ssee

UNIVERSITY OF OXFORD

ERC
ENERGY RESEARCH CENTRE
University of Cape Town

ELECTRICITY FOR INTEGRATED RURAL DEVELOPMENT

The role of businesses, the public sector and communities in Uganda and Zambia

Project RISE practitioner report 2019

Research for this project was conducted by an international team of researchers from the University of Cape Town and the University of Oxford. The support of the Economic and Social Research Council (ESRC) is gratefully acknowledged. This report was prepared in partnership with the Centre for Development Alternatives based in Kampala, Uganda.

University of Oxford Smith School of Enterprise and the Environment

Aoife Haney – Principal Investigator
Susann Stritzke
Philipp Trotter
Akaraseth Puranasamriddhi

University of Cape Town Energy Research Centre

Amos Madhlopa – Co – Principal Investigator
Bothwell Batidzirai
Peter Twesigye
Alfred Moyo

Centre for Development Alternatives (support for writing the report)

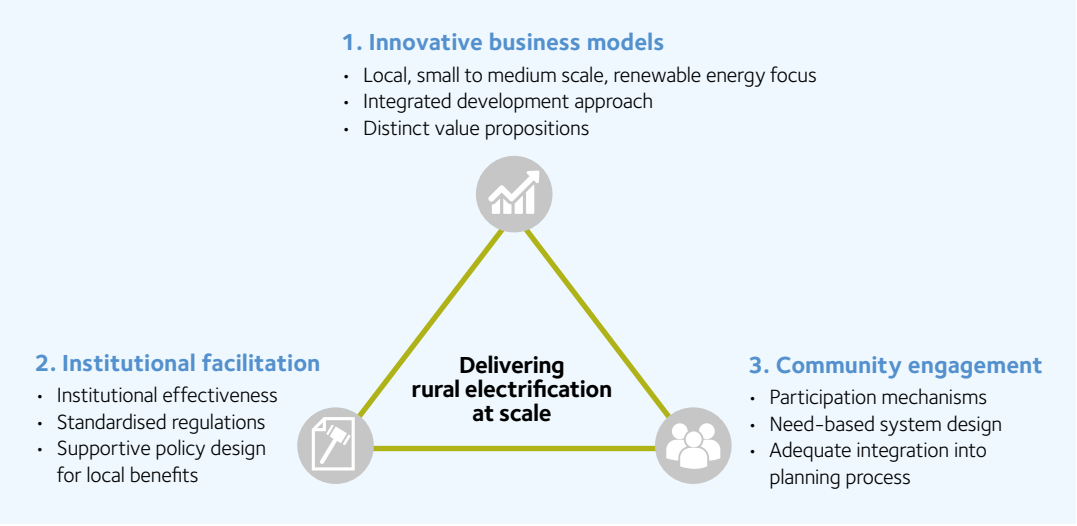
Max Walter
Ester Kovandova
Yusuf Kiranda
Evelyn Mugisha
Andrew Panton

ABOUT THE PROJECT

Project RISE (Renewable, Innovative, and Sustainable Electrification) is an interdisciplinary research project carried out by the University of Cape Town and the University of Oxford. The project aims to identify integrated, actionable and transferable development strategies for the local off-grid energy sector in sub-Saharan Africa (SSA). Two national case studies, Uganda and Zambia, form the basis of the project. The research pursues three mutually reinforcing areas of inquiry (Figure 1): Innovative business models for scalable and impactful electrification; suitable institutional arrangements to facilitate the development of the industry; and enabling community involvement with a focus on rural areas. The following research questions govern each of the three pillars:

1. **Innovative business models**: Which business models for small to medium-sized enterprises (SMEs) in the renewable energy sector are best suited to establish and scale off-grid electrification?
2. **Institutional facilitation**: Which institutional setup best enables the development of sustainable local markets for renewable energy in SSA?
3. **Community engagement**: How can communities engage with and contribute to the development of sustainable electrification, especially in rural areas?

Figure 1: The three pillars of project RISE



The research utilises a mixed-method approach of extensive qualitative interviews and a detailed household survey. The research team has conducted semi-structured interviews with 35 off-grid energy companies in Uganda, Zambia, Nigeria, Tanzania and Ghana, as well as another 45 with public sector stakeholders. The team collected and evaluated primary data on company business models as well as on energy policy-making processes and regulatory frameworks. Furthermore, a novel household survey with 106 questions was developed and administered in rural Uganda and Zambia (N = 1016) to understand local energy needs.

CONTENTS: KEY MESSAGES

EXECUTIVE SUMMARY

The dominant approaches to rural electrification in Uganda and Zambia leave great potential for economic development untapped. More than 85% of the rural population in Uganda and Zambia live without electricity. Population growth has considerably outpaced connection rates in both countries in the last few decades. Labour productivity and rural income per capita gains have been slow and uneven. The Ugandan and Zambian governments have put forward ambitious electrification plans, viewing private sector-led off-grid energy as an important lever to overcome these challenges. The rapid growth of solar home system sales has been instrumental in providing lighting and phone charging services to many remote end-users. To fulfil the vision of energy-enabled economic development, sufficiently sized and reliable mini-grids currently constitute the most promising - but only infrequently deployed - solution for remote communities where reliable grid-based electricity will not become available in the near future.

This report presents the results of studying the three main stakeholder groups in the off-grid sector in Uganda and Zambia, (1) the private sector, (2) the public sector, and (3) communities in relation to off-grid energy for sustainable development.

(1) Mini-grid developers are designing innovative business models that go beyond delivering energy and towards supporting rural development. Developers are faced with a well-known conundrum: How do you provide sufficient and reliable electricity to meet more than customers' basic needs without being able to charge cost-reflective tariffs or to rely on large subsidies? The solution several innovative mini-grid developers across sub-Saharan Africa are coming up with, referred to as Integrated Developers (ID) throughout this report, is to increase revenues from not only selling kWhs, but from selling electricity-enabled productive goods and services. This increases the per-kWh value-add of the mini-grid. Crucially, it also aligns community and private sector goals: As ID companies become integrated in rural value chains, economic development in the village directly improves companies' financially viability. The considerable potential of the model comes at the cost of increased complexity for the ID in terms of products offered, revenue model and required networks.

(2) Uganda's and Zambia's public sectors are fostering private sector-led off-grid electrification, but several barriers remain to unlock the full potential. The policy focus in both countries is much more on access per se, rather than on viewing electrification as one of several dimensions to foster sustainable development. As a result, off-grid solutions are often promoted and supported in isolation rather than as an integrated component of a broad and holistic sustainable development programme. Both Uganda and Zambia are currently overhauling their off-grid energy regulations in a bid to improve the sector's enabling environment and attract further private sector investments. Our research identifies a number of inefficiencies, both in terms of structure (integration of on-grid and off-grid electrification, restrictive tariff construction and business model requirements, lack of focus on productive use of electricity) and decision-making processes (poor monitoring and evaluation, slow permitting and licensing, lack of inclusion of local-level stakeholders) that may hold progress back.

(3) Rural communities demand much more than basic needs – and the off-grid market is not yet providing solutions at scale. We find that rural households feel most burdened by agricultural work and other business activities, firewood fetching and household chores. All of these needs would benefit from sufficient and reliable electricity access. Basic needs of lighting, phone charging and light entertainment rank highest in community needs. Notably, the biggest percentage gap between current and desired uses of electricity exists for cooling, cooking and productive use of electricity, with between 40 and 50% of respondents wanting to use electricity for these services, but less than 10% being able to do so. While the off-grid market is making important strides towards meeting basic needs at scale through small-scale solar home systems (SHS), mini-grids which can deliver electricity for cooling, cooking and productive use are not yet available at sufficient scale. Furthermore, communities feel that they are left out of energy-related decision-making, making it difficult for community needs to be integrated into rural electrification strategies.

A concentrated effort from all stakeholders is required to capitalise on the significant opportunity of off-grid electrification for rural development. While significant steps have been taken in the past by all stakeholders, further actions are required to realise the potential of energy-enabled development. Businesses need to focus first on innovating for profitability and then on scaling for impact. The public sector needs to embed off-grid electrification into holistic development interventions that prominently feature productive use of electricity, and improve conditions for innovation in their respective countries. Communities need to be given the conditions to actively engage in concrete electrification decisions to maximise their value. Involvement from international donors is crucial in both countries but would benefit from better coordination between the many different initiatives before engaging national stakeholders. Crucially, as this report argues, the respective interactions between these stakeholders need to be re-imagined to realise the full potential of off-grid energy for development.

INTRODUCTION

Access to modern energy is closely linked to many aspects of sustainable development. The United Nations (UN) has defined Sustainable Development Goal 7 (SDG7) to ensure access to affordable, reliable, sustainable and modern energy for all by 2030. Recent research (McCollum et al. 2018; Nerini et al. 2018) shows that SDG7 has a synergetic relationship with the majority of the 169 SDG targets formulated by the UN as part of it Agenda 2030, including eradication of poverty, health and well-being, quality education, and gender equality.

In Uganda and Zambia, population growth has outpaced connection rates, with rural areas mainly affected. Official figures quantify Uganda and Zambia's electrification rates as 22% and 40%, respectively (compared to a 35% SSA average, see also Table 1). The electrification rates among rural populations is estimated at 11% in Uganda and, according to Zambian public sector data, below 10% in Zambia (compared to an estimated 20% SSA average). Notably, high population growth has outpaced some noteworthy gains in new electricity connections. This has led to the overall number of unelectrified people in Uganda and Zambia increasing by 15 million and 3 million people between 1991 and 2017, respectively. Hence, on average, there have been roughly 1,600 additional unelectrified people in Uganda and 300 in Zambia every single day since 1991 (The World Bank 2019). This phenomenon has occurred in the overwhelming majority of countries in sub-Saharan Africa (SSA) (The World Bank 2018). The vast majority of unelectrified populations live in rural areas: The share of all unelectrified people who live in rural areas are 88% and 82% in Uganda and Zambia, respectively.

Inadequate electricity supply limits achievable productivity gains. A common development model for countries that have managed to leap from low-income to middle or high-income status in the 20th century entails increasing labour productivity by shifting resources from agriculture to manufacturing and services. Many value addition processes across the economy rely on electricity. As well as being the lowest in the world, labour productivity (value-added per person) in SSA is currently growing at half the pace of the global average, further widening the productivity gap. Where electricity is available, it may be prohibitively expensive for consistent use. The cost of diesel-driven electricity in rural SSA today is as high as 30 times what the average household pays in the EU (Szabó et al. 2013). In addition, electricity provision is often highly unreliable: Grid-connected firms in Uganda experience an average of 6.3 blackouts per month, firms in Zambia experience 5.2 per month (The World Bank 2019). These numbers are likely to be significantly higher for rural businesses.

Table 1: Electricity access in Uganda and Zambia in numbers (The World Bank 2019)

	Uganda	Zambia
Total population (2017)	41 million	17 million
Electrification rate (2017)	22%	40%
Population without access to electricity (2017)	33 million	10 million
Rural electrification rate (2017)	11%	<10%
Rural population without access to electricity (2017)	29 million	8 million
Average number of additional unelectrified people every day since 1991	1,600	300
Number of blackouts per month experienced by grid-connected firms (2013)	6.3	5.2

Off-grid energy offers a much debated yet still largely untapped alternative for accelerated energy access. Numerous national and international energy initiatives during the last 10 years have focused on increasing electrification in SSA. While they have had limited impact on rural electrification and have often not markedly reduced urban-versus-rural electrification inequality (Trotter 2016), they have managed to place off-grid electrification on the agenda in most countries in SSA. The solar off-grid market is growing particularly quickly in both Uganda and Zambia. Uganda features the more developed off-grid market of the two countries, with over 300,000 solar home systems alone sold to date (UOMA 2018). Over 100 active companies exist in the Ugandan market. The heavy usage of mobile money for bill payments, combined with customer finance options has considerably broadened the customer base (Muchunku et al. 2018). Despite the fact that off-grid renewable energy systems are widely seen to be crucial to closing the access gap, their performance is lagging behind expectations. In 2010, the International Energy Agency estimated off-grid systems to be cost-optimal for 60% of all new generation in SSA until 2030 (IEA 2010). If current capacity addition trends continue, this figure will be missed by over 40 percentage points (IFC 2018).

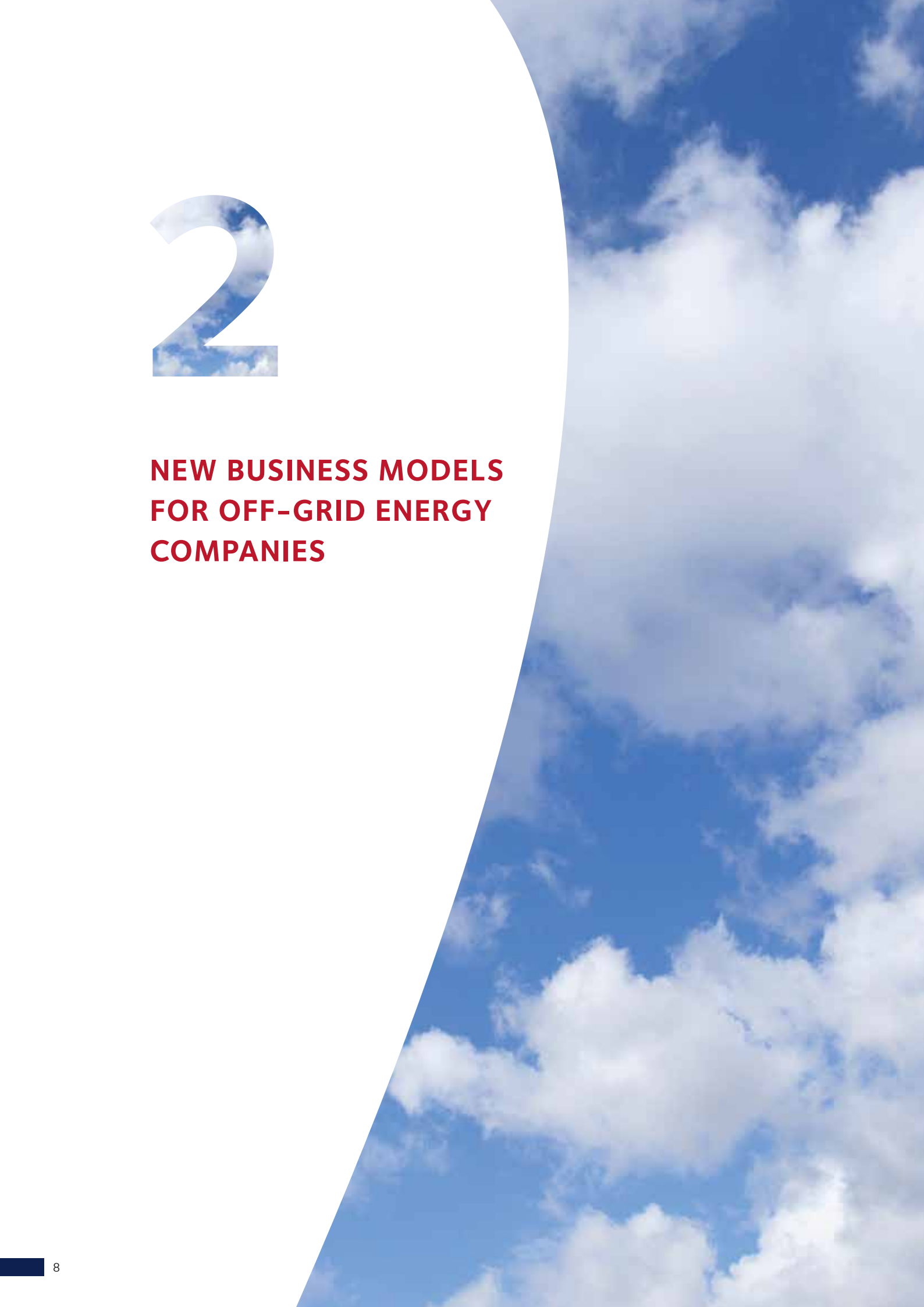
Major challenges for scaling impactful and sustainable off-grid electrification exist across the three key stakeholders. Both Uganda's and Zambia's focus on private sector development of off-grid electrification positions off-grid energy companies as a major stakeholder in addition to the public sector and communities. Considerable barriers for sustainable electrification for development exist for all three of these groups:

1. **Off-grid energy businesses struggle to be financially viable and deliver sufficient electricity for productive use**. In many rural areas across SSA, renewable off-grid solutions are the cheapest and cleanest electrification option due to their abundance and rapidly falling system costs (Mentis et al. 2017; Trotter, Cooper, and Wilson 2019). Despite the significant opportunities to provide people with electricity across SSA, low and seasonable income of end-users combined with financial limitations and the nascence of the sector imply tough business conditions. Off-grid projects are sensitive to exogenous effects that impact rural household income. Several established off-grid companies experienced financial difficulties in 2019, illustrating the challenges for firms in the sector. Publicly funded efforts have largely focused on grid expansion, with off-grid companies receiving miniscule shares compared with the large-scale potential of the solution. Business model innovations in the last 5 years have led to significant progress, but the solutions are either limited to pico-scale domestic uses (light and phone charging), or require large-scale subsidies to be both affordable and profitable (Peters, Sievert, and Toman 2019). Existing off-grid solutions have thus not yet managed to enable productive use of energy at scale.

2. **Institutional frameworks governing rural electrification can pose significant challenges for speedy service delivery**. Rural electrification has suffered from institutional barriers including a lack of standardisation (within and across countries), transparency and regulatory consistency (Ulsrud et al. 2018). Furthermore, there are often no regulations guaranteeing benefits for the local energy industry from foreign investment (Trotter and Abdullah 2018). There are often no clear legal provisions for off-grid operators in response to the expansion of the grid to an area they service which poses a significant risk to off-grid investment.

3. **Community members are often far removed from electrification decisions, which can lead to underestimating their needs**. While a rich body of research has shown the significance of community engagement in planning and implementation for successful electrification projects in rural SSA, communities are often left at the margins of the electrification process (Miller et al. 2015; Muhoza and Johnson 2018). Case examples attest to several potential negative consequences of excluding communities, including rejecting new technologies, challenging cultural norms, and isolation of project advocators (Peterson 2006). Furthermore, the recent top-down approach of electricity provision largely informed by a 'meeting-basic-needs' paradigm is vulnerable to applying one-size-fits-all solutions to communities with different and often more sophisticated energy demands than what may meet an outsider's eye.

To foster rural development enabled by off-grid electrification, a holistic approach across business models, institutions and community engagement is required. Based on project RISE's systematic approach of researching the implications of off-grid energy for businesses, public sector and communities, this report identifies and discusses novel models of electricity provision in SSA. These models reflect the needs of the target consumers while remaining profitable, the regulatory shifts and reforms required for new business models to operate at least possible risk, and they identify productive needs and preferred modes of community engagement to ensure local support. A combination of measures across all three stakeholders is key for off-grid electrification to reap its full potential.



