL are hoping to deter the practice without creating extra long-term costs. Unfortunately, thus far, equipment replacements have only occurred on a reactionary basis: sections of wiring are only improved *after* an incident has happened, leaving in place many opportunities for future theft.

Residents are skeptical that a solution will come from the power companies' end. Charles Okello, the Chief Administrative Officer of Kamuli Local Government, cites the unprofitability of providing power to Kamuli as the reason behind UEDCL's apparent lack of attention to the theft problem:

> "Say there are 100 households in an area like Kamuli which are using power. That's 100 connections that have to be maintained and 100 meters that have to be read, all for an insignificant profit (not to mention losses from defaulting customers). Umeme may also have a customer like Tororo Cement, which uses 300 times the power, is a reliable customer, and requires only one meter or connection."[22]

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[21] Interview with Kristine Nazziwa, Kamuli Resident and Retired Nurse

[22] Interview with Charles A. Okello, Chief Administrative Officer of Kamuli Local Government

When resources are limited, he reasons, it is in the best interest of private companies to preserve connections to major customers, leaving districts like Kamuli to solve the problems themselves. Mr. Okello also believes that this idea, in conjunction with the lack of industry in the area, may be the reasons why Kamuli experiences high levels of load-shedding.

Calls for police patrolling of the transmission area have not fallen on deaf ears, though the geography of the region makes patrolling difficult. Police currently lack proper transport to patrol the transmission lines. Thieves are able to find isolated areas (swamps etc.) in which to work and they typically steal at night. Opule David, an investigative officer with the Kamuli Police Department, notes the difference between his staff and a specialized security force. "A city officer," he says "is not a field man." Kamuli Police officers are incapable of properly policing lines even if they are assigned to do so, as they lack sufficient training in that area. When probed about community-based responses to theft, he replied "local people can't keep quiet about theft. Still, many power theft cases are lost as they work their way up the ladder or go unreported." It is likely that no successful patrolling of transmission lines will occur until a well-trained security force—whether it consists of police, Umeme contracted guards, or community members—is created and implemented specifically for the purpose of policing the equipment areas.

Kalangala, Ssese Islands: A Case Study in Electrifying Unique, Isolated Areas

The process of rural electrification carries inherent difficulties. High capital costs, low revenue collection rates, insufficient generation capacity, and theft all constrain government and utility operations. These difficulties are severely augmented when the area targeted for electrification is remote and unique in nature.

Uganda's Kalangala District is just such a place. Located entirely within the boundaries of Lake Victoria, the district encompasses the 84 Ssese islands, 64 of which are inhabited. The population is estimated to be 40,000, though gathering census data from the transient inhabitants can be difficult. Most of the population and commercial activities are focused in small, clustered fishing communities along the shores. The main and largest island houses Kalangala town, the local government offices, and the district's

secondary schools. The region is only accessible by ferry, leaving either from Entebbe or Masaka for the main island, once daily. No bridges exist between islands. Currently, the main industries are fishing—though the dwindling fish population of Lake Victoria is leaving fishermen with empty nets—and resort tourism.

No centralized source of electricity exists in Kalangala. Those who have power utilize private generators—usually diesel or petroleum—or solar panels. A government-sponsored large fuel generator and mini-grid was operating for some time in late 2007 but has been dormant since then.

Unique Impediments to Electrification: Geography and Uncertain Consumer Bases

Interviews with Kalangala residents and officials revealed a unique set of impediments to electrification. Two main areas were highlighted as the culprits undermining reliable, large-scale power generation and distribution: the island district's geography—both internally and relative to the mainland—and an indeterminable consumer base.

Geographic isolation prevents both connections to the mainland grid and any implementation of traditional input-based generation without exorbitant costs. Import costs of fuel are extremely high and supply is unreliable. Connections to the main land would require marine cables, which would be both expensive and potentially detrimental to the lake's ecosystems and Kalangala's fishing industry. Those desiring power have resorted to localized sources, either generators or photovoltaic cells, which typically produce just enough power for a single household and are only run for select hours in the evening. Resort hotels suffer specifically from this condition, since out-of-town guests often require consistent power.[23]

