

Mini-Grid Market Opportunity Assessment: Uganda

Green Mini-Grid Market Development Programme:
SEforALL Africa Hub & African Development Bank

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The African Development Bank has an overarching objective to spur sustainable economic development and social progress in its Regional Member Countries (RMCs), contributing to poverty reduction. The Bank Group aims to achieve this objective by mobilising and allocating resources for investment in RMCs, and providing policy advice and technical assistance to support development efforts.



The Carbon Trust wrote this report based on an impartial analysis of primary and secondary sources. The Carbon Trust's mission is to accelerate the move to a sustainable, low carbon economy. It is a world leading expert on carbon reduction and clean technology. As a not-for-dividend group, it advises governments and companies around the world, reinvesting profits into its low carbon mission.



SNV is a not-for-profit international development organisation, working in agriculture, energy, and water, sanitation and hygiene. SNV aims to alleviate poverty by increasing income and employment opportunities and increasing access to basic services. The organisation currently works in 38 countries in Africa, Asia, and Latin America.

The Carbon Trust would like to thank the following organisations that made this report possible: Uganda Ministry of Energy and Mineral Development (MEMD), Uganda Rural Electrification Agency (REA), Uganda Electricity Regulatory Authority (ERA), Uganda Electricity Generation Company Ltd. (UEGCL), Uganda Bureau of Statistics, Uganda Solar Energy Association (USEA), United States Agency for International Development (USAID), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), UK Department for International Development (DFID), the World Wildlife Fund (WWF), KfW, Energy4Impact, SNV, TetraTech, Conserve, Pamoja Energy, Tronder Power.

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This paper, part of the Green Mini-Grid Market Development Programme (GMG MDP) document series, assesses “green mini-grid” market potential in Uganda. Green mini-grids include mini-grids powered by renewable energy resources – solar radiation, wind, hydropower or biomass – either exclusively, or in combination with diesel generation.

Mini-grids are not a new phenomenon in Africa. Almost all national utilities own and operate diesel-powered generating facilities not connected to the main grid, which supply electricity to secondary towns and larger villages. This solution to rural electrification often results in significant financial losses for the utility, needed to sell power at prices significantly below the cost of production and delivery. It also leaves the most remote towns and villages without electricity. The latest Sustainable Energy for All (SEforALL) Global Tracking Framework estimates that the urban-to-rural divide in access to electricity in Africa is as high as 450 percent, with 69 percent of the population in urban areas having been electrified compared to only 15 percent in rural areas.

There are three principal options for providing new connections to currently unserved populations in Africa: (1) extension of the national grid; (2) installation of separate “mini-grids” to operate independently from the main grid; (3) stand-alone generating systems that supply individual consumers (typically Solar Home Systems or SHS). The most cost-effective approach for powering mini-grids is to use renewable energy sources, which are widely available across Africa.

However, the development of GMGs is not without its challenges. In addition to unfriendly policy and regulatory frameworks, barriers to growth of the private mini-grid sector in Africa include a lack of proven business models, market data and linkages, key stakeholder capacity, and access to finance.

In response to these challenges, the SEforALL Africa Hub at the African Development Bank (AfDB) designed and launched Phase 1 of the GMG MDP in 2015, with grant funding from the AfDB’s Sustainable Energy Fund for Africa (SEFA).¹ The GMG MDP is a pan-African platform that addresses the technical, policy, financial and market barriers confronting the emerging GMG sector. It is part of a larger Department for International Development (DFID) funded GMG Africa Programme, which also includes GMG initiatives in Kenya and Tanzania; country-specific GMG policy development through SEFA; and an action learning and exchange component implemented by the World Bank’s Energy Sector Management Assistance Program (ESMAP).

In its *Africa Energy Outlook 2014*, the International Energy Agency (IEA) predicted that by 2040, 70 percent of new rural electricity supply in Africa will most affordably come from stand-alone systems and mini-grids. The GMG MDP, SEforALL, SEFA, ESMAP and similar programmes, which are contributing to falling costs, technological advancements and more efficiencies in GMG development, will help ensure that up to two thirds of this supply is powered by renewables.

The goals of the green mini-grid programme are central to AfDB’s mission of spurring sustainable economic development, social progress and poverty reduction in its regional member countries. Off-grid and mini-grid solutions are a key component of the AfDB’s New Deal on Energy for Africa, launched by the Bank’s president in January 2016. The New Deal, a transformative and partnership-driven effort, aspires to achieve universal access to energy in Africa by 2025.