2

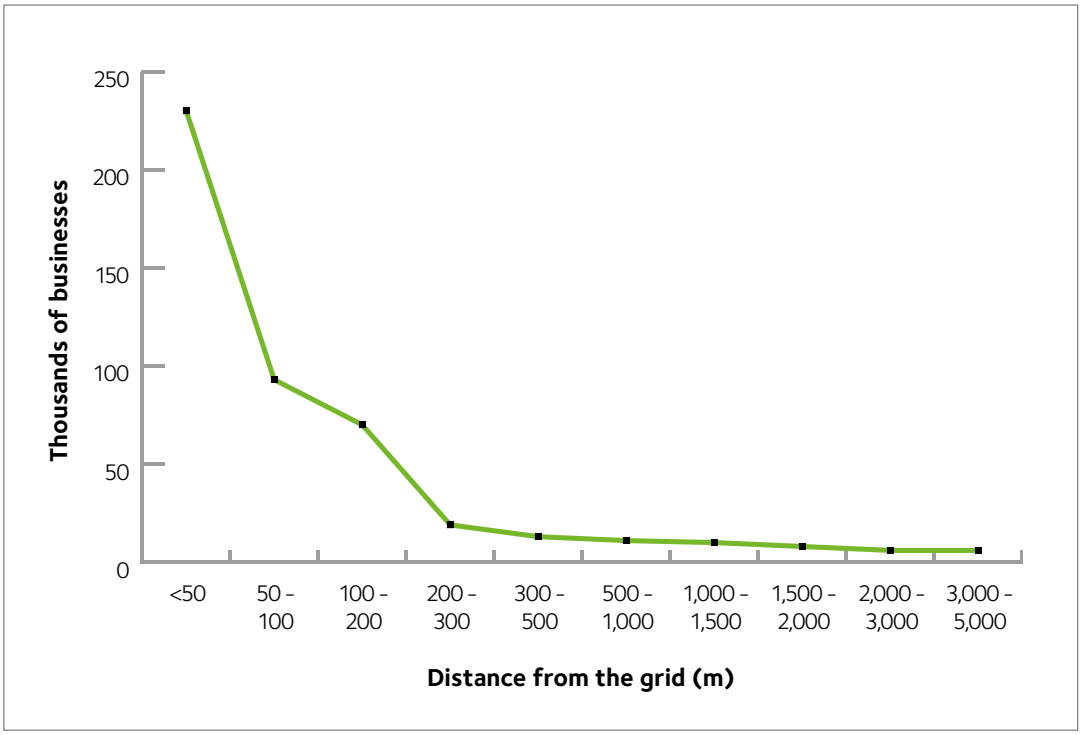
NEW BUSINESS MODELS FOR OFF-GRID ENERGY COMPANIES

MESSAGE 2.1

Businesses are conceiving of a novel, bottom-up "Big Pull" paradigm for energy-enabled rural development

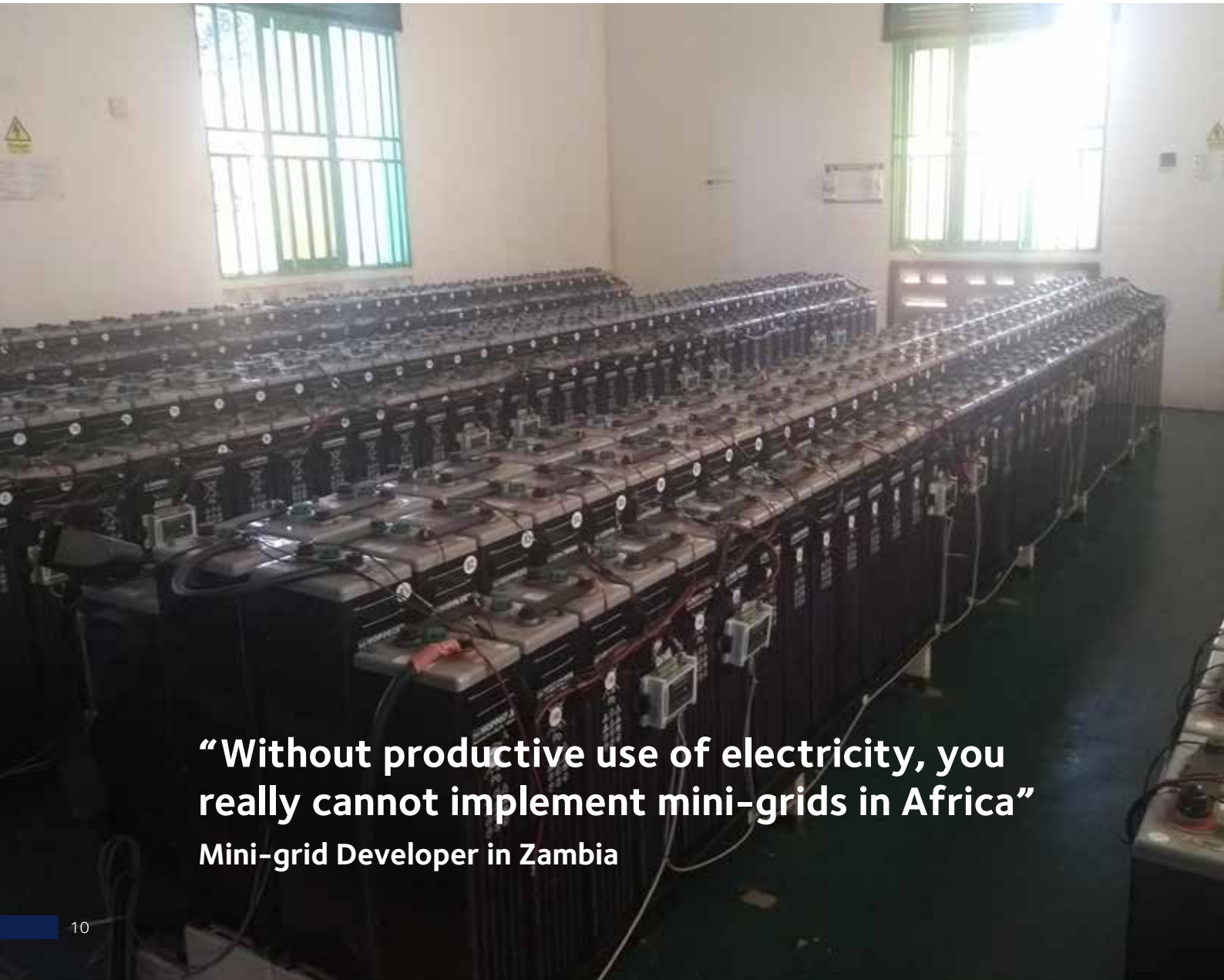
Modern energy is a key input for development. Though academia has not reached a consensus on the direction of causality, there is a strong correlation between energy consumption and economic growth. A recent geographic information system (GIS) analysis from Uganda by Kampala-based company Geo Gecko shows that the concentration of where businesses are located is closely associated to where the grid is located: The further away electricity is available, the fewer businesses exist (Figure 2). Electricity is necessary to run water pumps, irrigation, agro-processing and manufacturing equipment, service businesses, health centres, quality education facilities, communication systems and household activities. Labour productivity, which has been slow to increase in both Uganda and Zambia, is aided by sufficient access to reliable electricity.

Figure 2: Grid proximity and number of business in Uganda (Geo Gecko 2017)



Electricity, however, is not sufficient for development. Energy access projects often fail to realise their desired economic development impact because energy demand is not sufficiently catalysed. Electricity on its own is not useful. It needs affordable appliances to galvanise its potential on a micro-level, and enabling commercial and industrial policies on a macro-level. Furthermore, energy demand is curtailed by income poverty among households. The off-grid energy companies interviewed for this report largely agree that successful business models have to remove barriers of expensive appliances and charging tariffs which are not cheap but affordable. Without unlocking these barriers, energy will not drive development.

A "Big Pull" approach as a solution to the frequently cited chicken-and-egg problem of electricity demand and economic development. Recent discussions about energy in Uganda and Zambia have raised what has been referred to as a chicken-and-egg problem: Do you first provide energy infrastructure and wait for companies to take it up, or do you first create electricity demand by focusing on building productive companies before energy companies can come in and operate viable businesses? To break this paradox, innovative off-grid companies are starting to see that, in fact, you need to do both at the same time. This notion is similar to Paul Rosenstein-Rodan's 1943 concept of a "Big Push" (Rosenstein-Rodan 1943), however, crucially, in this case, it is driven in a bottom-up fashion rather than top-down: Mini-grid companies are not replicating the common development approach of simply pushing resources (e.g. energy infrastructure) onto a specific problem (e.g. lack of energy access and low economic development) and hope the problem disappears (Christensen, Ojomo, and Dillon 2019). Instead, they carefully assess the local situation, viewing the lack of energy-enabled development as a business opportunity for productivity gains in rural supply chains. Following what can be called a "Big Pull" approach, in addition to providing reliable electricity, they pull in resources and inputs for energy-enabled rural development. Depending on local circumstances, these may be an ice production plant, a fish drying factory, telecommunication towers, milling equipment, irrigation systems, customer-finance for small-scale electrical appliances and even electric transportation.



"Without productive use of electricity, you really cannot implement mini-grids in Africa"

Mini-grid Developer in Zambia

MESSAGE 2.2

Selected mini-grid businesses are switching to an integrated business model built on fostering rural development

Innovative off-grid companies operationalise the "Big Pull" paradigm by re-defining their business models: the 'Integrated Developer' approach. The new business model is based on the recognition that rural development aids both the community and the energy provider because both benefit from local economic development: The community members achieve higher income, the energy provider can better monetise its electricity sales. This is embodied in an emerging energy provision business model we call 'Integrated Developer' (ID). It is motivated by the fact that if mini-grids merely serve poor households, they are usually unable to recover capital costs and require heavy subsidies instead which is prohibitive to scaling them and reaching their full potential. Instead, the ID approach connects and sells electricity by the kWh to a set of commercial and domestic consumers. Crucially, in addition, it also powers the ID company's own production plants - built alongside the power source - which uses electricity as a production input to add economic value to goods or services. It realises higher value-add per kWh by using significant shares of the electricity generation to increase rural value chain productivity. This commercial revenue can then be used to cross-subsidise household electricity demand, allowing for lower costs for households. An ID can target existing and create new rural supply chains, thereby contributing to economic diversification, job creation and income generation.

Examples of ID value-adding products and services attached to the electricity generation facility are diverse. They include ice production for fruit and vegetable supply chains, grain mills that sell milling services by the hour, fish drying plants, chicken egg incubation stations or ground-water pumps to sell irrigation services. Agricultural examples are common, but the model is capable of offering products across all economic sectors (agriculture, manufacturing, services and public goods). It also has the flexibility to go beyond the mere production of input services and instead sell the actual end-product itself, such as fish, maize flour or drinking water. ID models are currently being developed or piloted using hydro power, biomass and solar PV with battery storage. Our interviews reveal that this business model is appearing in different country contexts such as Uganda, Nigeria and Tanzania, albeit at varying stages of realisation.

The ID business model is distinct from the current three existing business model types in the off-grid energy space, namely: Standard Retail (SR), Consumer Finance Retail (CFR), and Micro Utility (MU). SR Companies sell off-grid energy solutions over the counter with 100% down payment, while CFR companies allow customers to use their systems while paying it off in small instalments similar to a leasing arrangement (this is often, though technically speaking wrongly referred to as pay-as-you-go (PAYG) as PAYG usually implies a per-unit charge rather than leasing). MU companies develop and run mini-grids much like a regular utility (including different licensing processes), albeit at a much smaller-than-national scale. A business model can be divided into its core elements products, revenues, mission statement and structure (Alt and Zimmermann 2001). Using this definition, Table 2 provides the main characteristics of all four off-grid models, showing the innovation of the ID approach. Table 3 illustrates the main opportunities and challenges of the business model.

Table 2: Summary of business model characteristics of the four off-grid energy business model archetypes

	Standard Retail (SR)	Consumer Finance Retail (CFR)	Micro Utility (MU)	Integrated Developer (ID)
Products	Capacity (kW): complete stand-alone or mini-grid systems, in rare cases coupled with appliances Solar PV, hydro 0.005 – 5,000 kW	Capacity (kW): complete stand-alone systems, often coupled with small-scale appliances (lights, radio, TV, fan, etc.) Mainly solar PV 0.01 – 0.5 kW	Energy (kWh): Metered share of energy units generated in a mini-grid Div. technologies 5 – 5,000 kW	Energy (kWh), as well as various productive goods and/or services (agro-processing, cooling, water access, ...) Div. technologies 100 – 5,000 kW
Revenue model	One-time payment, 100% upfront Low finance needs Instant payback time	Payments over finite time period in small instalments (consumer finance) High finance needs 2-3 year payback time	Regular, continued billed or prepaid High finance needs Very long (if any) positive payback time	Sell energy (kWh), services and products as part of rural productive value chains High finance needs No data on payback times, but potential to be lower than MU
Mission statement	Offer high quality solutions with high customisation	Make energy for basic needs broadly accessible	Enable economic development and meet basic needs	Actively create and monetise economic development through energy-enabled service
Structure	Mostly local companies Limited amount of business partnerships	Mostly companies with international (finance) ties 2 – 3 core partnerships (telecom company and distribution)	Both local and international companies, often with international finance ties; 2 – 3 potential partnerships (customer acquisition, micro-finance)	International companies with local ties, or local companies with international ties Heavy partnership requirements across value chain

> **"Our value proposition now is to deliver an integrated community development project rather than a mere mini-grid."**
>
> **Local Mini-grid Developer In Uganda**

Table 3: Opportunities and challenges of the Integrated Developer (ID) business model

	Opportunities of ID	Challenges of ID
Products	• Encompassing development of rural areas in low-income countries • Address multiple needs in rural communities, namely basic energy services, advanced domestic needs, productive input and directly setting up new income generation activities • Flexibility to react to demand increase	• Variety of products requires in-depth knowledge of energy provision and rural productive value chains • In-depth local knowledge and experience required for choosing the right rural value chains to integrate into • Limiting activities to a level of integration (depth and breadth) which is manageable for the company
Revenue model	• Overcoming the key financial burden of rural communities to buy appliances to use productive electricity • Higher effective per-kWh return from non-electricity sales improves financial viability • Lower domestic tariffs become possible through cross-subsidies • Long-term customer relationship model is similar to existing MU model • Lower default risk due to diversification of revenue sources	• Increased complexity through different types of revenue streams • Potential of non-electricity income is highly context-specific, poorly documented and much more diverse than straight-forward kWh-demand • Requirement to balance domestic end-users, commercial customers and own operations in terms of electricity provision • (Slightly) higher local currency risk compared to MU model
Mission statement	• Ability to formulate a credible value proposition centred around measurable economic impact and quality of life improvements	• Need to frame value proposition such that it appeals to international funders, local regulators, the various partners and communities
Structure	• Integrated setup institutionalised the link between electricity access and rural productive value chains, allowing efficient management structures	• Finding adequate partners to integrate into value chains is necessary and tough to do • Navigating multi-national setup requires management expertise

Illustrative example of an Integrated Developer business case

Table 4 illustrates an example of the business case for the ID model. This is based on data obtained from an off-grid energy company that is building a cooling facility powered by its mini-grid. The cooling generates an additional revenue stream by renting out cold storage space. Small businesses who deal with perishable goods are ready to pay substantially for this service as it generates additional income for them. This higher willingness to pay increases the revenue from 1 kWh from 0.30 USD (from domestic sales) to close to 1 USD (from selling cold storage), and 0.50 USD for the whole plant on average. While a cut of this revenue has to pay for the slightly higher capital expenditure, as well as to local partners to integrate the facility into the local fishing value chain, the overall margin is significantly enhanced.

Table 4: Comparison of Micro Utilities (MU) and Integrated Developer (ID) model for an exemplary 33 kW solar PV mini-grid (data outlined by one private sector interviewee)

	MU: Selling kWhs	ID: Selling kWhs and services
System size	37 kW solar PV and battery storage	37 kW solar PV and battery storage plus cooling facility
CAPEX (including project development cost)	300,000 USD in year 0, plus replacements of battery pack every 5 years (40,000 USD each) and inverters every 7 years (12,000 USD)	320,000 USD (plant plus cooling facility), plus replacements of battery pack every 5 years (40,000 USD each) and inverters every 7 years (12,000 USD)
Exemplary capital structure	100,000 USD debt at 10% p.a., remainder is equity	120,000 USD debt at 10% p.a., remainder is equity
OPEX p.a. (without interest payments)	10,000 USD	12,000 USD
Interest payments year 1	10,000 USD	12,000 USD
OPEX year 1	20,000 USD	24,000 USD
Generation for direct sales p.a.	70 MWh	50 MWh
Tariff charged	0.30 USD/kWh	0.30 USD/kWh
Revenue from direct sales p.a.	21,000 USD	15,000 USD
Generation for services p.a.	-	20 MWh
Revenue from services p.a.	-	20,000 USD
Total revenue p.a.	21,000 USD	35,000 USD
Implications for payback	Total revenue per annum is similar to OPEX, no possibility to recover significant shares of CAPEX	Total revenue per annum is several thousand USD higher than OPEX, CAPEX can be slowly recovered

MESSAGE 2.3

An off-grid energy innovation ecosystem is emerging

The private off-grid energy sector is producing a nascent innovation ecosystem with individual specialisation to drive profitability. While early industry trends tended to produce off-grid companies which wanted to keep all core and supporting tasks in-house, there is an emerging move towards higher specialisation among companies in the off-grid sector. Driven by a need to be profitable, companies are beginning to understand the value of outsourcing supporting tasks to concentrate on their core strength. The emerging ecosystem is characterised by a closely linked web of private sector actors who work together to deliver value for the customers. A group of partners come together to create and bring to market an innovation that will be of value to customers (Adner 2017). An innovation ecosystem thus requires the development of complementary products and services. For example, the value of a smartphone increases exponentially when it can make use of complementary goods and services such as applications, operating systems and mobile networks.

Innovation ecosystem activities are often related in some way to some focal firm, and can be grouped into upstream components or downstream complements of a focal firm's innovation or product. The **components** of an innovation are the pieces necessary for its conception, production and delivery (licensing, system production and logistics)**.** The **complements** are the goods and services that allow the practical use of the innovation; these can be developed separately from the core product, but their good/service provision must be mutually beneficial to both parties. In the off-grid system, an example is a remote monitoring and control software supplied by an IT company for the focal energy provider to better operate its business and improve aftersales services.