Geographic isolation also increases maintenance costs. Few skilled engineers reside on the island, and this situation forces power consumers to seek assistance from the mainland when generators break down. Any funds allocated for repairs must include the additional costs of transportation and room and board for the engineer, and the importing of spare parts upon request. Bishop Dunston Memorial Secondary School, one of Kalangala's few secondary institutions provides us with a good a example of this condition: although the school is in possession of solar panels and a large diesel

[23] Discussions with Mirembe Resort Beach Staff

generator, both have been inoperable since January 2009. At the time this paper was composed, the school had yet to gather enough funding to hire an engineer. Instead, the underfunded school has been running a petroleum generator for 1.5 hours a day to provide light to boarding students from 7:30 until 9:00 in the evening. The generator burns 10 liters of petroleum a day, creating a burdensome cost.[24]

Finally, a small and uncertain consumer base hinders electrification in Kalangala. Utility providers in the district must forgo the benefits that come with large-scale distribution, making the business climate undesirable. Though some sensitization and surveying about electricity has been conduced on the main island, it is still difficult to estimate consumer capacity since a large portion of the population is vagrant. Augustine Kasirye, the (Hon) Chairperson of the Kalangala District Land Board, guesses that out of the entire population maybe 5,000 individuals would use available power on a household level.[25] Without large, consistent industrial consumers, and in the absence of government fuel subsidies, private investors have been reluctant to pursue utility projects in the district thus far.

The Kalangala Mini-Grid Project: History and Explanation of Failure

Visitors to Kalangala's main island of Bugala may be surprised to learn that there's no electricity flowing through the visible system of power lines. A select number of households, businesses and government buildings in Kalangala town have connections to the grid, yet the inhabitants will tell you they've been relying on backup generators for over a year now.

In May of 2006 a plot was designated as the future installation site for a medium-scale thermal generator.[26] Promises of power had been floating around since early 2006 in relation to that year's general elections. The thought of the new thermal generator and small electrical distribution grid (mini-grid)—which would provide power to government buildings and surrounding areas—was thrilling, since the island had never had a

[24] Tour of Bishop Dunston Memorial Secondary School with headmaster
[25] Interview with Augustine Kasirye
[26] The history of and statistics related to this project are public knowledge. For this paper, the information was obtained through Oliver Hope Nakyanzi, the Kalangala District C.A.O.

centralized power source of any kind. The construction cost of Ush. 910,000,000 was covered by the Government of Uganda, and operations were monitored by the REA.

The project was commissioned on May 23, 2007. Ferdsult Engineering Services Ltd. undertook infrastructure installation as part of a Public-Private-Partnership (PPP). The idea behind PPP—that private companies, which are more experienced in effectively and efficiently tackling utility projects, could operate facilities successfully under government supervision—would govern most aspects of the project from its inception onward. The grid would initially connect a limited number of government buildings, commercial and residential areas in Kalangala town, and more connections would be added with time. Critically, the island's water supply facility (pump, etc.), a large consumer of power, was left out of this initial connection plan.

On July 25, 2007 WSS Services Ltd. was introduced as the project's concessionaire. Operation of the plant began in August 2007 and continued successfully until January 2008 when generation and distribution ceased. At that time WSS wrote the Executive Director of REA to point out serious flaws in the project. After 5 months of operation the plant was only providing power to 20% of the total available consumer base. WSS estimated that they needed consumer capacity bumped to at least 50% to break even financially, and noted that they were currently operating at a loss of Ush. 5,000,000 per month. High fuel costs were also burdensome in the absence of government subsidies. REA had failed to install both a 10,000-liter reserve tank for fuel and a 6km HV line to the water supply facility, thereby excluding a large customer and lessening the reliability of fuel supplies. Even so, WSS estimated that with these additions consumer capacity may still only reach 35%. To ease the burden WSS requested a review of the lease agreement and government subsidies or waivers on fuel (both consumed already and anticipated).

Initially the government had thought WSS was to blame for the project's failure. Accusations of mismanagement surfaced as consumers began to question the company's tactic of providing power to the town before trying to reach the resort and fishing villages on the shoreline. Though WSS was exonerated in a 2008 stakeholders meeting, investigations into why the project failed are still happening.