This report was prepared by the Carbon Trust, Netherlands Development Organisation (SNV) and United Nations Environment Programme (UNEP) at the request of the AfDB. It was written by William Hudson and Antoinette Gous of Carbon Trust, Ruth Kuteesa and Peace Kansime of SNV, and Tomo Sandeman (independent consultant). Carbon Trust is a mission-driven organisation helping businesses, governments and the public sector accelerate the move to a low carbon economy. SNV is an international development organisation established in the Netherlands.

¹ The SEforALL Africa Hub partnership includes the African Union Commission, the New Partnership for Africa’s Development (NEPAD), the United Nations Development Programme (UNDP), and the Regional Economic Communities (RECs), which are represented on a rotating basis. <http://www.se4all-africa.org>

The content of this report was reviewed by Jeff Felten of the AfDB's GMG team and cleared by Dr Daniel-Alexander Schroth, SEforALL Africa Hub Co-ordinator at the AfDB. It was edited by Kimberlee Brown.

LIST OF ACRONYMS

AA	Action Agenda (SE4ALL)
BEST	Biomass Energy Strategy
DFID	UK Department for International Development
DWRM	Directorate of Water Resource Management
E4I	Energy 4 Impact
EDT	Electricity Disputes Tribunal
EIA	Environmental Impact Assessment
EIB	European Investment Bank
ERA	Electricity Regulatory Authority
ERT	Energy for Rural Transformation Project
EU	European Union
EUL	Eskom Uganda Ltd.
GDP	Gross Domestic Product
GEF	Global Environment Fund
GET-FIT	Global Energy Transfer Feed-in Tariff
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMG MDP	Green Mini-Grid Market Development Programme
HV	High Voltage
ICD-PS	Islamic Corporation for the Development of the Private Sector
IEA	International Energy Agency
INDC	Intended Nationally Determined Contribution
IPP	Independent Power Producer
IEMP	Indicative Rural Electrification Master Plan
KfW	Kreditanstalt für Wiederaufbau
km	Kilometre
kV	Kilovolt
kWh	Kilowatt-hour
LDC	Least Developed Country
LV	Low Voltage
MEMD	Ministry of Energy and Mineral Development
MoU	Memorandum of Understanding
MV	Medium Voltage
MW	Megawatt
NARUC	National Association of Regulatory Utility Commissioners
NEMA	National Environmental Management Authority
O&M	Operations & Maintenance
PPA	Power Purchase Agreement
PSIP	Power Sector Investment Plan
PV	Photovoltaic
R&D	Research and Development
RE	Renewable Energy
REA	Rural Electrification Agency
REB	Rural Electrification Board
RECP	EU Renewable Energy Cooperation Programme
REF	Rural Electrification Fund
RE-FIT	Renewable Energy Feed-in Tariff

REIP	Renewable Energy Investment Plan
RESP	Rural Electrification Strategy and Plan
SEforALL	Sustainable Energy for All
SEFA	Sustainable Energy Fund for Africa
SSA	Sub-Saharan Africa
UBOS	Ugandan Bureau of Statistics
UECCC	Uganda Energy Credit Capitalisation Company
UEDCL	Uganda Electricity Distribution Company Ltd.
UEGCL	Uganda Electricity Generation Company Ltd.
UETCL	Uganda Electricity Transmission Company Ltd.
UIA	Uganda Investment Authority
UNBS	Uganda National Bureau of Standards
UNFCCC	United Nations Convention Framework on Climate Change
UNRA	Uganda National Roads Authority
UNREEEA	Uganda National Renewable Energy and Energy Efficiency Alliance
UOMA	Uganda Off-Grid Market Accelerator
USAID	United States Agency for International Development
WB	World Bank
WENRECO	West Nile Rural Electrification Company
WTP	Willingness to Pay
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

This country report is one of a series of country reports under the Market Intelligence business line of the African Development Bank's Green Mini-Grid Market Development Programme (GMG MDP). The MDP has the ultimate objective of fostering access to electricity across Africa by promoting the development of green mini-grids where they represent a technically and economically better option than the extension of the main grid. The Market Intelligence business line aims to provide comparable, actionable data on the potential for GMGs across countries in Sub-Saharan Africa. This report provides an analysis for Uganda. Previous country reports can be downloaded from the GMG Help Desk (<http://greenminigrid.se4all-africa.org>).

This report's methodology combines a high-level opportunity assessment with practical knowledge and information targeted at mini-grid practitioners. Information provided covers key stakeholders, raw data on physical and non-physical factors and a policy and regulatory analysis. Assessing the potential for mini-grids is challenging as such analysis requires plenty of data and assumptions. This report therefore aims to capture available data and highlight general assessments that would be relevant to most mini-grid stakeholders. Raw data is provided with this report so stakeholders may further conduct their own specific analysis.