> **"We as a tech company make solar businesses more profitable by digitising their key processes, right from system monitoring to aftersales services. We generate huge cost savings for our clients"**
>
> **Local Technology Entrepreneur**

The ecosystem carries potential, but comes with certain distinct challenges. Sustainable energy access provided via a business ecosystem is likely to face greater coordination challenges than in a case of firms uniting all associated tasks under one roof. With comparably well-developed global supply chains and standardised product designs, components for products such as SHSs and mini-grids can easily be imported. However, local complementors are tougher to replace as they may provide key control technologies, payment systems or customer acquisition. The inherent issues of trust need to be addressed through greater levels of transparency while protecting intellectual property, implying additional legal challenges for companies in an ecosystem.

MESSAGE 2.4

The off-grid energy sector has tremendous opportunities for domestic companies.

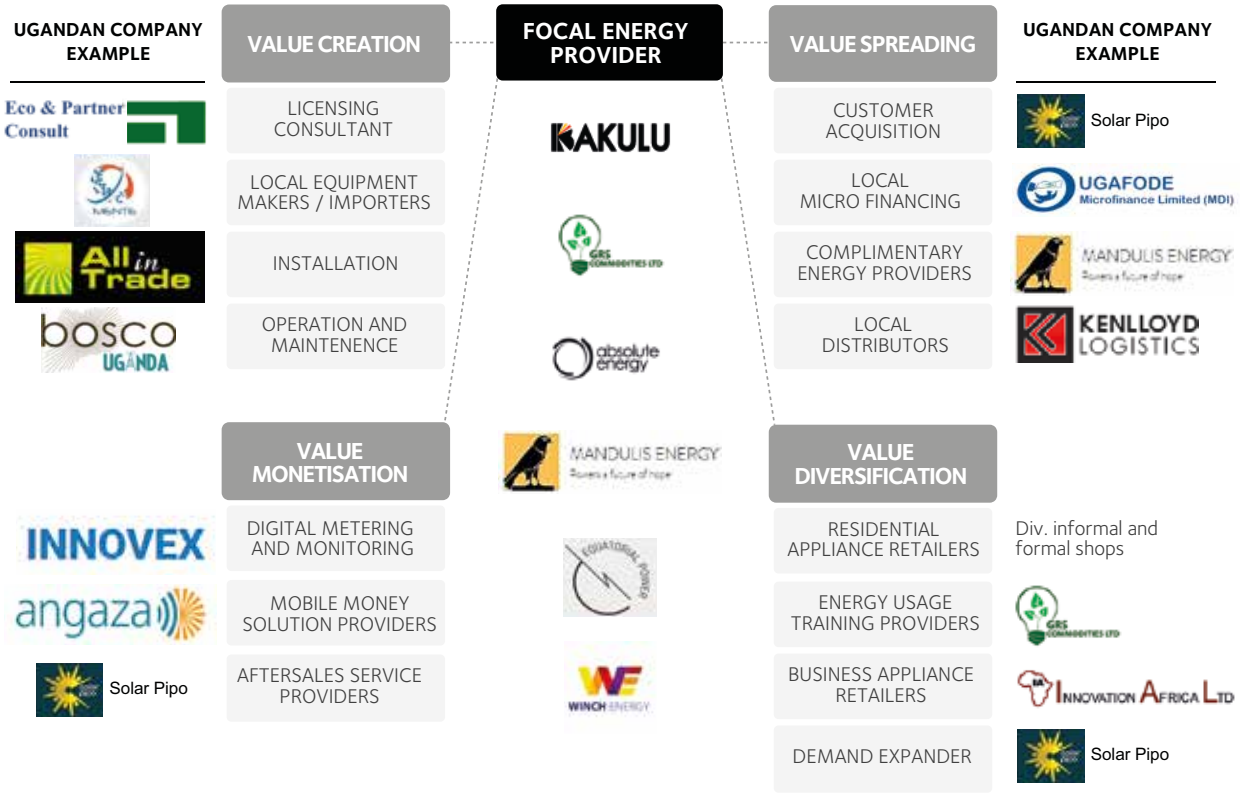
There is a widespread understanding among international energy companies that local expertise is required to maximise value creation. While international companies commonly have advantages in terms of finance, technical skills and research & development, there are numerous skills where local companies are decisively better equipped to add value. These include aspects along the value delivery system where local knowledge of the market, the institutions and regulations and the needs of different types of end-users before and after electrification are required to improve service delivery and ultimately, firm and sector profitability. Rather than offering energy systems, these complementors add both tangible and intangible solutions to off-grid energy products.

Domestic companies in Uganda are already exploiting opportunities along the off-grid energy value chain. Despite limited public sector support, especially in Uganda, the off-grid electrification start-up scene is burgeoning, producing complementary products and services and allowing for business to business collaborations to enhance value offerings. For example, SHS providers partner with small-scale IT providers to establish a digital platform for their systems which unites mobile payment, remote monitoring and system performance forecasting for better long-term service provision. SHS providers also explore cooperations with micro-credit institutes who possess more local currency capital and can give loans directly to end-customers. Partnerships with local community organisations, sales agents and training providers have given mini-grid developers the local context understanding necessary and visibility necessary to allow them to diversify away from mere basic service provision to productive uses of electricity. Local companies supply appliances for households as well as for small businesses (e.g. refrigeration, irrigation, ice-making plants, and milling machines) through leasing models to overcome the upfront investment burden. In another example, to increase their customer base, mini-grid developers in Uganda have partnered with a local entrepreneur who collects rural energy demand profiles and sells the most promising to developers, bringing down their per-customer acquisition cost by 50-70%. Figure 3 shows an example of value complementors in the nascent Ugandan ecosystem. It illustrates that complements in the off-grid ecosystem play a crucial role in value diversification, value monetisation, value creation and value monetisation.

"We as a local company are able to monetise our close links to the communities. We collect demand data and help energy providers target the right end-users"

Local Off-grid Energy Sector Entrepreneur

Figure 3: The emerging Ugandan off-grid ecosystem with opportunities for local companies



There is immense untapped potential for domestic companies to add value in the off-grid energy ecosystem. It is important to note that the off-grid ecosystem is emerging, and far from complete. The Ugandan case shows the potential for countries like Zambia where these structures do not yet exist as strongly. Several Ugandan companies have entered the off-grid sector at the margins of the ecosystem, and have managed in only a few years to ascent to more recognised players with a strong and growing portfolio. These success stories, however, do usually not happen unaided, but play out in a context of policy and regulations. As the following message 2.5 argues, several challenges need to be overcome in order to create an environment where local innovation and acceleration of business opportunities can thrive.

MESSAGE 2.5

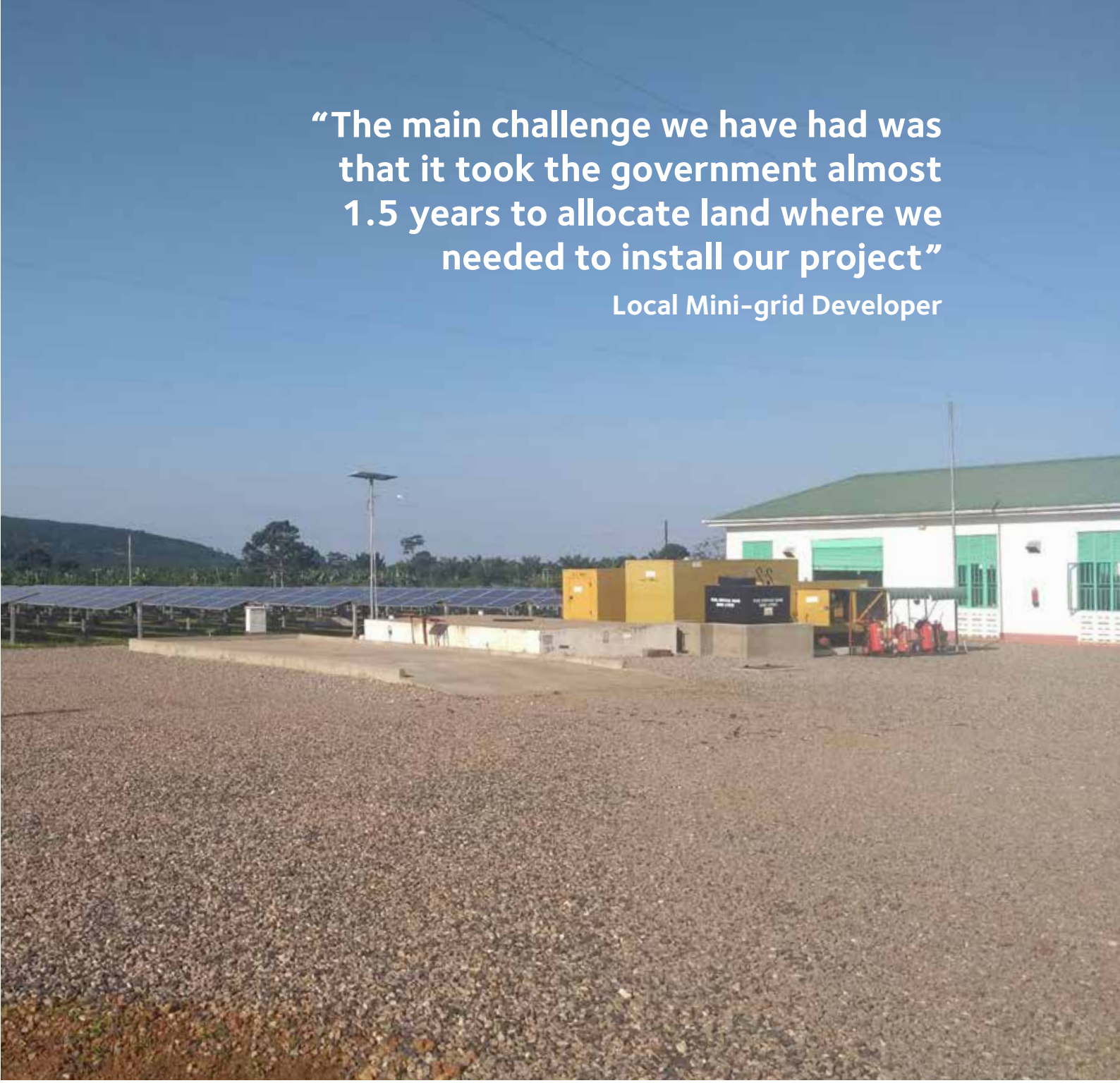
Off-grid companies demand an adequate environment for innovation

Both Uganda and Zambia intend to let the private sector lead off-grid energy deployments. Similarly to most countries in sub-Saharan Africa, yet unlike some countries like Ghana, Uganda and Zambia both aim to attract private sector investment into their off-grid energy markets. Given the limited progress the national grid coverage has made in either country, there is thus an implicit reliance on the private sector to play a significant role in providing electricity access to some of the most underserved areas and communities in both countries. Recent developments such as commercial off-grid sector tenders in Uganda and the current overhaul of off-grid energy sector regulations in both countries (see section 3) show a continued interest of both countries to increase private sector involvement in energy access programmes.

To meet Uganda's and Zambia's goals, the off-grid market requires innovation. This section has discussed the type of business model innovations companies are adapting at length. In part, these innovations can be viewed as a necessary response to the restrictive policy environment in Uganda and Zambia. Whereas mini-grid companies in Nigeria can charge whichever tariff they negotiate with the target community, a strict focus on affordable energy tariffs in Uganda and Zambia forces businesses to develop creative solutions to generate additional revenue streams to recover costs.

The regulatory environment is has a crucial influence on the business perspectives of off-grid developers and is viewed as a burden for companies in Uganda. Nearly all companies we have interviewed have said that major policy and regulatory barriers for innovation exist in Uganda. For instance, while Uganda's Electricity Regulatory Authority (ERA) intended the license exemption process to be considerably shorter and easier than obtaining a full license, all developers we have interviewed which have gone through the process have said that they believed the effort required to obtain a license exemption is between 95% to 100% of that of a full generation licence. Most developers needed over one year to obtain the license exemption for a single site. For small companies, the associated project development cost can increase during this idle time to a point where it is not sustainable in the long term. Another example concerns the fact that ERA currently prohibits energy providers from generating revenue from any business other than electricity sales for fear that domestic electricity tariffs may be increased to fund these other activities. The integrated development model described above means that, on the contrary, these companies use revenue streams from non-energy sales to cross-subsidise household demand, which meets ERA's objective to decrease household off-grid electricity prices for end-users. While these challenges have not been reported in Zambia, inconsistencies during the licensing and permission process as well as the limited digitalisation of the processes are challenges for developers in Zambia.

Policy needs to promote business model innovation – not hinder it. Especially the Ugandan case indicates that economically restrictive, socially-oriented policy regimes combined with a policy paradigm open towards private sector development can help spur private sector-led innovation. A number of different companies are re-imagining their revenue model, their value proposition to customer as well as their value networks. However, it is crucial that the Ugandan and Zambian government create conducive conditions for innovation to take place given the fact that they both require them if off-grid is to become a success at scale in both countries. Three key barriers need to be overcome: First, domestic companies underinvest in innovation due to a lack of risk-sharing and R&D capacity support. Additional start-up support to seed-/early-stage domestic companies in the ecosystem, especially for R&D, and adequate tax exemptions would help foster local innovation. Second, there are no dedicated entrepreneurship support programmes for local



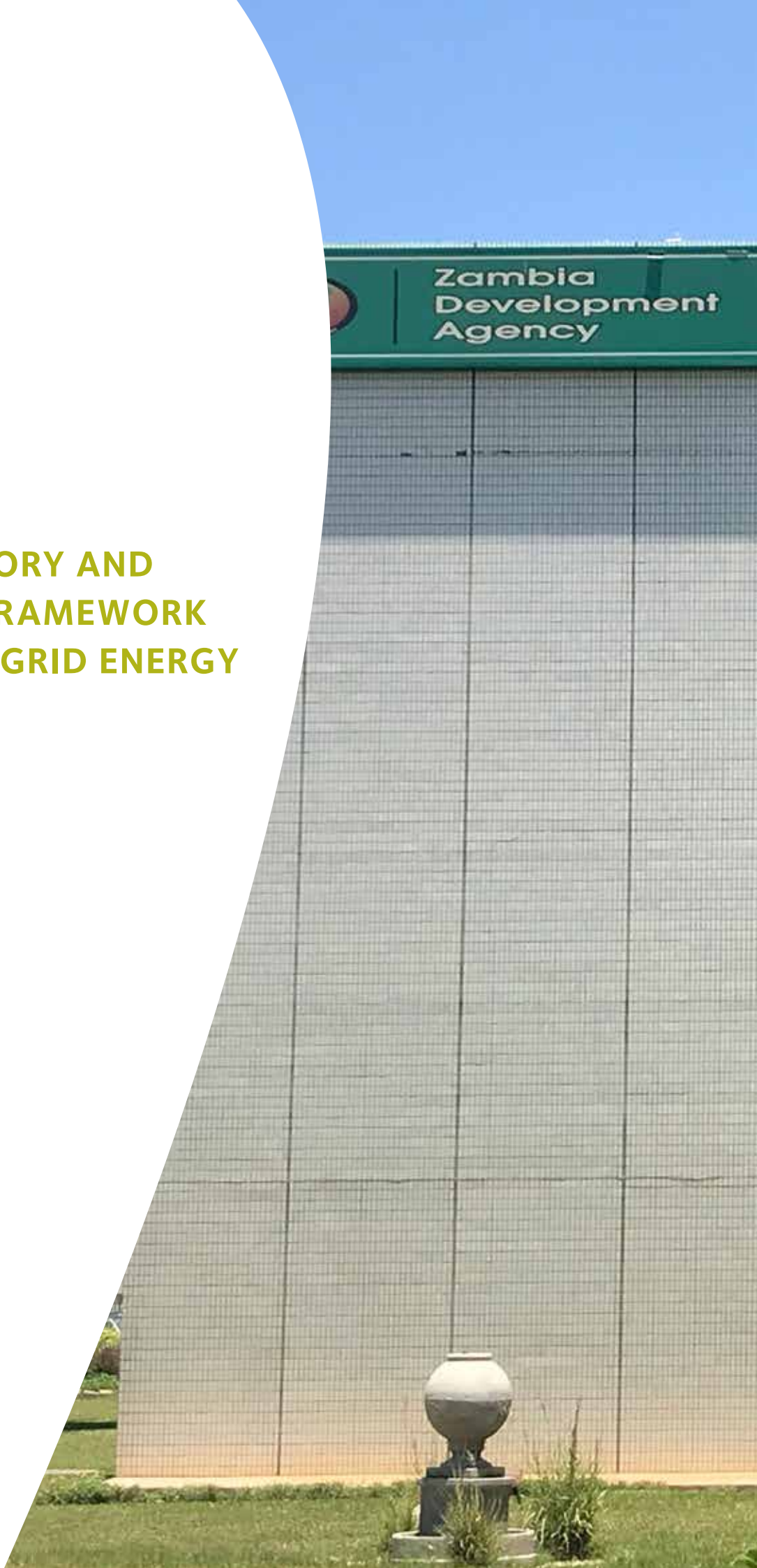
"The main challenge we have had was that it took the government almost 1.5 years to allocate land where we needed to install our project"

Local Mini-grid Developer

Ugandan and Zambian energy companies. Access to finance, office space and business incubation skills and trainings need to be made available to allow for a successful start-up scene to emerge. Thirdly, local content requirements are all but absent in both countries. Especially within support services, such requirements could help to build specific expertise along the value chain. Splitting the many tasks of off-grid electrification among partners with key skills and means for each specific task has significant potential to improve the entire sector's profitability, for both local and international companies involved. Fourthly, high project development costs take a significantly higher toll on small companies than on large ones. Simpler regulations and licensing processes (the Nigerian model may serve as a guide in some of these aspects) reduce idle time for developers and bring down those costs, which can be up to 30% of total project development cost. Several developers mentioned that it would be helpful to both them and the regulator to provide detailed templates with each required information specified for them to fill out. This would dramatically limit the time the developer spends to complete the application, and the regulator could review applications much quicker as well. Finally, the Ugandan and Zambian government need to encourage local-currency financing for off-grid companies to share the risk more efficiently.