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Two main lessons can be drawn from this project. REA recently decided to replace the current generator with a smaller one that may be more suitable for the consumer base in Kalangala town. The previous operation met hurdles when consumer capacity was not reaching the generation capacity of the plant. This begs the question: was enough research conducted to determine consumer capacity and a feasible plan of distribution? As mentioned in the introduction to this section, Kalangala's population is transient and census data has been difficult to gather. In recognizing the uncertainty of this consumer environment it may have been prudent to start with a smaller generation capacity and expand the project when consumers became less reticent.

Next, because of Kalangala's location petroleum products are even more expensive than they are on the mainland. Toward the end of its life, the project was so limited by fuel costs that power could only be made available for a few hours in the evening. This was neither enough to entice new consumers, nor appease the old. Thermal generators, therefore, may not be well suited for this environment without significant financial assistance from government.

A (potentially) Bright Future for Kalangala

In spite of past failures and a unique set of difficulties, electricity may be on the horizon for Kalangala District. The problem of demand will potentially dissolve with the construction of two industrial processing plants, one for seafood, the other for palm oil. Kalangala District Local Government has been promoting the idea of "adding value" to enterprises—packaging and refining products in house rather than shipping them to the mainland as raw materials. Distribution to these new industries may also prove to be easy, if planned properly: populations tend to be clustered in small fishing communities along the shoreline, which could be reached easily by a single line.[27]

One company, BIDCO Uganda, a vegetable oil producer, has invested heavily in palm oil plantations in Kalangala. A processing plant is supposed to come online between June and October 2009, creating new jobs and transforming Kalangala from a primarily fishing district to a major producer of vegetable oil. Although stakeholders are claiming that the project will help to rehabilitate deforested areas along the shoreline, BIDCO has come under fire for neglecting the environmental effects of the palm

[27] Interview with Michael Omara, Independent Electrical Engineer

monoculture on Kalangala's biodiversity.[28] The project, known colloquially as the Oil Palm Project, will undoubtedly alter life in Kalangala.

The BIDCO operation may hold the solution to at least part of Kalangala's power woes. Baliremwa Novato Mukajanga, Kalangala's District Engineer, believes that the Oil Palm Project has the potential to become self-sufficient in terms of energy usage:

> "To supply the Oil Palm Project, the [Government of Uganda] was talking about ferrying power from Bukakata to the main island via marine cables. The power requirements of the plant would be around 3MW, 4MW if you incorporate other needs in the immediate area. However, after processing, palm wastes *must* be managed in some way. Waste can be used to run a boiler, which will be highly effective in fulfilling the plant's power needs. 80% of the 3MW needed is steam. 11,000 hectares of palm (what's set aside for the project) will produce, after processing, enough waste to produce 6.5MW. The additional 2.5MW not needed for the plant can be used to supply other areas and nullifies the marine cables."[29]

Of course, the plant would only be operational during harvest times, making additional sources of power necessary to ensure a consistent flow of power to consumers.

Part of this deficit will be filled by a new development project commissioned by Kalangala Infrastructure Services (K.I.S.). Along with proposals for new ferries and improved roads, the project includes plans for a solar "garden," comprised of industrial-sized photovoltaic panels and a supportive thermal generator. Solar has already proven itself in Kalangala, an area with few alternatives (presently, all health centers in Kalangala District are running exclusively on solar, courtesy of the Icelandic International Development Agency).

Kisiizi Hospital: A Case Study in How Things Could Be

One notable rural electrification project is making real headway. The small hydroelectric facility at Kisiizi Hospital in southwestern Uganda has been a prime example of localized electricity generation and distribution for over 50 years. Built with

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[28] http://www.monitor.co.ug/artman/publish/business_power/Kalangala_Bidco_oil_mill_starts_in_June_71559.shtml

[29] Interview with Baliremwa Novato Mukajanga Kalangala District Engineer

the permission of the British protectorate in the 1950s, the Anglican hospital has served the surrounding area well. The original hospital buildings were converted from a WWII flax factory that had been powered by a small generator run off of the nearby waterfall. Since that time, three incarnations of generators have been housed at that location in attempts to match the hospital's growing demand for electricity. The fourth installment, which includes a 60 kW German-made machine, new piping, and an extended grid will be completed in summer 2009. This project, which builds upon decades of generation in the area, serves as an informative case study in how things could be with rural electrification if the pieces fall into place.