Uganda is a landlocked country in East Africa with a total area of 241,038km², a population of circa 39 to 43 million people in 2018, and a current population growth rate of 3.3% annually (World Bank, 2017). Uganda is bordered by South Sudan to the North, the Democratic Republic of Congo (DRC) to the West, Rwanda to the Southwest, Tanzania to the Southeast, and Kenya to the East. The country is divided into four administrative regions: Northern, Eastern, Central and Western, which are further divided into 121 districts. The capital Kampala is located in the south of the country around 30km north of Lake Victoria. Uganda currently has one of the highest population growth rates in the world at 3.3% annually, with the vast majority of the population (>90%) living in rural areas outside of Kampala (Population Pyramid, 2018).

Uganda lies on the great plateau of east-central Africa at an altitude of between 1,000m to 1,200m above sea level, and is characterised by a warm, temperate climate with average temperatures ranging between 20°C and 25°C. Despite the low temperature variation throughout the year, warmer periods are experienced between December and March and cooler periods between June and September. Mountainous areas are much cooler, including the Rwenzori Mountains which run along Uganda's western border with the Democratic Republic of Congo (DRC), the Virunga Mountains on the border with Rwanda and DRC, and the Kigezi region in Southwest. The annual average rainfall for Uganda is between 1,000 and 1,500 millimetres, giving rise to a fertile, green country commonly referred to as the "Pearl of Africa".

Uganda is a Presidential Republic where the President of Uganda is both Head of State and Head of Government. President Yoweri Museveni and his National Resistance Movement have ruled Uganda without interruption since taking power in 1986 (most recently winning an election in 2016). Presidential elections occur every five years through a popular vote system, with the next election due in 2021.

Uganda is a Least Developed Country (LDC) with GDP of \$25.9bn and GDP per capita of \$600, with economic growth of around 7% over the past decade. The country is endowed with significant natural resources, including ample fertile land, regular rainfall, as well as mineral deposits including copper, gold and oil. Recent economic growth has been driven by the information and communications sector, and favourable weather conditions for the agricultural sector. The services sector comprises 50% of the economy, including retail, telecommunications, hospitality, transport and tourism sub-sectors (Government of Uganda, 2018). The industry sector includes manufacturing, construction and electricity provision, accounting for 25.5% of the economy. The agricultural sector accounts for the remaining 24.5% of the economy, employing approximately 70% of the population (Uganda Investment Authority, 2018). Cotton, tea and coffee comprise the bulk of agricultural exports and are the dominant sources of export revenue.

While the economic outlook for Uganda remains positive, this is tempered by a number of significant internal and external risks. Risks include instability in South Sudan (Uganda's main export market), high energy costs, a very high population growth rate, inadequate transportation and energy infrastructure, corruption, volatility in commodity prices, and

slowdown in trading partner economies (PwC, 2017). Other internal risks that the Ugandan economy faces include slower than expected investment in oil production, adverse weather conditions affecting food supply and agricultural production, and volatility in the local currency (the Ugandan shilling depreciated 50% against the dollar between 2015 and 2017) (Central Intelligence Agency, 2017). These factors are currently inhibiting economic development and damaging investor confidence.

Uganda meets more than 93% of national energy demand with biomass fuel (firewood, charcoal, and crop residues), and a further 6% from imported fossil thermal fuel (mainly diesel and heavy fuel-oil). Total primary energy consumption is 14.9 Mtoe annually. Electricity only contributes around 1% to the national energy balance. Uganda currently has among the lowest per capita electricity consumption in the world with 215kWh per capita per year (Sub-Saharan Africa's average: 552kWh per capita, World average: 2,975 per capita), with hydropower accounting for 692MW of a total 822MW of electricity generation capacity (84% of total). The three largest hydropower stations are Kiira (200MW), Nalubale (180MW) and Bujagali (250MW). Several other smaller hydropower stations are additionally in operation. Other sources of electricity include two thermal power plants (50MW and 80MW) and two biomass cogeneration plants that run on bagasse (combined output of 30MW) (Energypedia, 2018). In terms of renewable energy generation, although there are a few mini-grids, solar photovoltaic (PV) technology is mainly found as standalone solar home systems (SHS). Wind and geothermal energy remain unexploited.

Uganda has one of the lowest electricity access rates in the world, with only 19 to 26% of the total population having some form of electricity access. Reports of urban versus rural electricity access vary, from 18.6% to 19.9% in rural areas, to 23.3% to 54.8% in rural areas (low end of range based on International Energy Agency energy access database; high end of range based on Uganda Bureau of Statistics) (IEA, 2016) (SE4ALL, 2015). Approximately 18% of the population live in urban areas versus 82% in rural areas.