3

REGULATORY AND POLICY FRAMEWORK FOR OFF-GRID ENERGY

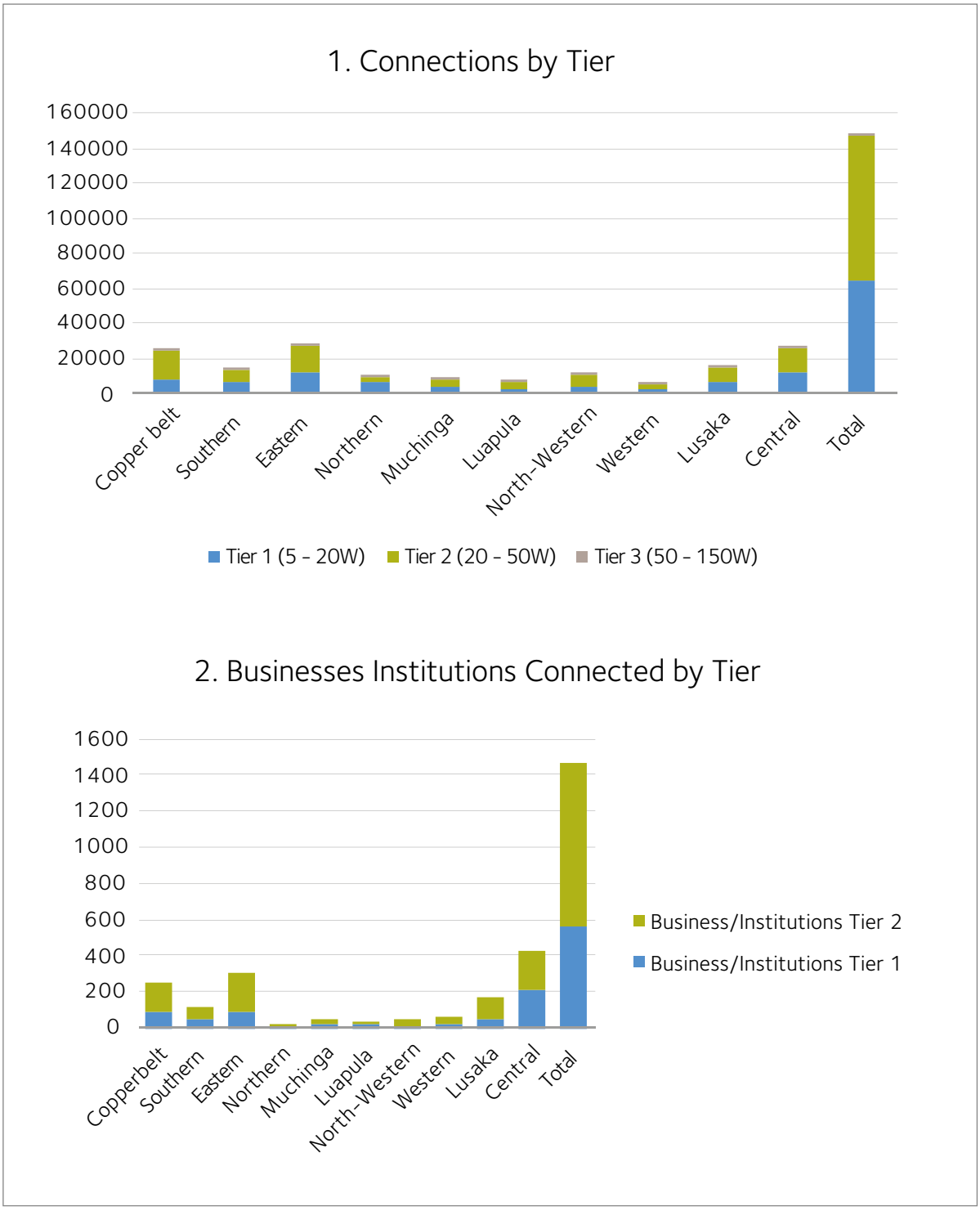


MESSAGE 3.1

On-grid and off-grid energy access strategies need to be aligned and coherent with national energy policies and feature effective progress monitoring and evaluation

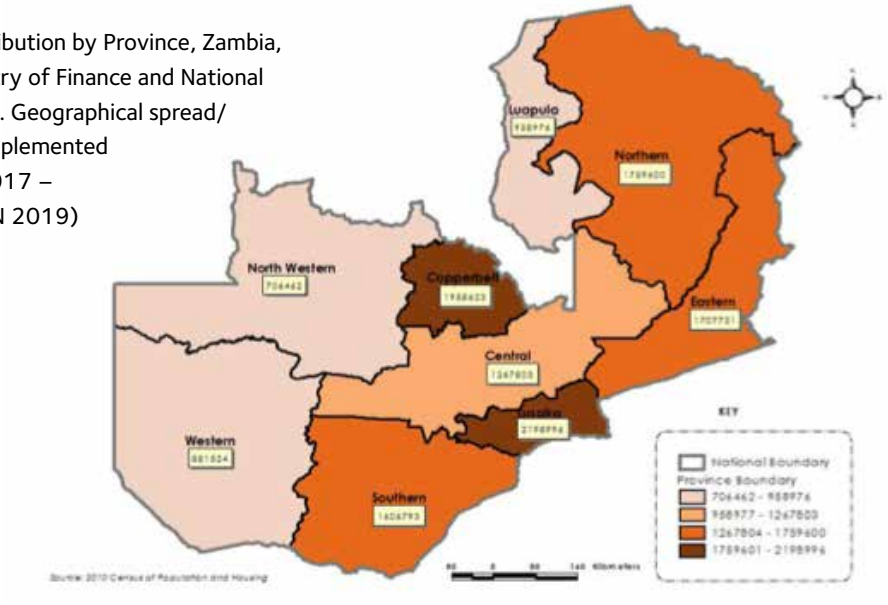
Both Uganda and Zambia have set ambitious targets about energy planning and increasing energy access in their national development strategies. Zambia aims to increase the rural electrification rate from around 4% in 2014 to 51% by 2030 (Rural Electrification Authority Zambia 2019). Uganda plans to achieve 60% (Electricity Regulatory Authority (ERA) 2018) electrification by 2027 and universal energy access to energy of which 80% is provided through grid connections by 2040 (Government of Uganda 2016). In Zambia, the electrification policy-making processes to achieve these targets are highly dynamic and have experienced a two-fold strategic shift. The first is a general strategic move from considering grid-expansion and mini hydro-power stations implemented by the Rural Electrification Authority Zambia (REA), financed through the Rural Electrification Fund (REF) and based on the Rural Electrification Masterplan (REMP) of 2008 (Japan International Cooperation Agency (JICA) 2008) as the main drivers for rural electrification towards decentralised solutions including solar PV mini-grids and SHSs. Secondly, this process was significantly pushed by foreign donor organisations as the Zambian government has ceded some control over rural electrification planning, and project procurement to international donor organisations (SIDA 2015) which cooperate closely with the private sector. These strategic shifts had significant positive as well as critical impacts on the current landscape of off-grid electrification in Zambia. The most notable recent off-grid electrification programme with this regard is the 'Beyond the Grid Fund for Zambia' (BGFZ) supported by Power Africa, the Swedish International Development Agency (SIDA) and Renewable Energy and Energy Efficiency Partnership (REEEP). Through the EUR 20 million results-based "social impact procurement" fund (REEEP 2019), the BGFZ has established around 148,000 off-grid connections so far, mainly through SHS with connection sizes between 5 to 50W (Tier 1 & 2) in rural Zambia as Figure 4 illustrates. It also reveals that despite the significant overall number of connections that have been implemented, the number of institutional and business customers which indicates productive use of energy is minimal and lies only between 0.86% for Tier 1 and 1.09% for Tier 2. This low proportion might be the result of the type of solution (often SHS) mainly offered through the programme as they might not be suitable or affordable for slightly larger consumers. It strongly indicates that alternative, strategic planning approaches, and programmes are needed that are more suitable for productive users of energy in Zambia. Close cooperation between the government, mainly through the Department of Energy, private sector companies, local level representatives, and donors could provide an opportunity to develop innovative strategic programmes that are specifically focused on supporting the productive use of energy.

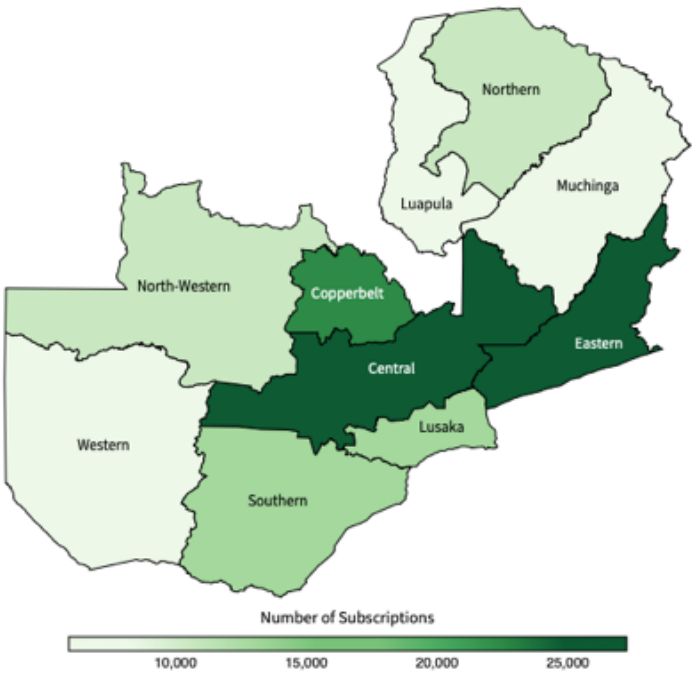
Figure 4: Number of overall connections via mini-grids and solar-home systems by Tier implemented through the Beyond the Grid Fund for Zambia (BGFZ) in the 10 Zambian provinces between 2017 – 2019 (EDISON 2019)



The structure of the BGFZ programme has not only driven specific patterns of energy usage, but also regional distribution. The procurement and implementation of donor-driven electrification programmes like the BGFZ are usually not based on strategic planning processes on a national level. The REMP for example identified 1,217 Regional Growth Centres that were clustered in 180 project packages, almost evenly distributed across all Zambian provinces. Donor driven private sector procurement programmes typically leave it to the private sector company to select the area of operation or a specific project site, a decision that is usually driven by logistical and economic considerations. Figure 5 compares the geographical spread of BGFZ subscriptions with the population density in Zambia. It illustrates that certain areas might be detached from electrification processes due to their geographic location which can create tensions and uneven development.

Figure 5: Population Distribution by Province, Zambia, 2010 (orange map, Ministry of Finance and National Planning Zambia 2011) vs. Geographical spread/ Number of connections implemented through BGFZ between 2017 – 2019 (green map, EDISON 2019)





“If donors find the government without a policy or guidelines, they will really experiment on you”

Government Official

The current dynamics of off-grid electrification processes in Zambia illustrate that the ‘outsourcing’ of these processes to the private sector and driven by donor programmes can achieve substantial progress in the market but also create specific gaps. These gaps could be filled by incentivised strategic government programmes to foster productive use, or target areas which have been underserved by the private sector. It also illustrates that successful off-grid electrification requires a combination of aligned strategic approaches which identify targets, strategies and mandates through an inclusive process.

In Uganda, on-grid solutions are still being prioritised by the government over off-grid solutions, even when the latter would provide a similar level of service at a lesser cost. While the Ugandan government has made efforts to develop an ‘Off-Grid Electrification Master Plan’, it has not been made available to the public, which makes it difficult for non-government actors to plan accordingly. This is especially problematic as off-grid systems development has primarily been left to the private sector and donors. Thus, the strategies and plans currently being implemented by the Ugandan government will be insufficient to meet short and long-term objectives. Greater coherence of programmes and initiatives to enhance energy access in Zambia and Uganda are desirable. This includes a publicly available, strategic plan that combines grid-expansion, SHS and mini-grids (with clearly defined risk management protocols in response to for example grid expansion into off-grid areas), and which clearly defines the roles and mandates of the various actors (government, donors, private sector). Also to be addressed are inequalities between energy tariffs in urban vs rural areas (SDG 7 “affordability of energy”), and the private sector’s focus on economically attractive sites, which however leads to the likelihood of excluding the last mile (SDG 7 “no one left behind”).

There is a need for greater coherence and better integration of on- and off-grid planning in national energy strategies. In Zambia, the 2008 Rural Electrification Master Plan (REMP) offers detailed strategic and policy recommendations for achieving the energy access targets. While it acknowledges the role of SHS in complementing grid-expansion projects, it does not mention solar mini-grids. Moreover, in practical terms, implementation of the REMP has been stalled due to a lack of funds and changes in project planning objectives (owing in part to political considerations). In Uganda, the primary implementing agency for electrification programmes is a Rural Electrification Agency (REA), which deploys funding through the Rural Electrification Fund (REF). The Rural Electrification Strategy and Plan 2013-2022 (RESP) provides the national planning and financing framework for rural electrification. This is based on a multi-technology on- and off-grid concession model. However, the absence of comprehensive Rural Electrification Master Plans to determine how to execute the RESP in each of the thirteen geographically zoned territories has made the agency vulnerable to pressure from donors and private operators who push for unsolicited bids to build mini-grids in areas of their choice, on their terms, since they are mostly financed with grants of private capital. In addition, the agency’s capacity to conduct detailed feasible technical plans is inadequate.

Poorly defined mandates and roles, and an absence of implementation plans hinders the effective execution of national energy strategies. In both countries are gaps of explicit coordination between stakeholders and with regard to the definition of their mandates. As a consequence, policy-processes between the energy sector and other related sectors such as infrastructure or agriculture, are often not harmonized. Central initiatives are sometimes conducted in an ad-hoc manner based on political rather than strategic considerations. It is advisable to strengthen the coordination of these processes at the central level and align planning, implementation and policy-instruments. This process should include a work

plan and the comprehensive review of existing documents including legislation, donor programmes, current review processes and actors involved. Such an approach would streamline the many uncoordinated on-going reform processes, often pushed by foreign donors, and mitigate future gaps. In Zambia for example, the bill to revise the Energy Act is to be tabled in Parliament, but an energy sector review is underway at the same time which is comprised of reform processes by internal and external stakeholders. It might be unlikely that the outcomes of these reviews will be incorporated into the already drafted Act, so a new draft and tabling process might be required. In Uganda, the draft off-grid regulations have been developed ahead of the on-going review of the Energy Policy yet to be completed, while the overarching Electricity Amendment Bill does not incorporate all the proposals referenced in the draft off-grid regulations. These examples highlight the importance of the Ministry of Energy having a stronger lead in setting a timeline, coordinating and defining mandates of various stakeholders to avoid costly misalignment of activities.

More effective monitoring and evaluation is needed to guide and monitor progress against national and local energy strategies. Effective monitoring and evaluation of the implementation of the Ugandan and Zambian energy strategies are hindered in both countries by three interrelated weaknesses. First, there is no coherent definition of what affordable energy access means within the various policies and programmes. For example, there is uncertainty whether small SHS can be considered 'affordable energy' when they tend to supply a limited amount of electricity at a higher price per kWh. A case in point is a recent report by Power Africa which counts people who purchased a solar lantern as 'electrified' (Trotter 2019).

Second, limitations in government resources restrain the Ministry of Energy and governmental agencies to perform adequate monitoring processes for planned, on-going or implemented energy projects. This limits effective controlling, the overhaul of unsustainable off-grid projects and the generation of essential learning lessons, especially in Zambia where solar mini-grids are still a relatively nascent technology. The accessibility of data from the BGFZ which is a unique tool shows the importance of monitoring and evaluating off-grid electrification programmes on macro-level to derive essential learning lessons for future strategic adaptations and which should be mirrored by the evaluation of on-site projects by the Departments of Energy.

Third, reliable data on energy access is lacking, and there are inconsistencies in national targets, especially in rural areas. According to the World Bank, Zambia's energy access rate in rural areas rose from 4% in 2014 to almost 14% in 2017(The World Bank 2019), however this increase can only partially be explained by grid extension projects and the 2016 introduction of decentralized RE systems through BGFZ and government officials denied the accuracy of such data. REA currently estimates the electrification rate with under 5% in rural Zambia. In Uganda, the reported energy access rate according to the World Bank in rural areas rose from 12% in 2014 to almost 18% in 2016, then dropped to 11% in 2017. These findings raise questions about potential data inconsistencies. Moreover, contradictory targets in key strategy documents (Government of Uganda's Vision 2040, SE4All Action Plan and the RESP) lead to a lack of clarity, inconsistent decision making, and a lack of defined roles and responsibilities for stakeholders. This leads to reactive planning and difficulties monitoring and evaluating actual progress towards improvements in electrification rates.

MESSAGE 3.2

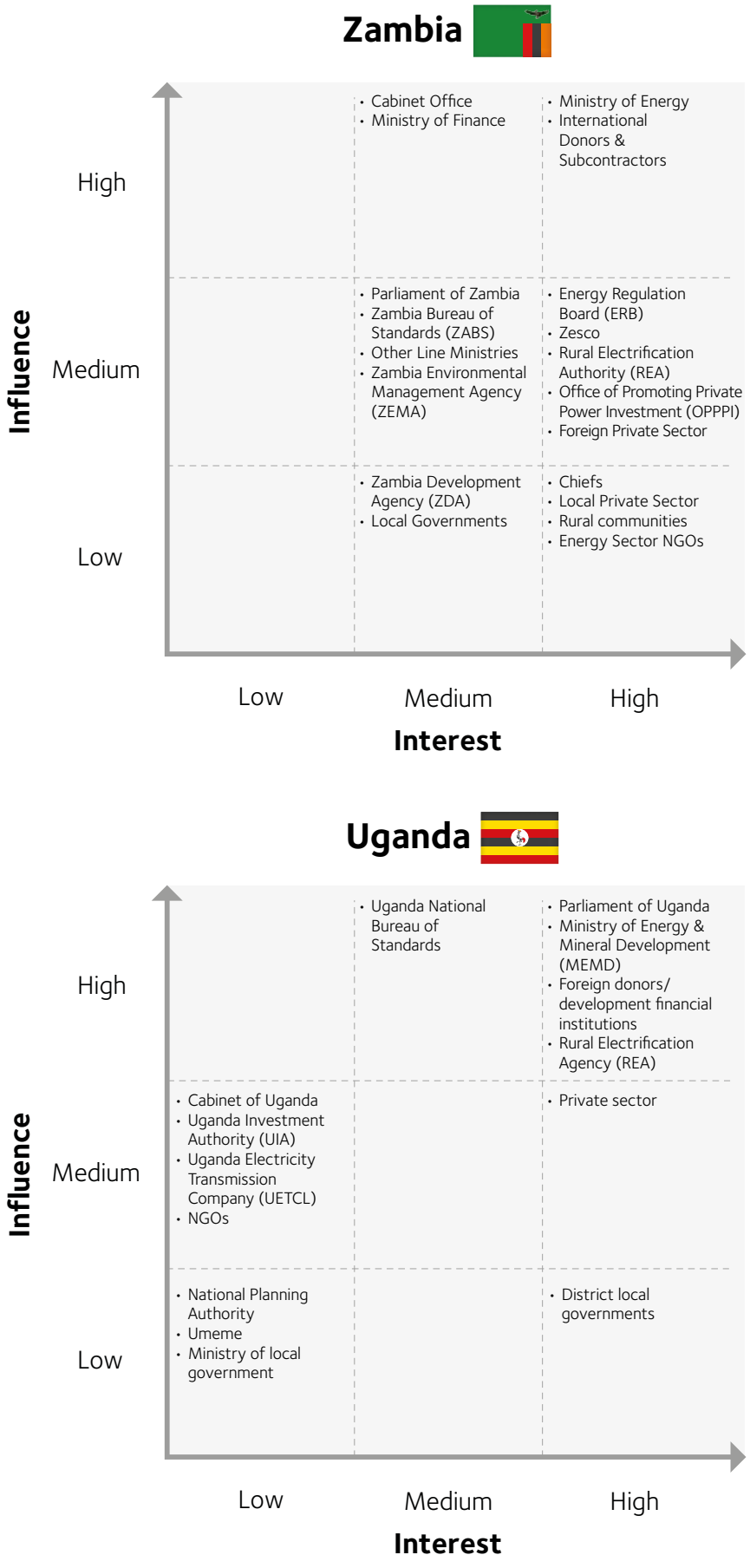
Energy planning and policy could benefit from greater involvement of local-level authorities and communities

Community involvement in energy policy-making is insufficient. The evaluation of energy policy-making and planning revealed that decision-makers aim to consult a range of stakeholders when developing policy such as private sector companies, civil society organisations (CSOs) or various Ministries and State-Owned Entities (SOEs). Figure 6 shows an overview of the perceived influence different energy sector stakeholders have on energy policy-making on national level in Uganda and Zambia. However, there is a general lack of involvement of local representatives in both countries: District level representatives (LC5s, CAOs, and RDCs) in Uganda - who exercise the decentralised political and administrative leadership roles in communities, and traditional leadership groups (House of Chiefs) in Zambia. In Zambia, Chiefs see themselves as responsible drivers for local development in their chiefdoms and are widely consulted in various policy-areas, but not energy (except when it comes to concrete project planning and implementation). Similar issues have been raised in Uganda by a respondent Chairman L5. CSOs in Zambia have responded that, despite them being consulted by the government, they feel their suggestions are not taken into consideration sufficiently and that their involvement make little difference to actual outcomes.