The current project began in 2000 when two private consulting firms were hired to survey the site, measure the river's head, and compute the falls' generation potential. Both consultants approved of the project, but made unfortunate mistakes in their calculations. Had they not been addressed properly, these statistical discrepancies could have ruined the project, and construction was delayed until late 2004. At this time, the construction was funded primarily by the World Bank (60-65%), with the remainder of the funds coming from philanthropic hospital supporters and long-term loans, and aided by the REA.

Once completed, the facility at Kisiizi will provide reliable power to the hospital and the surrounding area. Already street lamps line the main drag, and electricity is supplied to the homes of hospital staff. The current 8 km distribution grid will be extended through additional 30 kV wires and 7 new transformers to reach a nearby secondary school and residential areas.

Although the Kisiizi rural electrification project is relatively successful, certain difficulties extended the project length from 3 years to nearly 9 years. Donor constraints were a major factor as lead funding for the project shifted from the World Bank to long-term loans and donations issued by Kisiizi Hospital supporters. This switch allowed the project manager a desired level of flexibility but left progress stalled during the transitional period. Further issues with credit slowed the obtainment of the generator, pushing the project into 2009.

What Makes Kisiizi Different

The Kisiizi project is succeeding while others fail. Conversations with Charles Swainson, the project's manager, and members of the Scottish and Southern engineering team revealed four factors that can explain why the project is nearing completion. Firstly, the funding for this project, including subsidies and donations, was sufficient, even if delays happened. The estimated project cost of around $US 800,000 has been accounted for almost entirely. Other rural electrification projects have struggled to get funding after the initial phases, leaving them incomplete. Secondly, private investors carried the project financially during gaps in funding. Charitable individuals who cared deeply about the smooth operation of the hospital footed the bill during desperate times—a luxury that does not exist for most projects. Thirdly, those involved with the project created their own company, Kisiizi Hospital Power Ltd., to govern the affairs during and after construction. The board of directors, comprised of the hospital's medical and administrative directors and the area bishop, operates with a personal connection to the hospital. Because the company's only facility is at Kisiizi, the project gets the attention it needs. Finally, because the facility is operating under 500 kW, Kisiizi Hospital Power Ltd. is legally allowed to set its own tariffs, raising profit for the hospital without overburdening its customers.[30]

In the future, Kisiizi Hospital Power Ltd. will bring in an outside administrator to turn the company in its first year of full operation. The company is expected to make a profit (almost unheard of for rural electrification projects), and projected upkeep costs are low. Already, creative methods of preventing overuse are being implemented: devices are installed in the homes of all hospital staff that shut off outlets if appliances are using too much electricity. A prepaid power scheme will also be implemented, making things easier on both company and consumer. Mr. Swainson believes that "basically, people should pay for what they use." "With prepaid," he says "you don't get debt…everyone's used to it with phones…it works."[31] Kisiizi Hospital Power Ltd. will soon be operating a consistent generation facility with abundant supply a network that is friendly to consumers, all the while continuing to build on nearly a half-century's worth of top-of-the-line rural electrification.

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[30] Interviews with members of the Scottish and Southern volunteer engineering team
[31] Interview with Charles Swainson, Kisiizi Power Project Manager

Conclusion and Recommendations

Getting power to the people of Uganda is a complicated, expensive, and tedious process. Economic incentives for private companies are generally lacking, putting pressure on the government to obtain outside financial assistance and facilitate projects. The problems of power-theft and insufficient generation make supply inconsistent, hurting consumers and forcing distributors to prioritize customers. Yet access to electricity is important, particularly to rural communities: healthcare, education, and industry are all aided by even small (if consistent) amounts of electricity at reasonable rates.

The following recommendations are rooted in the findings and experiences gathered during the research period. While these are merely suggestions, they do carry some validity and are at least worth considering.

Consider Prepaid Power

Electricity distribution companies operating in Uganda should strongly consider implementing prepaid power schemes. Such schemes would eliminate over-charging and estimating—volatile practices that harm consumers—and increase revenue collection, providing an incentive for companies to pursue rural electrification. Prepaid power also has the potential to reduce theft, as connections only become active once a code or card is inserted into a meter.