"We as District Leaders are not consulted at all in electrification planning and implementation, yet the people who elected us expect us to provide them with electricity services; why can't the Ministry or REA provide a structure that mimics the role of a District Electricity Engineer in every district, as is the case with the Water Sector?"

Local-level Politician

Figure 6: Stakeholder involvement in national energy policy-making processes in Uganda and Zambia, grouped by potential interest in energy policy/projects versus perceived influence on energy policy and strategic planning on national level as stated by different interview respondents



The limited involvement of local-level stakeholders in national policy-making processes results in over-centralised approaches that do not capture the needs of the consumers and communities who need electricity the most. In Uganda, the Ministry of Energy and the Electricity Agencies involved in electricity planning and project implementation have a highly centralised planning structure that is ineffective and does not provide for a bottom-up approach to electricity planning needs and choices. In contrast, the water sector has district water engineers at every political district, which allows for a local assessment of water needs/plans and programs from communities, and these are reflected in national sector plans for prioritisation and implementation. The energy sector lacks such a system: there is no decentralised structure that provides for the formalisation of inputs from a "district electricity engineer" on rural electrification needs.

On a national level in Zambia, there is a significant data and awareness gap with regard to the specific energy needs, demands and socio-economic challenges of rural communities which concerns representatives from institutions, donor organisations and even some private sector companies. This situation renders most district/ community electricity needs un-attended and energy infrastructure are not designed in accordance with local requirements which negatively impacts the long-term sustainability of these projects. Due to this significant institutional and informational gap, some communities are left without any hope for electricity and at the mercy of a few private project developers for interventions like SHS, and a few scattered solar PV mini-grids. Greater cooperation between local representatives as well as a focus on 'bottom-up' information structures could contribute to the development of strategies and solutions that fit community-needs, enhance the sustainability of energy solutions and empower communities to play a more active role in formulating their needs and reach out to project developers.

In Uganda, there is no clear communication from policymakers on what constitutes private and public investment. There is a need for clarity on this categorisation, as well as what their respective roles are within the electrification agenda. Currently, policy priorities shift in a relatively ad-hoc manner; a long-term plan for the energy sector would provide assurances and decrease investment risk, thus lowering the cost of investment in electrification expansion.

"If I don't play a role in development in my chiefdom, there will be no development in the chiefdom" Chief In Zambia

MESSAGE 3.3

On-grid and off-grid energy access strategies need to be aligned and coherent with national energy policies and feature effective progress monitoring and evaluation

Inefficient regulatory frameworks and slow permit and licensing acquisition processes are holding back off-grid projects. The regulatory frameworks for mini-grid development and operations are frequently re-visited in most countries, due to fast-moving market developments. An overview of the current situation in Uganda and Zambia is provided in Table 5. Licensing processes for mini-grids are highly variable between countries. With EU support, the Energy Regulation Board Zambia has implemented a new regulatory framework for mini-grids in 2019 which offers a 'light-handed' approach for systems below 100 kW. It has to be seen how the framework is applied in practice. Though the process in Zambia is relatively straightforward, there have been issues of lack of consistency in licensing procedures and lack of clarity among developers and issuing authorities concerning license requirements, timelines, entry points and the licensing process. These processes have been under review and Zambia has launched an off-grid electricity portal which provides an overview of licensing and permitting requirements. Applications for licenses and permits, however, must still be made physically at the issuing authorities which increases costs for those developers that are not based in the capital. It has yet to be seen whether a shift towards more transparency and coordination can be observed.

The process in Uganda is much more complex and lengthy; institutional permits take up to a year to secure and require costly feasibility studies. The detailed licensing requirements are as a result of the provisions of the Electricity Act that are mandatory. However, the laws can be amended to provide flexibility. Unclear, time-consuming processes negatively impact off-grid providers' ability to operate and scale; governments should focus on streamlining licensing and regulatory processes, and standardising these between countries.

Table 5: Comparison of regulatory frameworks in Zambia and Uganda

	Zambia	Uganda
Licensing Process	Relatively straightforward overall Some lack of consistency & clarity in licensing processes among developers and issuing authorities with regard to license requirements, timelines, entry points "Analogue" system that requires physical submission of documents	Lengthy and complex Institutional permits take between six months and one year to obtain Require costly feasibility studies Likely high transaction costs
Potential 'grid-encroachment'	Generates uncertainty as on-grid tariffs are not cost reflective (subsidized) while off-grid tariffs are required to be cost-reflective and the legal implications of 'grid arrival' are still debated	Less problematic as off-grid tariffs are almost cost reflective
Regulatory framework for innovative off-grid business models	New regulatory framework with a light handed-approach for <100 kW; suitability of the new framework for innovative tariffs models yet to be tested	The draft off-grid regulation currently under development provides some flexibility for business model innovation, within the existing laws.
Government involvement in off-grid financing	Beginning of government interest shift towards off-grid, but policy lead and financing largely left to donors; No tariff subsidies in off-grid sector	Government policy mainly geared towards grid expansion, but also provides physical and monetary subsidies for off-grid expansion through REA
Trade policy	Improvements on import codes but still limited clarity with regards to some solar components	Prohibitive duties on mini-grid component imports while solar PV equipment is Tax exempt.

There are regulatory uncertainties when the grid reaches an area powered by an off-grid solution. Grid encroachment is an obvious and frequently stated risk for off-grid businesses in Uganda and Zambia. The new mini-grid regulatory framework in Zambia suggests several options for the grid-arrival which currently are at a draft stadium and would be subject to negotiation with the state-owned utility ZESCO. It is debated how legally binding the clauses. This legal uncertainty increases financial and operational risks of mini-grid investments which drives financing costs and can limit the scaling up of off-grid projects. The development of a strategic plan that combines grid-expansion, SHS and MGs, would provide greater legal security to off-grid developers, attract more investment in the off-grid sector and enhance energy access in rural areas.

Trade policies can obstruct off-grid projects. In several African countries, solar components are legally exempt from import taxes. However, inconsistencies within the legal frameworks, for example with regard to certain components of solar products as well as with regard to the application of import regulations are still a serious challenge for importers and project developers in Uganda and Zambia. At the same time, local markets are not established enough or there is no sufficient government support for these infant industries to provide competitive local alternatives. Due to high national interest rates, local banks are often unable to provide mini-grid developers with affordable local currency loans.

Given the challenges of local mini-grid component producers to be cost-competitive, it seems reasonable for governments to reduce import taxes on components and further streamline customs processes, while at the same time supporting local infant manufacturing businesses. An important step for lowering mini-grid production costs would be the leveraging of regional free trade enabling the sourcing of different components for mini-grids from different developing countries. Such a free-trade zone has existed in South Asia since 2004 and is about to come into effect in Africa. However, electrical equipment is one of the main items not or only partly covered by this free-trade agreement. Zambia has taken first steps to review its import policy on renewable energy/solar components which are exempt from import duty. However, developers have complained about inconsistencies with regard to import codes and limited clarity with regards to some assembled products that contain solar components. Such inconsistencies can limit the willingness to invest in the off-grid sector and lead to increased costs for RE companies (Kuungana Advisory Limited 2018). A review process is underway by the Zambian off-grid taskforce, and it has to be seen how fast the changes will be implemented and applied. In terms of finance availability, as soon as mini-grids move beyond pilot-stage, obtaining affordable local currency finance from local development banks would greatly lower the capital costs and risk of investment. Replication of efforts like the Rwandan government's commitment to establish low-interest loans for mini-grid developers is crucial.

There are tensions between current regulations on tariff and subsidy structures and achieving sustainable electrification at scale. In Uganda, the regulatory priority is to stabilise tariffs, but the current allowable tariffs are not high enough to allow traditional mini-grid developers to break even. Subsidies are thus a heavily relied-upon mechanism to foster private sector engagement. By contrast, in Zambia, off-grid tariffs are required to be cost-reflective and although the implementation of RE mini-grids is supported by external donor organisations providing CAPEX funding levels between 50 - 80%, tariffs and operational costs are not subsidised. This is especially critical as off-grid systems are deployed in rural areas with high poverty levels where the affordability of energy is a significant challenge. Hence, leaving the provision of electricity in rural areas purely to private sector companies while the off-grid sector is heavily subsidised is not only ethically questionable but also threatens the long-term sustainability of off-grid systems.

Thus, an off-grid electrification strategy should include innovative tariff models which, for example, can comprise government subsidies to helping consumers and mini-grid developers overcome the prohibitive upfront connection or longer-term operation costs. The government could consider transferring some subsidies earmarked for on-grid expansion (which come from a mix of tax-payer money and concessional loans) over to subsidising off-grid projects. This would decrease the tariffs off-grid operators would have to charge to cover their costs, thus increasing their ability to charge lower tariffs closer (or even equal) to on-grid tariffs (Kuungana Advisory Limited 2018). In Uganda, a regulatory shift towards providing more tariff incentives to private off-grid system developers within the new draft off-grid regulations which offer a positive outlook to the sector can be currently observed.

"Our mandate is to ensure that Off-grid RE projects deliver value to the customers and must be viable to the developer. We thus ensure to balance the interests of the various stakeholders- government, consumers, private developers and operators, yet this is a great challenge"

Government Official Uganda

MESSAGE 3.4

Improved coordination between donors could reduce duplication of efforts, with country governments taking a stronger strategic lead

Donors have increased their focus on off-grid solutions, but do not have a coordinated strategy for off-grid electrification. A lack of coordination of efforts between donor organisations is still prevalent despite many donors acknowledging this issue and their attempts to mitigate it. This is especially problematic in circumstances where governments lack a coherent off-grid electrification strategy. Duplication of donor programmes, missed opportunities for synergy and cooperation in scaling up of efforts are potential consequences, as are the creation of 'white elephants': Projects that have received significant upfront CAPEX funding but are not sustainable in the long-term operation. The risk exists that investors will leave the project once the donor stops funding it, thus rendering it obsolete. Lastly, donors may have a short-term focus, and de-prioritise investment in local capacity-building necessary for the long-term success and scaling of off-grid electrification projects.

Donor projects do not necessarily reflect government priorities concerning site selection and tenders. Although donor involvement in some cases helps unlock finance crucial for budget-constrained countries like Uganda and Zambia, their programme design, and capacity building measures, donor tenders often disadvantage local companies due to their lesser ability to access financing or demonstrate a regional track record. This may result in exclusion of local players from the renewable energy sector. In Uganda for example, there is donor competition to fund REA service territory master plans so as to identify viable project sites that they can pass on to their preferred project developers which creates tension with the local rural electrification agency's competitive award criteria. Heavy-handed donor involvement also limits the ability for a broader range of local stakeholders to have a say in decision-making processes for off-grid electrification.

Ministries of Energy and their affiliated agencies dedicated to rural electrification should take the driver's seat in creating an integrated energy strategy. This strategy should then form the basis for the coordination of tasks and role assignments for various stakeholders, including donors and other ministries. An agenda including a timeline must be set to ensure the correct sequencing of programme, policy, or project implementation steps. This should include the identification of gaps and capacity building as first priorities, followed by the identification of policy goals, and only then implementation of pilot projects.

"Different donor perceptions should be explored as they are currently not well coordinated or coherent with regard to electrification strategies. This leads to frustration among local partners who might think that donors only perceive their own interest."

International Donor Representative

MESSAGE 3.5

Productive use of electricity would be encouraged through adequate regulatory frameworks and incentives

The promotion of off-grid electrification, with a particular emphasis on productive use, should be made a priority in government plans for electrification. The productive use of energy is vital to trigger local rural development and overcome the challenges of the affordability of electricity. Yet in both Uganda and Zambia, electrification is largely governed by energy access per se, rather than the quality and reliability of service provision. The evaluation of the BGFZ data (Figure 4) has shown that the productive use of energy in rural areas is still at an infant stage in Zambia despite the substantial investment through the fund and the acknowledgement of the issue on the national level. The government, in consultation with the private sector and donor organisations, is advised to put a stronger focus on generating framework conditions to foster productive use. This could be done, for example, by incentivising the provision of productive use assets or further reducing import duties for specific productive use appliances with high potential in the country. The ERB may have a role in this process when reviewing tariff models during mini-grid licensing procedures since innovative concepts might shift from charging solely for energy (e.g. per kWh) to more integrated services concepts as explained in section 2. The Government of Uganda has launched a Renewable Energy Fund that will be crucial to the scaling of off-grid, renewable energy solutions. In addition, USAID through the Uganda Off-grid Energy Market Accelerator (UOMA) programme has assisted in mapping out the private sector players and facilitate productive-use solar products in their offering, as well as advocate policy change.

Current governmental policies have little to no special provisions for innovative business models. Off-grid energy businesses are developing novel tariff schemes and revenue models (see section 2.2 for the example of Integrated Developer (ID)). As traditional utility-like approaches are unlikely to be successful at scale, such innovation increases the potential for off-grid company profitability and, crucially, local socio-economic development. Conducive government involvement in promoting the implementing ID approaches has the opportunity to capitalise on the electrification-development nexus in rural areas. Crucially, while regulations are important to provide security for the sector, they need to be lenient enough to allow for novel tariff structures like time of use, standing charges and leasing, and revenue models that go beyond selling only kWhs. This is especially true if governments are not willing to accept mini-grid developers charging cost-reflective tariffs as such business model innovations ultimately aim to make mini-grids profitable while resulting in low household prices. Initiatives such as Public-Private Partnerships (PPPs) and the Integrated Distribution Framework (IDF) could help provide the funds and technical expertise necessary for entering the market, and reduce the associated risks for private developers. The Ugandan government has already launched one such initiative in 2017. In partnership with GIZ, they piloted a bid for private-sector proposals for the electrification of the Lamwo District in the Northern region. The plan involved granting a 10-year concession coupled with subsidies (physical and monetary) to the developers chosen to perform the electrification. They included a productive use of electrical appliances as most sites in scope have the potential for milling run on electricity. More such plans could be implemented, notably under the auspices of REA in Zambia and the Renewable Energy Fund in Uganda, to promote ID businesses and help make them profitable in their first stages of development. Financially supporting innovative local entrepreneurs to grow the off-grid ecosystem with useful additive technology solutions and services is another policy lever governments have to help build specialised expertise in the sector to improve overall profitability and service delivery.

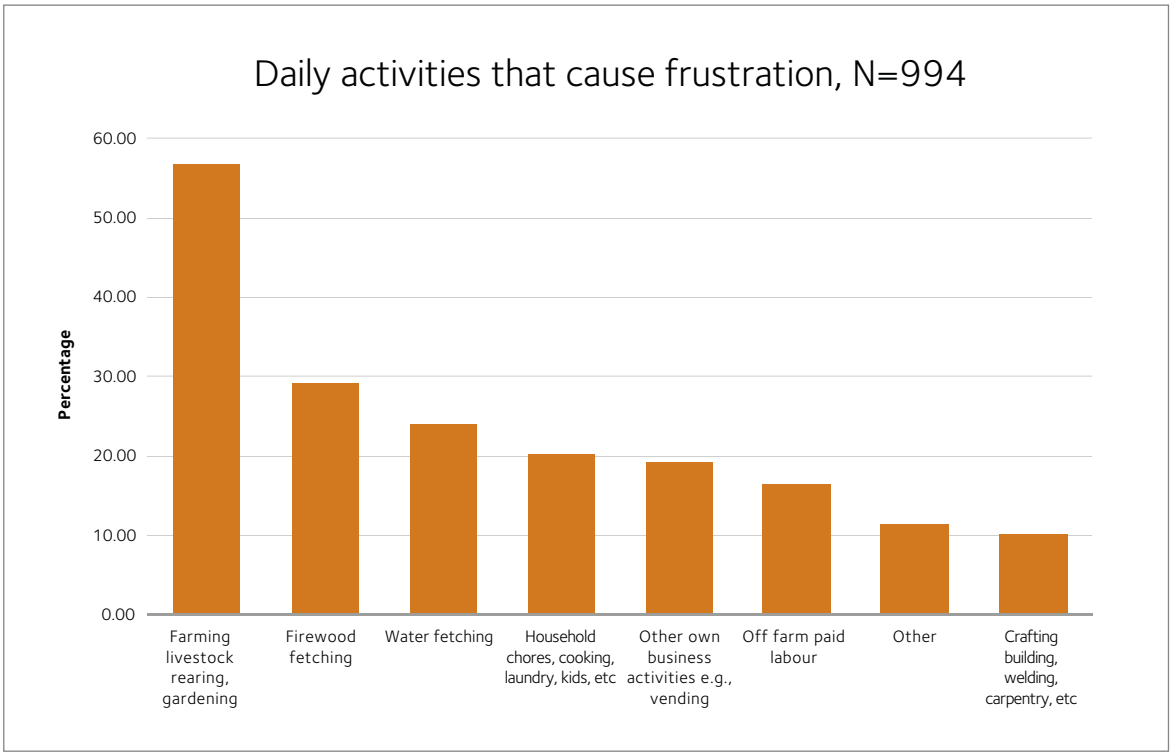
4

THE NEEDS AND ROLE OF COMMUNITIES

MESSAGE 4.1 Energy is key to improving the quality of life in rural Uganda and Zambia, but is not seen as a top-priority purchase

Daily frustrations are caused by activities which could benefit from electrification. Survey respondents indicate that most of their daily tasks such as farming, firewood fetching, water fetching, household chores and personal business activities cause them frustrations (Figure 7). Notably, all of these activities could benefit from affordable and reliable energy access. About 70% of the respondents derive their livelihoods from agricultural activities – which could be profoundly transformed through mechanisation and irrigation. Almost 30% of the respondents have challenges directly related to energy access (firewood collection), while 24% struggle with clean water access. Increased energy access, albeit only if targeted at these specific issues directly, thus appears to have significant potential for quality of life improvements in rural Uganda and Zambia. Over 90% of electrified respondents suggested that electrification has a positive impact on both their personal and communal life. Although over 50% of the respondents identified lack of tools and inputs as well as finance as key causes of frustrations, about 25% linked their frustrations directly to lack of access to modern energy services.