Currently, Ferdsult Engineering Service Ltd. operates the only prepaid systems in Uganda. These systems, located in Kibale and Kanungu districts, allow customers to purchase power in minimum increments of Ush. 10,000.[32] Unfortunately, usage is still small due to limited demand. Location has also become an issue since cards are only available at a single retailer in Kihiihi. Meanwhile, new projects, like the one in progress in Kisiizi, are planning to implement prepaid systems from the get-go with a ready consumer base. For prepaid power to take hold, Umeme, the leading distributor of electricity in Uganda, will have to conduct a complete overhaul of their current system—a costly endeavor. Still, problems with theft and low revenue collection rates may persuade Umeme to consider this change.

[32] Visit to Ferdsult Engineering Service Ltd., Kihiihi Office

Continue Efforts to Increase Sustainable Generation Capacity

As noted, one of the major problems with the power sector in Uganda is market failure. As long as demand continues to outpace supply, power will be overly-expensive and too inconsistent to meet the needs of Ugandans.

Construction on the hydropower facility at Bujagali has begun. By 2010, the dam is expected to produce an additional 50 Mw of power. When fully commissioned, the plant is expected to add an additional 250 Mw of power to the national grid.[33] In spite of this increase, however, the project will only stem the growing demand for electricity for a short while. Built along the Nile like the Nalubaale and Kiira facilities, Bujagali will be also subject to fluctuations in the water levels of Lake Victoria, not to mention scrutiny from other East African nations who utilize the lake and the river.

Prospects for increased generation may lie in the waters of Lake Kyoga, located in central Uganda. Unlike the catchment area (the drainage area where rainwater is collected) for Lake Victoria, which crosses the boarders of Rwanda, Burundi, Tanzania, Kenya and Uganda, the catchment area for Lake Kyoga is contained almost entirely within Ugandan territory. Man made fluctuations in water levels, therefore, could be controlled through national policy, without the hassle and politics of multi-national negotiations.[34]

Make Efforts to Diversify and Increase Alternative Energy Sources

Hydroelectricity is a superb fit for Uganda. High installation costs may be burdensome, but the low level of requisite maintenance (as evidenced by the continuing operation of the Owen Falls Dam, built in the 1950s) nullifies these costs in the long run. However, policy makers should take care not to over-rely on hydroelectricity. Not only are dams vulnerable to environmental and political factors, they have a mutually adverse relationship with other sectors, namely fishing, agriculture, and tourism.

Uganda's capacity for solar energy should be further explored. Uganda's location on the equator translates into abundant and consistent exposure to sunlight throughout the year, even during the rainy season. REA has been dedicated to the implementation of photovoltaic projects as a means to get power to isolated areas, but more can be done.

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[33] "Bujagali Power House Takes Shape," *The Independent* April 24-30 2009

[34] For a map of these catchment areas, see appendix B.

Solar paneling can provide power on a truly localized level—be it hospital or household—and, like hydro, has a high installation cost but almost no cost of upkeep.

Consider Weaning Off of Thermal Generators

Thermal generators are expensive and unreliable, especially for rural communities. Even though oil exploration in Uganda is increasing, oil remains a finite resource. A continued reliance on thermal generation will leave Uganda reliant on other producers. Furthermore, REA makes a concerted effort to secure funding by operating in concordance with international climate and environmental regimes. A reliance on thermal generation undermines this effort and threatens donor participation.

Determine the Appropriate Level of Public-Private-Partnership

Since the electricity sector was unbundled in 1999 private companies have led efforts to electrify the country. The hope was that private companies would bring a level of efficiency and accountability unseen under UEB, and that competition would yield results for consumers. However, because rural electrification is commercially undesirable, some government intervention is necessary to create an environment suitable for private investment. Uganda should make every effort to tease out the appropriate level of public and private involvement on a project-to-project basis. Government should not be reluctant to step in when the private sector is failing and should remember that Uganda is a unique country requiring unique solutions.

Public-Private-Partnerships have already proven to be successful: the generation facilities at Nalubaale and Kiira are owned and monitored by UEGCL (a state-owned company) but operated and managed by Eskom Uganda (a private enterprise). 2009 marks the tenth year anniversary of the 1999 Electricity Act: it is time to assess the introduction of private entities into the energy sector.

Finally, Be Patient

In the grand scheme of things, it is unreasonable to expect a complete, successful overhaul of a utility sector in any country in only ten years' time. Donors and policy-makers alike should continue to think long-term, assess progress regularly, and not expect instantaneous results.