Figure 7: Daily activities in rural areas that cause frustration to respondents in rural Uganda and Zambia (N= 994)

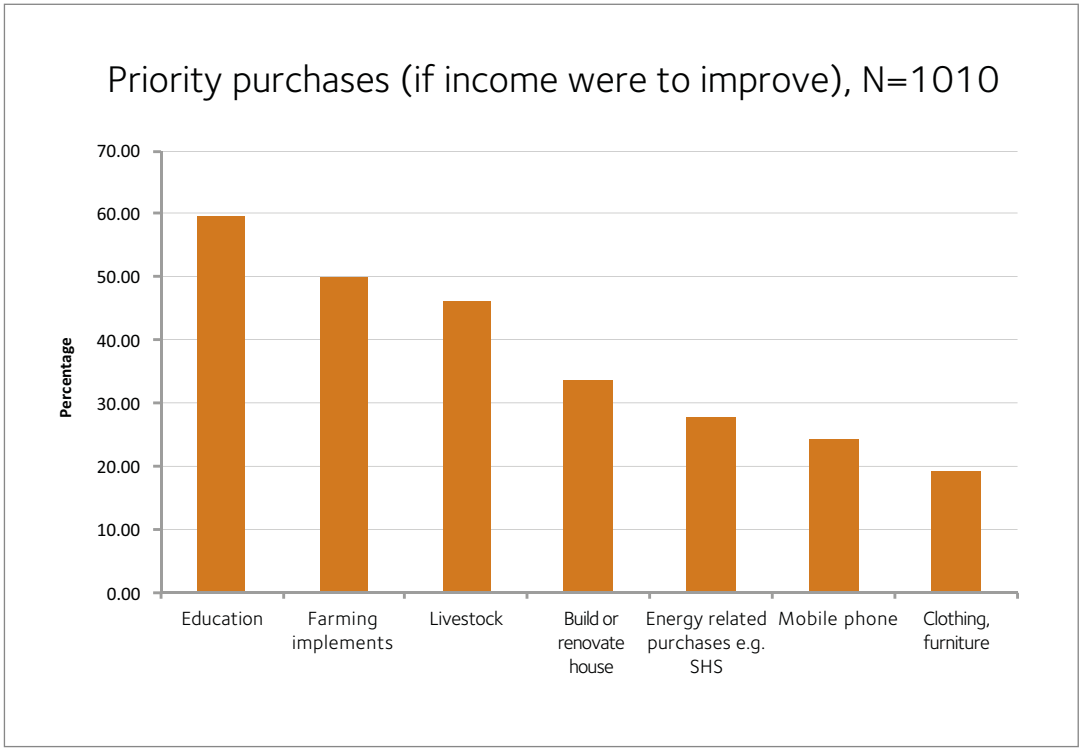


Energy is not a top priority purchase in Uganda and Zambia. If the income of rural households were to improve, they would mainly spend it on education (60% of respondents), farming (50%) and agricultural inputs (45%) and their own home (Figure 8). The existence of these pressing needs implies limited ability to pay for modern energy services, despite the fact that they would improve the quality of life.

However, willingness to pay (WTP) for modern energy services is high, about 86% of the respondents are willing to pay for a new or upgraded electricity connection. This includes 87% of households, 81% of businesses and 93% of community leaders. WTP for electricity defies the income groups – over 90% of the lowest income group (<40 USD per month) are willing to pay compared to 67% of high-income group (> 500 USD per month income). About 84% of the sample population earn less than 125 USD per month, and only about 2% earn above 500 USD per month. There are no distinct differences in WTP by age group, although the younger age groups (about 90% of the 18-30 years age group) are more willing to pay for electricity compared to about 80% for those over 70 years and also the 31-50 years age group.

The desire to have electricity is shown by the higher willingness to pay by unelectrified respondents – 96% of unelectrified willing to pay for electricity, while 76% of electrified willing to pay more (for upgraded) electricity. Interestingly, WTP is inversely related to education level, and the more educated, the less willing to pay – about 65% of college-educated respondents are willing to pay for electricity compared to 96% of those respondents without formal education. This can be compared to WTP by 79% of those with secondary education versus 91% of those with primary education.

Figure 8: Priority purchases for rural dwellers if income were to suddenly improve in rural Uganda and Zambia (N = 1010)

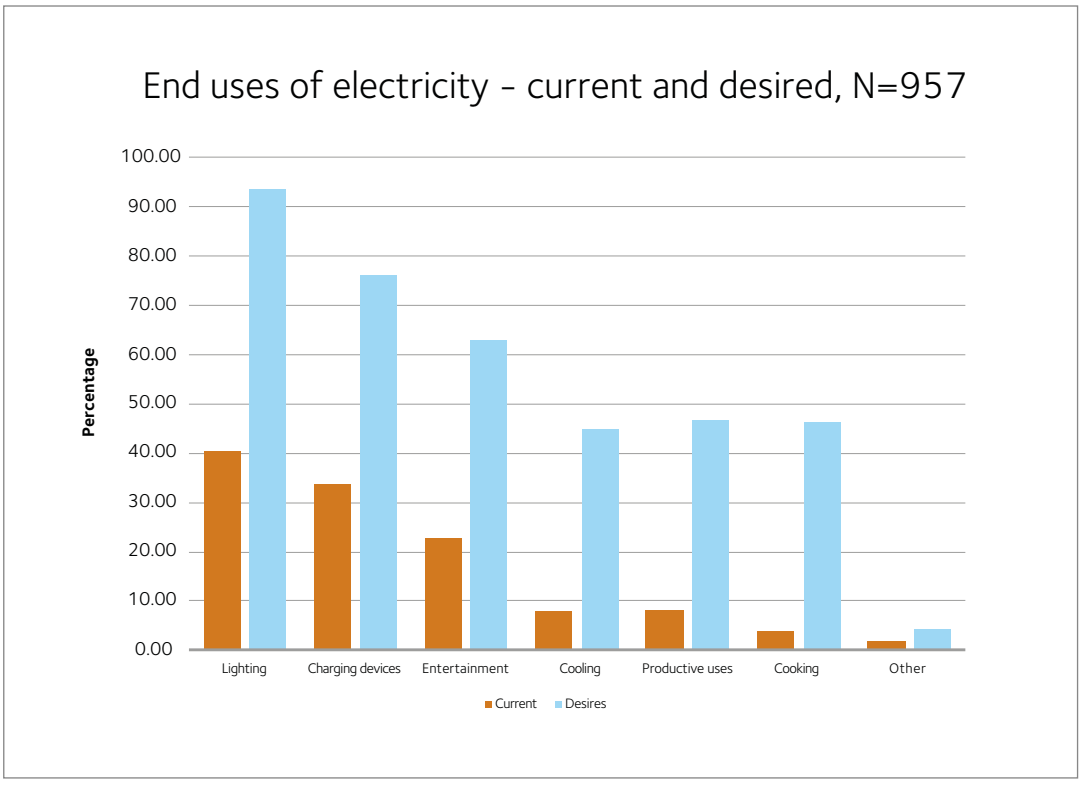


MESSAGE 4.2

There is tremendous unmet demand for electricity-enabled cooling, cooking and productive use, but severe challenges remain to unlock it

The percentage gap between desired and current electricity use is largest for cooling, cooking and productive uses. Not surprisingly, the current main uses of electricity in rural areas are lighting, charging devices, and entertainment. These demands can be served through solar home systems for off-grid systems or lifeline tariffs in the case of on-grid connections. However, there is a substantial and unserved potential for cooling, cooking and productive uses, with a potential that outstrips current usage by over 400 - 500% (Figure 9): Nearly half of all respondents want to use electricity for cooling, cooking and productive uses, while less than 10% actually use electricity for these three services. Notably, 97% of all respondents who provided an answer indicated that they are willing to pay for electricity for productive uses and this true for across the different sectors.

Figure 9: Current and desired end uses of electricity in rural Uganda and Zambia (N = 957)

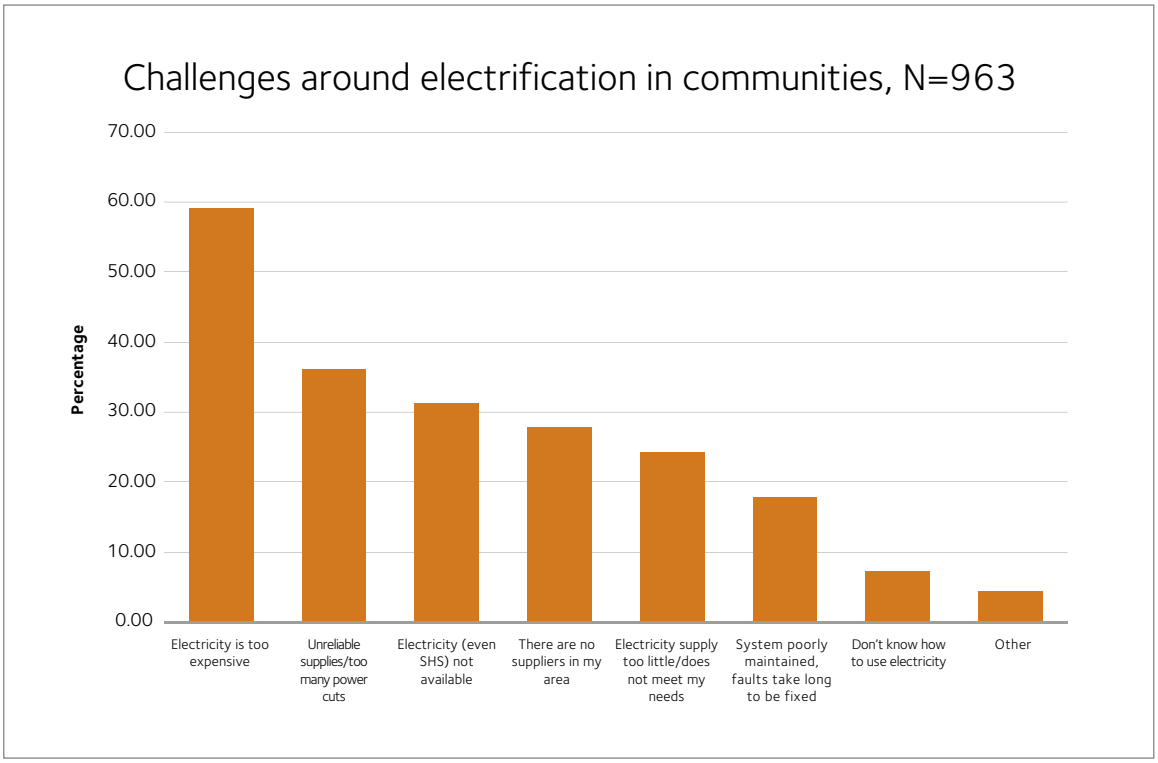


"My business operations have improved, preservation of fish is now easy with availability of ice. Other businesses in the area have been boosted, we now have many shops selling cool drinks, electrical appliances and other things. Our standards of living have changed for the better. There is now more harmony and bonded friendship even between the rich and poor. We now are at the same level." Fisherman From Kalangala, Uganda After Electrification

Current electricity access is perceived to be too expensive by a majority of households, businesses, and community leaders alike. About 60% of the respondents consider electricity tariffs to be too high. These include 63% of the households, 48% of businesses and 53% of the community leaders. There is no distinct pattern by income group – only the 250-500 USD/month income group does not consider electricity to be costly (31% of this group consider electricity too expensive compared to about 60% for the other income groups). There are slight differences in perception of electricity prices by age group – less than 50% of the youngest age group (<20 years) consider electricity to be expensive, compared to 54% for the 21-30 years group, 60% for the 31-50 years group. The older generation considers electricity tariffs to be high, i.e. 66% of 51-60 years, 78% of 61-70 years and 59% for those above 70 years. Furthermore, while less than 30% of agro-processing businesses consider electricity to be expensive, at least 50% of the other sectors consider electricity tariffs to be too high with the highest being entertainment (where 81% of the businesses indicated high electricity tariffs).. In addition, perceptions vary by level of education – those with no formal education consider electricity to be expensive (68%) compared to 63% (primary education), 58% (college education), and 53% (secondary education).

Community experience a range of challenges with electrification. Aside from the well-known issue of affordability, survey respondents point towards a lack of adequate systems to address their electricity needs (Figure 10). Reported issues include reliability problems, unavailability of access options, and insufficient system size for the end-users needs. Some off-grid customers also face several specific challenges regarding electricity access which range from poor service provision, safety concerns, the security of systems, bureaucracy in connection processes, technical problems with systems and limited awareness of technology and applications. In addition, poor service by the electricity service providers was noted by many respondents. One of the reasons for this might be poor working conditions for utility/SME staff. Some of the maintenance staff are abusive towards customers, and some are unavailable when needed to attend to faults. Community members also allege bad business practice, where service providers deny responsibility to fix faults or maintain systems. Also, some service providers are said to disconnect services without following due process and take time to reconnect consumers after payment is made. In addition, some service providers still collect payments for dysfunctional systems. Some respondents experienced damage to their electrical devices and spoiling as a result of power cuts. Others have abandoned community mini-grid systems due to poor reliability and opted to buy our own solar home system. Several respondents were not happy with the poor performance of solar systems, especially during the rainy season, and some reported problems with batteries.

Figure 10: Challenges around electrification in communities (N = 963) in rural Uganda and Zambia

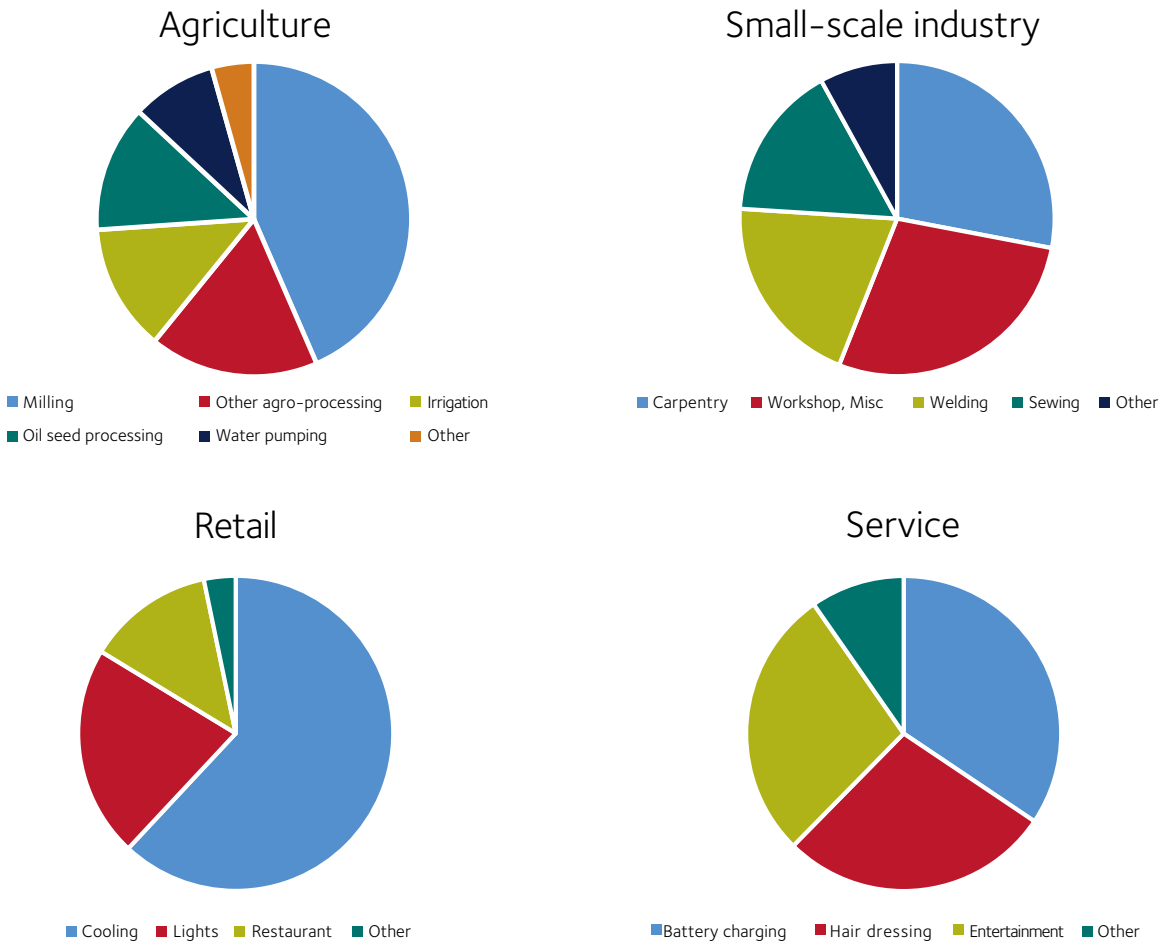


MESSAGE 4.3

Potential for more productive use of energy exist across all income-generating activities

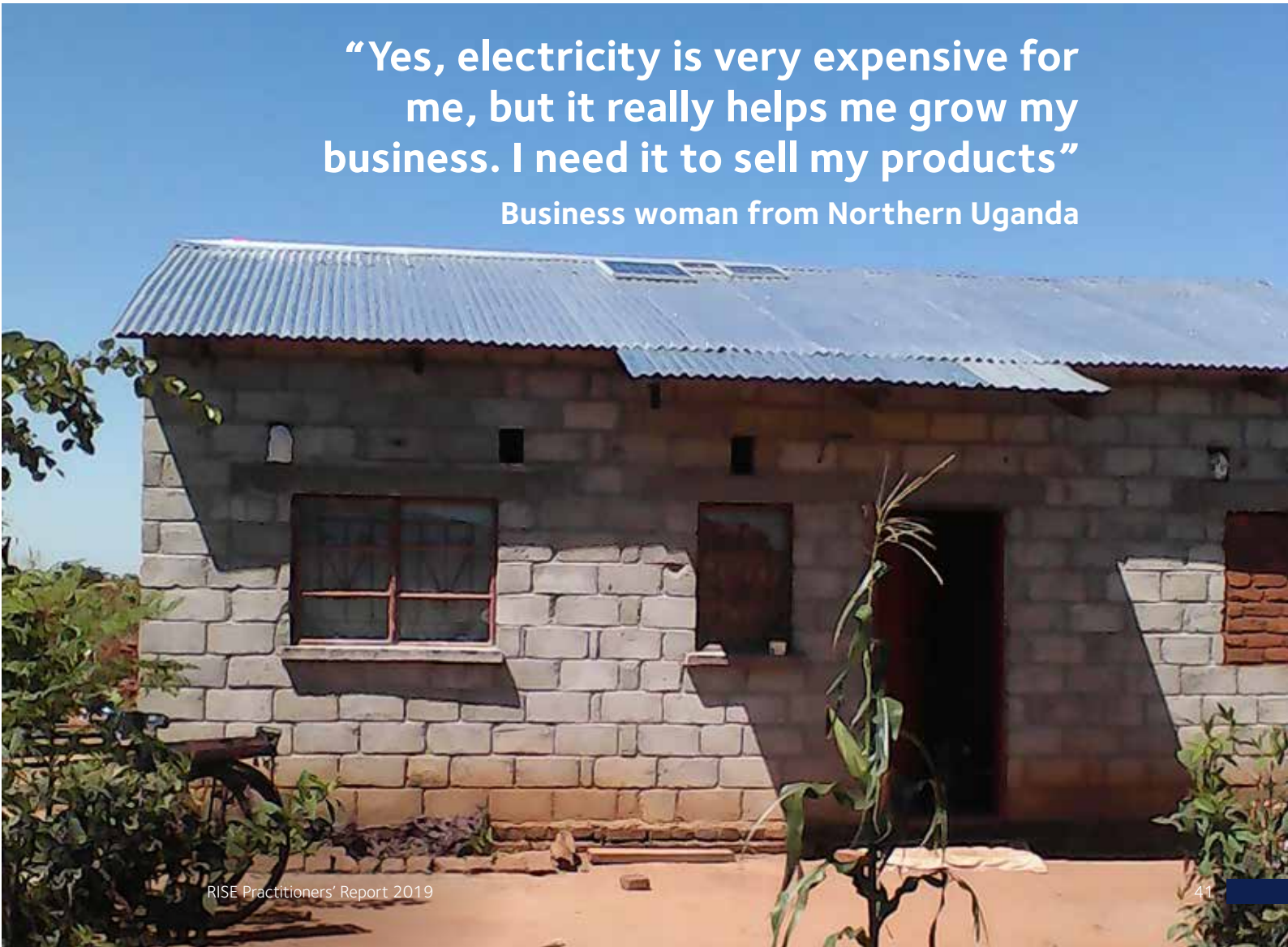
Productive uses of electricity can support a large range of income-generating activities across the agricultural, small-scale industry, retail and services sectors. Roughly 15% of survey respondents indicated that they currently use electricity for some form income-generating activity. The main current productive uses of electricity stated by respondents are cooling, battery charging, hair-dressing, entertainment applications (e.g. a TV or music in a bar) and lighting. Further activities include milling, carpentry, welding, sewing, other agro-processing and irrigation. Figure 11 illustrates the distribution of current productive use of electricity types by economic sectors. There are several 'Other' income-generating activities that could benefit from access to electricity. These include laundry (washing machines and ironing business) and cooking, particularly 'pop-corn making' and baking of various items. In addition, computer-based businesses could also benefit from access to electricity as a number of community members expressed interest in running computer centres, and providing internet café, printing, photocopying as well as secretarial services. Other notable income-generating activities desired by community members include fruit-juice making, landscape maintenance (lawn mowing, etc.), mechanised brick moulding, running pharmacies, and gadget repair shops.

Figure 11: Distribution of current productive use of electricity types by sector



The value-add of 1 kWh can exceed 1 USD for different small businesses. Based on data provided by interview respondents who sell cold drinks which they cool in a fridge and who dry fish in an electric dryer, every kWh of electricity implies an average net income increase of 0.70 – 1 USD for their small business. While they may not be able to scale indefinitely, this shows the income-generation potential of stable and sufficient supply in rural areas. Using data in (Booth et al. 2018), and depending on circumstances, 1 kWh of electricity can add over 1 USD of value, i.e. significantly more than current off-grid tariffs, when used for ice production in fish and fruit supply chains, irrigation of certain crops, or chicken egg incubation. Hence, even if current off-grid tariffs were to increase by 100% in Uganda and Zambia, there would still be a significant margin for many small business owners to run profitable small businesses.

The desired productive uses of energy significantly outstrip the current productive uses of energy. Large untapped potential exists across all sectors, i.e. in agriculture, for small-scale manufacturing, retail and services in rural areas. For example, less than 5% of respondents currently use electricity for agro-businesses but close to 30% desire to do so. There is a strong desire to provide cooling services in communities which are largely living without this service. This trend can be expected to become more salient in the coming years and decades as the impact of climate change will be felt in Uganda and Zambia. Hairdressing, sewing, cooking in restaurants, welding and gadget repairing are other examples where the needs of communities for productive means are significantly higher than what the market currently offers. Many of the preferred income-generating activities are suited to the rural community market, requiring low to medium initial capital inputs and limited technical skills.



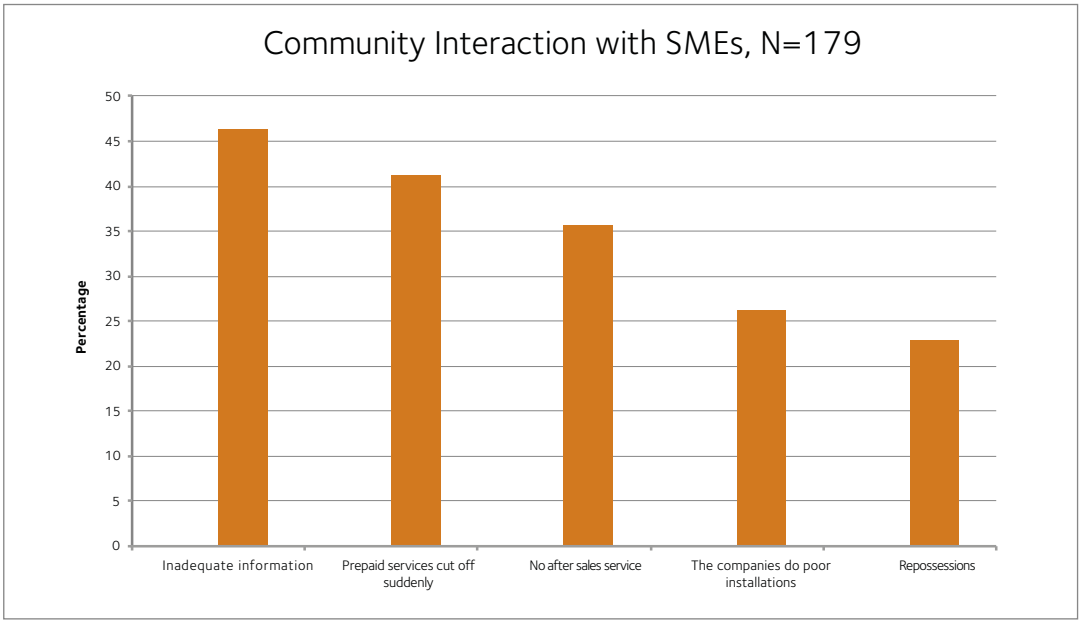
MESSAGE 4.4

Despite various information channels that exist, end-users are not yet well-informed enough about their energy choices

A lack of information and knowledge is the key issue of community interaction with energy providers. And this can be attributed to the inadequate outreach and visibility by service providers and key energy institutions. About half of the community members are not aware of energy service providers operating in their localities and of those aware about 70% have actually interacted with the service providers. There is however, higher awareness in Uganda (over 70%) compared to Zambia (less than 40%), and this also varies by region - in Southern Zambia awareness drops to almost 10%. This follows the electrification levels within the sampled population. Electrified communities are more aware of different energy businesses (74%) compared to unelectrified (35%) There is no distinct difference in awareness by age groups, although as could be expected the highest awareness (57%) is within the 31-40 years age group and lowest in the over 60 year age group (38%). There is also generally higher awareness among men (60%) than women (47%) showing gender disparities in access to information. However, marginally more women have interacted with energy businesses than men. As expected, there is higher awareness among the college-educated community members (76%) compared to uneducated (34%). In addition, the more affluent community members have better information access (64%) compared to other lower-income categories (~50%). Local entrepreneurs are generally more aware of service providers in their communities (60%) than households, and surprisingly community leaders are the least aware (at 37%). However, among those that are aware, more community leaders have actually interacted with firms (85%) compared to households (67%).

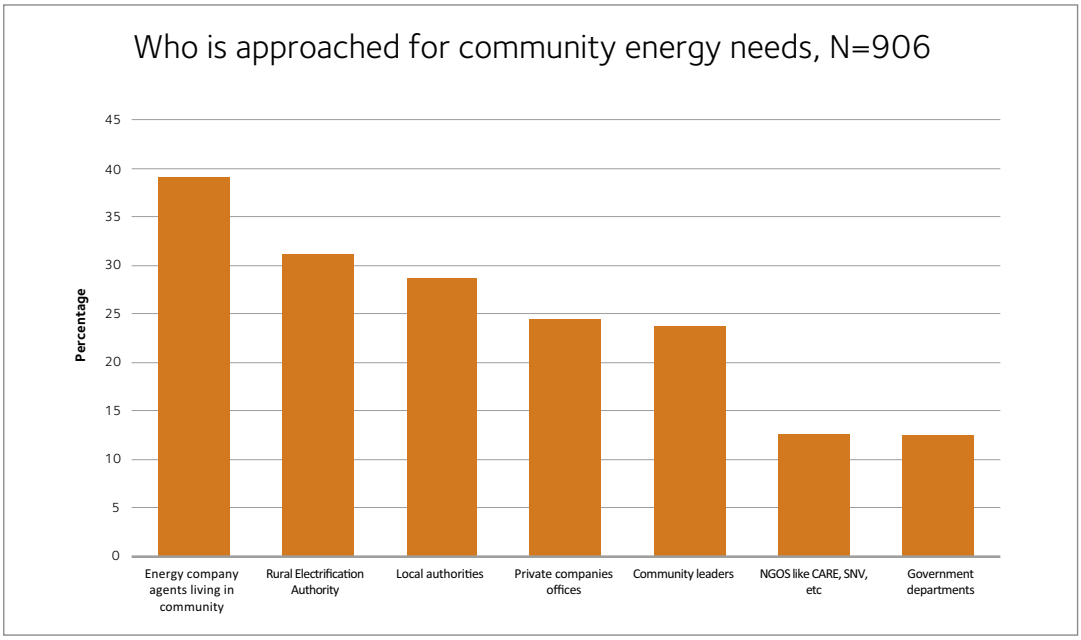
Community members face numerous challenges when interacting with energy businesses. Only 43% are satisfied with the energy services provided, and the same percentage of respondents have experienced problems with electrification businesses. The top-three challenges faced include inadequate provision of information, abrupt cutting off of prepaid services, and lack of after-sales services - all feature a gap of knowledge and understanding of the associated business model at their core (Figure 12). This highlights the importance of relationship building and communication between any new potential energy provider and the target community. Service satisfaction levels vary widely by region, from a low of 20% in Western Uganda to a high of about 70% in Southern Zambia and Central Uganda. Satisfaction appears to be directly related to education levels, the college-educated are most satisfied while the uneducated are least satisfied, probably a result of trust issues, poor decision making, or being taken advantage of. Community leaders are distinctly more satisfied (~60%) than both households and businesses (~40%). As expected, the unelectrified are unhappy with energy businesses (~30%) compared to the electrified (~50%). Of the key challenges, information availability is problematic mostly for the uneducated (70% cited inadequate information as a major challenge) compared to 30% for the college educated. Abrupt cutting of services is less of an issue for the uneducated (20%) compared to their educated colleagues (over 40% complain about this problem). However, only 30% of the college-educated perceive this as a problem. Repossessions are also a major problem for the uneducated with about half being unhappy about it. In contrast, only 15% of college-educated members are affected by repossessions. Aftersales services is a fairly uniform problem to everyone, although it appears to be less of an issue for the college-educated.

Figure 12: Community interaction challenges with energy businesses of those respondents who have interacted with them at least once (N = 179)



Many different sources of information exist. Five different information channels exist that are used by over 20% of respondents in terms of energy needs (Figure 13). Yet none of them is used by more than 37% of respondents, indicating a significant spread of where end-users obtain their energy-related information from. Although there are minor differences between Ugandan and Zambian communities, more Ugandans approach energy business agents in their communities for information compared to Zambia, probably due to a bigger presence or better visibility. However, this varies widely by region from 84% in Central Uganda to 19% in Western Uganda and only 3% in Southern Zambia. Significantly more Zambians (45%) go to the Rural Electrification agency for their energy needs compared to only 14% in Uganda. But significant differences also exist across regions. There are only marginal differences by gender. Also, the more-educated in the community (47%) engage with energy businesses directly than their less-educated counterparts (32%). In addition, the uneducated (42%) especially trust REA as an information source compared to the college-educated (19%). Across income levels, the more affluent prefer to get information directly from company agents (53%) and hardly use the community leaders (6%) and local authorities (13%) as source of information compared to the poorer groups. While community leaders (49%) prefer to get information from REA, businesses (17%) hardly use this state agency to obtain information.

Figure 13: Different actors who are being approached by community members about communal energy needs in rural Uganda and Zambia (N = 906)



MESSAGE 4.5

Communities want to be more included in energy-related decision making using adequate and case-specific points of contact

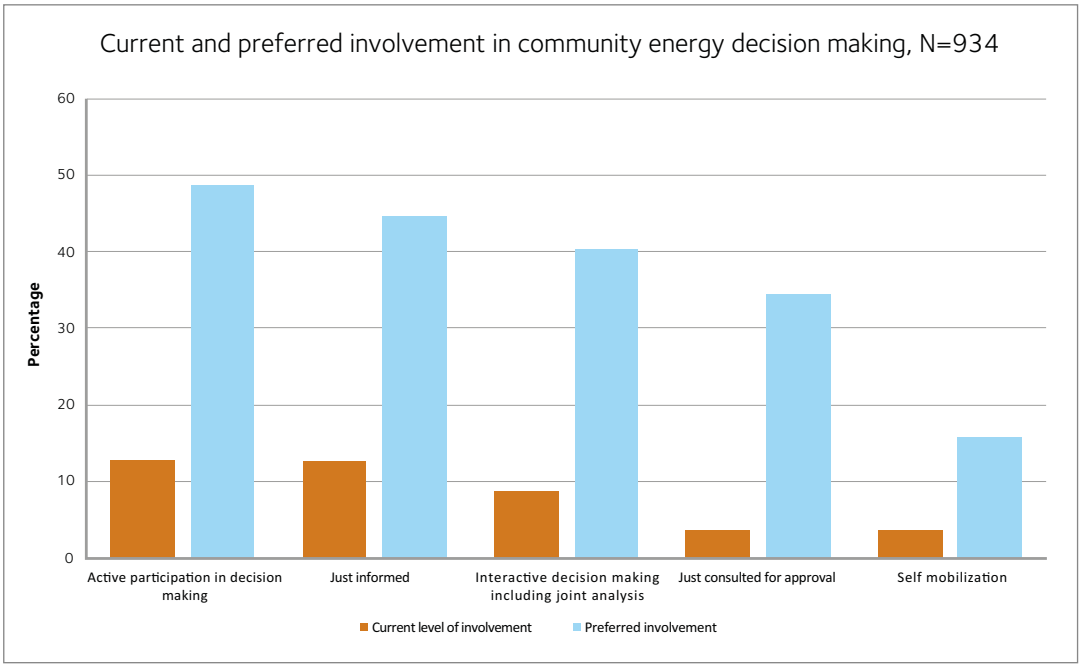
Current levels of community involvement in electrification projects are 30% in both Uganda and Zambia. There are significant differences in the level of engagement by region in both countries. While 70% are currently involved in Central Uganda and Southern Zambia, only 15% and 17% are involved in Northern Uganda and Eastern Zambia. There is a higher proportion of college-educated members involvement (45%) compared to the less educated with the lowest being the uneducated (at 11%). However, there is no distinct pattern across income level groups, probably showing the decoupled nature of affluence and decision-making in rural communities. As expected, community leaders are more involved in decision-making than ordinary households and businesses, but at only 43%, one would expect their involvement to be much higher. Also electrified community members are more involved than non-electrified (40% vs 20%).

Across all methods of community engagement, there is an appetite for stronger involvement in energy project planning and implementation processes. These concerns span from active participation to mere consultation for approval. Notably, mere consultation, which was identified to not feature heavily (<15% of respondents) among those who are involved in energy planning is the preferred engagement pathway for at least a third of the respondents who have not yet been engaged. Currently, about 53% of Ugandans are merely informed compared to 31% in Zambia, while a higher share of Zambians actively involved in community electrification though compared to Uganda. There is significant variation across regions in the two countries for each of the engagement approaches ranging (for instance) from less than 2% for Southern Zambia to over 60% in Central Uganda for 'just informed'.

There is no one-size-fits-all for community engagement. Amongst community members, there are no clear preferences regarding involvement methods in community energy decision making (Figure 14). While over 40% of respondents said they would prefer to be involved through active participation in decision making, this was closely followed by just being informed and being involved through interactive decision making. There is a higher proportion of uneducated community members (64%) who prefer just to be informed than more active participation (compared to 30% for the college-educated). The opposite is true for interactive decision-making approaches. Across income groups, there is a varied preference for involvement - the most affluent (> 500 USD per month) prefer to be consulted (57%) compared to other income brackets (<35%). More households (48%) prefer to be consulted than businesses and community leaders (<40%) but more community leaders (66%) prefer active participatory decision making compared to the other respondents (40-49%). Furthermore, non-electrified community members prefer to be involved in decision making across all engagement approaches - 51% prefer to be informed while 42% prefer to be consulted compared to 35% and 25% for electrified respectively. The same applies to active participation, interactive decision making, etc. Although there is general convergence across age groups, there are some slight differences in preference to community engagement approaches. Young people prefer more interactive decision making while the elderly people prefer to be merely informed. There is, therefore, a need to identify the desires of each individual community, thus ensuring adequate involvement through the relevant means.