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Appendix A: Uganda Electricity Sector Structure

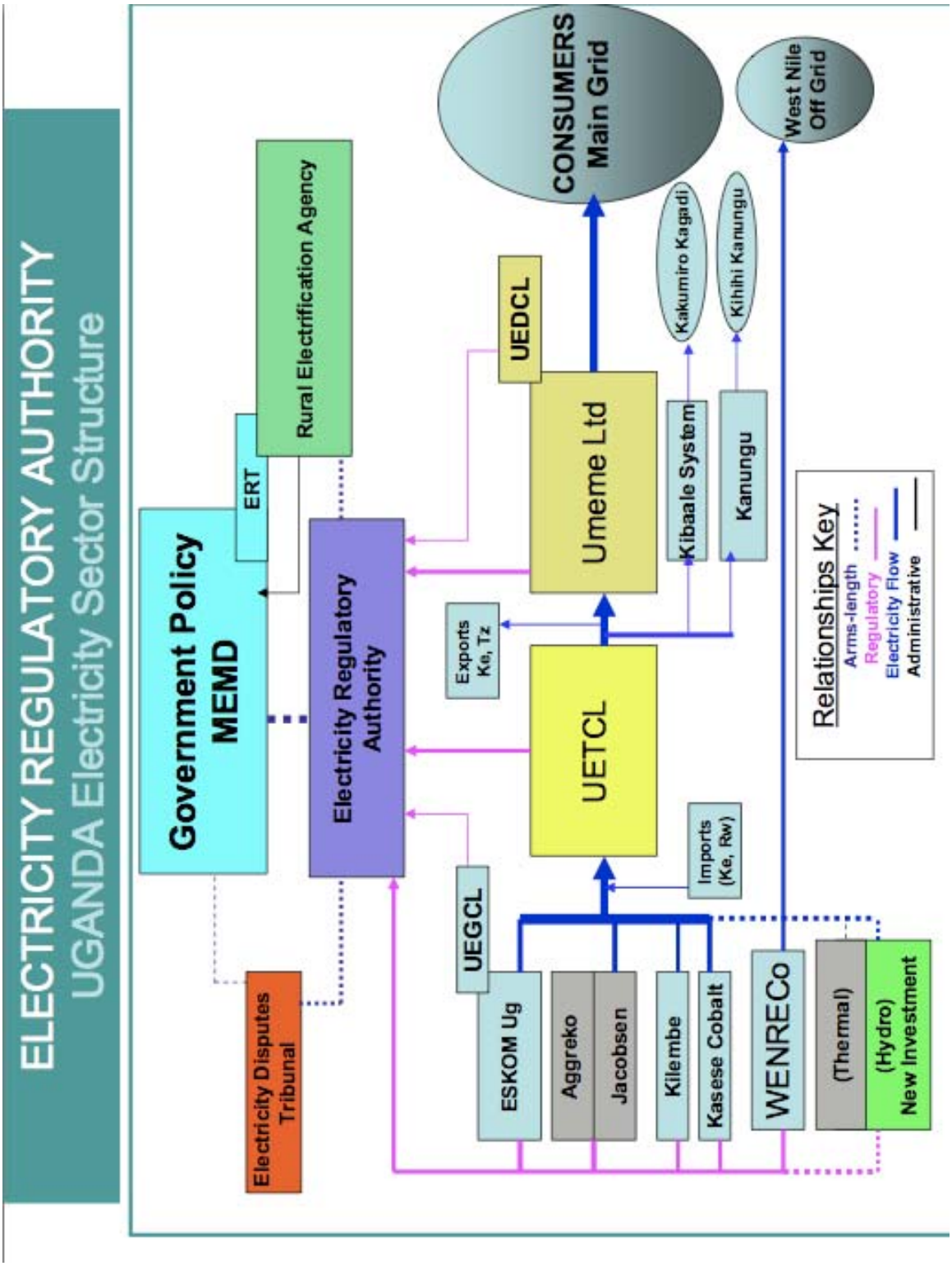

*Diagram courtesy of Electricity Regulatory Authority

Lake Kyoga and Lake Victoria Catchment Areas

*Estimates Only