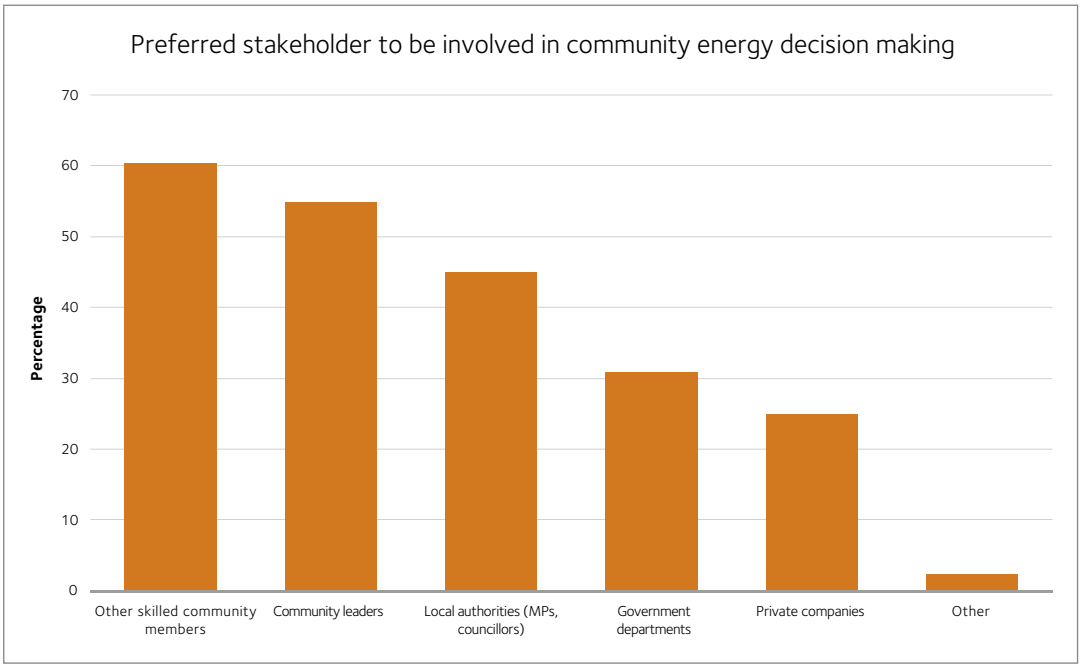
Community engagement does not necessarily imply involving every single household in the decision-making process. Community members who do not want to be actively involved in community energy projects would rather have other skilled community members, community leaders or, to a lesser extent, local authorities (e.g. MPs, councillors) negotiate on their behalf (Figure 15). At least 60% of the respondents prefer other skilled community members to decide on their behalf, while 55% and 45% prefer community leaders and local authorities. Private companies are less preferred (at 25% of respondents) and government departments (30%). While more Zambians (71%) prefer other

Figure 14: Current and preferred involvement in community energy decision making in rural Uganda and Zambia (N = 934)



skilled community members than in Uganda (48%), more Ugandans (70%) prefer Community leaders to act on their behalf compared to Zambia (43%). There is wide variation in preferences across regions and across the two countries. In Central Uganda and Eastern Zambia, over 80% of the respondents prefer other skilled community members to make decisions on their behalf. This is in contrast to less than 20% in Southern Zambia and 29% in Western Uganda. The private sector is least preferred in Northern Uganda (3%) and Southern Zambia (12%). There is significant variation in preferences across age groups - about 50% of young people under 20 years old prefer community leaders and local authorities as well as skilled community members, while those in their twenties prefer other community members. In contrast, respondents aged 60+ years prefer private companies (78%) and community leaders (52%) to initiate and manage community involvement. Income levels appear to give significant differences on preferences of engagement towards community leaders, local authorities, and government departments where the most affluent group have greater preference (85%, 57% and 43% respectively) compared to the poorest group (45%, 41%, and 23% respectively).

Figure 15: Preferred stakeholder to be involved in community energy decision-making (N = 934) in rural Uganda and Zambia



5 ELECTRICITY FOR RURAL DEVELOPMENT IN UGANDA AND ZAMBIA – DISCUSSION AND A WAY FORWARD

5.1 Businesses, public sector, communities and the promise of electricity-enabled development

The current model of off-grid electrification in Uganda and Zambia has primarily focused on basic needs rather than productive use and economic development. Despite the achievements of establishing a significant number of new connections in rural areas, this report has shown that businesses, the public sector and communities still face substantial challenges and unmet needs.

1. **Mini-grid developers** are struggling to make their solutions profitable without considerable amounts of subsidies, especially if they are limited to fulfilling basic needs such as lighting, phone charging and entertainment.

2. **The public sector** in Uganda and Zambia is under pressure both from within and outside to quickly develop its rural areas. While several efforts exist to increase energy access in rural areas, the provision of electricity alone does not induce economic development. It must have a productive use to provide added value to the community.

3. **Communities** have a desire to improve their quality of life through enhanced energy access. While their demand for high-quality electricity access for both basic needs and cooling, cooking and productive uses are high, current solutions - either far-away and often unreliable grid electricity or small-sized solar systems - are often inadequate to meet these needs.

Key energy sector stakeholders are working to overcome these challenges. Different off-grid businesses are developing a new business model of Integrated Developer (section 2). The model can help to resolve the chicken-and-egg problem of energy provision and development by addressing these two issues jointly. ID companies have the potential to fill the energy demand gap in rural areas while providing the energy-powered infrastructure, services, etc. needed for the community to participate in new productive activities (cooking, milling, cooling, manufacturing and services). Depending on the exact business model, this productive use can be integrated into the provider's own value chain (thus potentially providing new employment opportunities for the community), or sold as an energy-powered service to consumers in the community (farmers needing to mill grain, fishermen needing ice to cool fish etc.). The additional revenue streams allow the ID companies to charge lower household tariffs to maximise the uptake of their systems.

The public sector in both Uganda and Zambia have come a long way in terms of their off-grid electrification policies and regulations. A current overhauling of off-grid regulations aims to streamline the process. However, a number of further steps are required to accelerate the realisation of the electrification – development nexus (see section 5.2).

While this report has largely focused on the private sector, the national public sectors and communities, donors are a further key stakeholder in Uganda's and Zambia's energy sector. They provide important outside expertise and support for drafting the regulatory process, pilot new tendering schemes, foster potential productive uses and enhancing market viability. Donors could play a stronger role in facilitating the dialogue between developers, the national public sector and community members to design electrification approaches that reflect communal needs. National governments and their agencies should be in the driver seat of these processes and be given the capacity to tailor off-grid initiatives to their national needs. Donor initiatives can play a supporting role in enhancing the institutional capacities that are needed for these processes at the national and local level to ensure governmental buy-in and the development of a profound basis in the target country for a decade-long process of electrification.

5.2 Electricity for sustainable development in Uganda and Zambia – the way forward

Realising the nexus between electricity access and sustainable development in Uganda and Zambia crucially involves action from the three core stakeholder groups, namely businesses, the public sector and communities:

Businesses should innovate in order to shift more towards profitability rather than growth early on: The off-grid sector in Africa has largely been a tale of near-endless opportunity, with the gap of electricity access steadily increasing. However, the sector has learned that standard business models do not deliver profitability especially for mini-grids. A profitability focus early on is key to fostering a business model that is able to scale. Innovating for profitability means to both markedly increase revenues and decrease cost. The ID model (section 2.2) is a creative and promising, albeit non-trivial way of achieving the former, and may serve as a guide for those off-grid companies who continue to concentrate on only selling electricity. Local manufacturing, strategic make or buy decisions across the value chain, improved purchasing operations and tight project designs with the ability to modularly scale up in case of demand increases are potential measures to achieve the latter.

The public sector could make off-grid electrification for productive use a higher policy priority and adjust regulations to promote innovation. On-grid and off-grid energy access strategies need to be aligned more closely, for example to provide an indication of where and when different electrification approaches will be adopted. Effective progress monitoring and evaluation are key in order to update national electrification strategies. The current process of updating the off-grid regulations in both Uganda and Zambia presents a unique opportunity to include incentives to balance energy access and commercial viability. While a regulatory framework is important to provide security for both businesses and communities, it needs to be flexible enough to allow for revenue and cost innovation. Furthermore, especially in Uganda, the license exemption process involves considerable complexities. A timeline of often over one year to obtain a single license for a small-scale project jeopardises both profitability and scale potential of the private sector. Finally, both countries should elevate productive use of electricity via adequate regulatory frameworks and incentives to foster electrification and, more importantly, rural development at scale.

Communities could consider pro-active approaches of communicating their needs and initiating local level solutions. The survey results presented in section 4 illustrated that community members are not satisfied with current levels of their involvement in energy planning. While top-down changes are certainly required to improve the situation, communities have bottom-up leverage in both Uganda and Zambia which they can utilise to improve the situation. Formal institutions exist in both countries which allow for issues to be raised locally and discussed beyond village borders. In Ghana, the initiative and ownership of communities, for example, was instrumental in increasing the country's electrification rate from under 10% in 1990 to 85% today (Kemausuor and Ackom 2017), and the opportunities for a similar model in Uganda and Zambia could be explored. Community leaders and skilled community members play a key role in facilitating the flow of information towards all community members, and in mobilising resources to embrace the opportunities of electrification.

Furthermore, the links between these three stakeholder groups – the private sector, public institutions and communities - need to be strengthened and governed in a way that focuses on the ultimate goal of sustainable development.

The link between businesses and the public sector would benefit from increased dialogue to improve license processes and to support innovation in business models. Examples across sub-Saharan Africa show that political will for off-grid electrification is important for a thriving private sector to develop. Uganda and Zambia have repeatedly underlined their commitment to private sector development

in the off-grid space. It is crucial for this top-down drive to persist. The public sector needs to develop additional measures to support private sector development. Regulatory frameworks need to balance affordable energy access and commercial project viability. Tariff structures need to be less restrictive to allow for new cost and revenue models which are required to make mini-grids work at scale. Provisions for off-grid operators should be put in place to mitigate the risk (and loss) associated with the potential expansion of the grid to areas they previously serviced. In Uganda, representatives from developers and the national regulator should co-design all templates required for a license exemption, including detailed lists and fully filled-out sample applications. This would make submitting license exemption applications much more efficient for developers and would dramatically reduce the time required by the regulator to review them. Another key challenge to address between businesses and institutions is the lack of local currency debt. Most developers have been able to access hard-currency loans from foreign financial institutions and donors, however this bears significant exchange rate risks and added conditionality. Finally, given the potential of Integrated Developer models, it would be rational for governments to divert some of their spending on grid expansion to integrated off-grid expansion. In general, the regulatory environment should be conducive to the development of business-to-business partnerships that make ID systems more attractive and easier to implement.

The link between the public sector and communities would benefit from enhanced community engagement, the inclusion of local representatives and the flow of information in both directions. There is a concerning disconnect between rural communities and the public sector in terms of electrification planning and implementation. Enhanced formalised community engagement involving community leaders and skilled community members, governed by the goal to deliver suitable and efficient electrification is required to improve community ownership. Communities should clearly communicate to the policy-makers in charge of negotiations. The public sector in Uganda and Zambia need to improve how they inform communities about the implications of electrification. This would enable communities to formulate realistic demands which are likely to optimise the impact of electrification. Sharing information among different communities is crucial to build an informed knowledge base. Ghana's Self-Help Electrification Programme (SHEP) is an intriguing example of a public sector-driven programme which gave communities a framework to demand electrification. The SHEP required communities to mobilise resources to aid electrification (such as constructing the distribution grid themselves) while rewarding such communities with enhanced financial assistance during the electrification process.

The link between communities and businesses is strengthening as both stakeholders' goals become more aligned but it lacks efficient interaction and should be monitored closely by the public sector. By becoming an Integrated Developer, mini-grid companies have an incentive for achieving rural development: If a community develops economically, the Integrated Developer directly benefits financially through higher revenue levels from both its kWh-selling business as well as from its goods and service offerings. Hence, the ID model aligns the incentives of communities and businesses. In order to ensure successful implementation, developers must partner with community leaders as well as formal and informal local business associations to understand the local context. Developers wishing to implement an ID approach must also invest in helping to develop the knowledge and resources necessary within the community to manage new sources of income and operation activities. The target consumers must be made aware of how purchasing new services will ultimately add value to their business and increase their income. Communities can be more pro-active in putting themselves forward for electrification. Openly advertising electrification needs and the productive use of electricity opportunities which are usually mostly hidden to developers would make it more likely for businesses to identify suitable opportunities. This process should be supported by the public sector to ensure the needs of communities are adequately protected.

REFERENCES

Adner, Ron. 2017. "Ecosystem as Structure: An Actionable Construct for Strategy." *Journal of Management* 43(1): 39–58.

Alt, Rainer, and Hans-Dieter Zimmermann. 2001. "Preface: Introduction to Special Section–Business Models." *Electronic markets* 11(1): 3–9.

Booth, Samuel et al. 2018. "Productive Use of Energy in African Micro-Grids : Technical and Business Considerations." *Usaid, Nrel*.

Christensen, Clayton M, Efosa Ojomo, and Karen Dillon. 2019. *The Prosperity Paradox*. HarperBusiness.

EDISON. 2019. "The Energy Data and Intelligence System for Off-Grid Networks." https://edison.bgfz.org/info.

Electricity Regulatory Authority (ERA). 2018. *Uganda Electricity Connections Policy 2018 - 2027*.

Geo Gecko. 2017. *The Attractiveness of Energy*. Kampala, Uganda.

Government of Uganda. 2016. *Uganda Vision 2040*. Kampala, Uganda.

IEA. 2010. *World Energy Outlook 2010*. Paris, France.

IFC. 2018. *Insights on the Investment of IPPs and Renewable Energy in Sub-Saharan Africa*. Washington D.C.

Japan International Cooperation Agency (JICA). 2008. *The Study for Development of the Rural Electrification Master Plan (REMP) in Zambia Final Report Summary Report*.

Kemausuor, Francis, and Emmanuel Ackom. 2017. "Toward Universal Electrification in Ghana." *Wiley Interdisciplinary Reviews: Energy and Environment*.

Kuungana Advisory Limited. 2018. *Energy Africa – Zambia Technical Assistance to Model and Analyse the Economic Effects of Fiscal Policy Options for off-Grid Technologies In*. https://assets.publishing.service.gov.uk/media/5af2cc23ed915d586037ddcf/Zambia_FiscalAnalysis_FinalReport_201803_v2_2.pdf.

McCollum, David L. et al. 2018. "Connecting the Sustainable Development Goals by Their Energy Inter-Linkages." *Environmental Research Letters*.

Mentis, Dimitrios et al. 2017. "Lighting the World: The First Application of an Open Source, Spatial Electrification Tool (OnSSET) on Sub-Saharan Africa." *Environmental Research Letters* 12(8): 85003.

Miller, Clark A., Carlo Altamirano-Allende, Nathan Johnson, and Malena Agyemang. 2015. "The Social Value of Mid-Scale Energy in Africa: Redefining Value and Redesigning Energy to Reduce Poverty." *Energy Research & Social Science* 5: 67–69.

Ministry of Finance and National Planning Zambia. 2011. *2010 Census of Population and Housing*. Lusaka. https://unstats.un.org/unsd/demographic-social/census/documents/Zambia/PreliminaryReport.pdf.

Muchunku, Charles, Kirsten Ulsrud, Debajit Palit, and Wim Jonker-Klunne. 2018. "Diffusion of Solar PV in East Africa: What Can Be Learned from Private Sector Delivery Models?" *Wiley Interdisciplinary Reviews: Energy and Environment* 7(3): e282.

Muhoza, Cassilde, and Oliver W. Johnson. 2018. "Exploring Household Energy Transitions in Rural Zambia from the User Perspective." *Energy Policy* 121: 25–34. https://linkinghub.elsevier.com/retrieve/pii/S0301421518303914.

Nerini, Francesco Fuso et al. 2018. "Mapping Synergies and Trade-Offs between Energy and the Sustainable Development Goals." *Nature Energy* 3(1): 10.

Peters, Jörg, Maximiliane Sievert, and Michael A. Toman. 2019. "Rural Electrification through Mini-Grids: Challenges Ahead." *Energy Policy* 132: 27–31.

Peterson, Richard B. 2006. "Why Mami Wata Matter: Local Considerations for Sustainable Waterpower Development Policy in Central Africa." *Local Environment*.

REEEP. 2019. "Power Africa: Beyond the Grid Fund for Zambia." https://www.reeep.org/bgfz.

Rosenstein-Rodan, Paul N. 1943. "Problems of Industrialisation of Eastern and South-Eastern Europe." *The economic journal* 53(210/211): 202–11.

Rural Electrification Authority Zambia. 2019. "Www.Rea.Org.Zm."

SIDA. 2015. *POWER AFRICA : BEYOND THE GRID Energy Access for One Million Zambians*. http://www.sida.se/contentassets/f8089eb605cc4b1daab354cbd3476a8d/beyond_the_grid_fund_zambia_brochure.pdf.

Szabó, S., K. Bódis, T. Huld, and M. Moner-Girona. 2013. "Sustainable Energy Planning: Leapfrogging the Energy Poverty Gap in Africa." *Renewable and Sustainable Energy Reviews* 28: 500–509. http://dx.doi.org/10.1016/j.rser.2013.08.044.

The World Bank. 2018. *Atlas of the Sustainable Development Goals From World Development Indicators*. Washington DC.

The World Bank. 2019. *World Development Indicators*. Washington DC.

Trotter, Philipp A. 2016. "Rural Electrification, Electrification Inequality and Democratic Institutions in Sub-Saharan Africa." *Energy for Sustainable Development* 34: 111–29.

Trotter, Philipp A., and Sabah Abdullah. 2018. "Re-Focusing Foreign Involvement in Sub-Saharan Africa's Power Sector on Sustainable Development." *Energy for Sustainable Development* 44: 139–46. http://dx.doi.org/10.1016/j.esd.2018.03.003.

Trotter, Philipp A. 2019. "Ambitions versus Policy Design : Addressing Issues of the Power Africa Initiative ' s Quantitative Targets." *Energy Policy* 128(February): 900–906.

Trotter, Philipp A, Nathanial J Cooper, and Peter R Wilson. 2019. "A Multi-Criteria, Long-Term Energy Planning Optimisation Model with Integrated on-Grid and off-Grid Electrification–The Case of Uganda." *Applied Energy* 243: 288–312.

Ulsrud, Kirsten et al. 2018. "Pathways to Electricity for All: What Makes Village-Scale Solar Power Successful?" *Energy Research and Social Science* 44(April): 32–40. https://doi.org/10.1016/j.erss.2018.04.027.

UOMA. 2018. *Mapping the Ugandan Off-Grid Energy Market*. Kampala, Uganda.