Until 2009, much of Uganda's generation capacity came from Nalubaale and Kiira hydropower stations in Jinja in Southeastern Uganda. However, during droughts (such as in 2009), only around half of the installed capacity could be used as a result of the low water level of Lake Victoria. Continued strong annual growth in demand for electricity exacerbated this electricity supply problem, leading to load shedding and blackouts in previous years. A new 250MW hydro facility has subsequently been developed at Bujagali (north of Jinja), and has been operational since February 2012. Before Bujagali became operational, 150MW of thermal capacity was added as an 'emergency' measure to bridge the gap until the beginning of 2012, information received at the time of writing this report. There now exists a generation capacity surplus on the grid. While mini-grids are a significant opportunity, there is likely to remain a focus on grid expansion while this capacity surplus is absorbed.

Going forward, Uganda intends to significantly scale up renewable energy (RE) technology deployment, taking advantage of plentiful solar, hydro and biomass sources. Uganda's SE4ALL Action Agenda (AA) projects a renewable energy generation capacity scale-up to around 3,000MW to 2030, up from around 650MW today. This contribution will be dominated by large scale hydro power generation, with solar PV and biomass contributions around 2 to 3% of total.

The mini-grid market in Uganda has seen a number of successes to date, including the establishment of several successful mini-grid projects. Cross-government co-operation has seen approval of a number of projects, with financial viability achieved through subsidies from the national Rural Electrification Fund (REF) through the REA. Developers have also received support from donors throughout project planning, approval and development phases. In theory, there is no restriction on allowable mini-grid tariffs in Uganda, although in practice around 1,000 Ugandan shillings per kWh (\$0.27/kWh) is the political upper limit (according to stakeholders). The Electricity Regulatory Authority reports that they have allowed \$0.3 to 0.5/kWh for unregulated tariffs to be charged, although there is only one known example of this taking place (Absolute Energy, Ktibo Island).

Nonetheless, there remain a number of key barriers to mini-grid deployment in Uganda, including a lack of an appropriately detailed masterplan (although the Government is working towards publication of a new masterplan – due Summer 2018), challenges obtaining a mini-grid licence exemption (required for installations <2MW), a lack

of cost-reflective tariffs, a lack of clarity around required technical standards and compensation procedures when the grid arrives, and a lack of finance (particularly debt finance). Resolving these issues, and others detailed within this report, is likely to open up the off-grid sector further.

Under the present grid, the analysis estimates a total annual revenue market size of \$68 million (for mini-grids).

The highest-potential region is the Northern region, with an estimated market size of \$39 million and just over two million people most economically served through mini-grids. This reduces to a total market of \$10 million when including planned network extensions up to 2050, an 85% reduction compared to the market for mini-grids under the current grid. The largest market reduction when including these extensions is in the Western region, with a 91% reduction. The largest market remains in the Northern region at \$6 million. The actual market size may be greater than the estimates given here considering decentralised solutions could also be feasible in areas in grid proximity (<15km from the grid).

1. INTRODUCTION TO THE GREEN MINI-GRID MARKET DEVELOPMENT PROGRAMME

The African Development Bank's Green Mini-Grids Market Development Programme (MDP) aims to foster access to electricity across Africa. The MDP provides assistance to a range of stakeholders in overcoming the challenges for widespread and sustainable implementation of Green Mini-Grid (GMG) projects, by:

- Establishing a comparable, actionable understanding of the GMG market opportunity in Sub-Saharan Africa (SSA);
- Promoting the linkages between communities, public institutions, developers, financiers, and technology providers needed for successful mini-grid development;
- Strengthening capacity of developers to develop and operationalise GMG business models;
- Promoting a sound policy and regulatory environment; and
- Engaging project financiers and supporting the development of suitable financial solutions.

This country report is one of a series of country reports of the MDP's Market Intelligence business line, each of which provides an analysis of the GMG potential per country. These reports provide comparable, actionable data on the GMG potential across countries in SSA. GMG Opportunity Assessments for other countries can be downloaded from the GMG Help Desk (<http://greenminigrid.se4all-africa.org>).

The Market Development Programme is implemented by the Sustainable Energy for All (SEforALL) Africa Hub, through a grant of the Sustainable Energy Fund for Africa (SEFA). The SEforALL Africa Hub, hosted by the African Development Bank, is a partnership of African institutions dedicated to support the continent's progress towards the SEforALL initiative's three main objectives on energy access, renewable energies and energy efficiency.

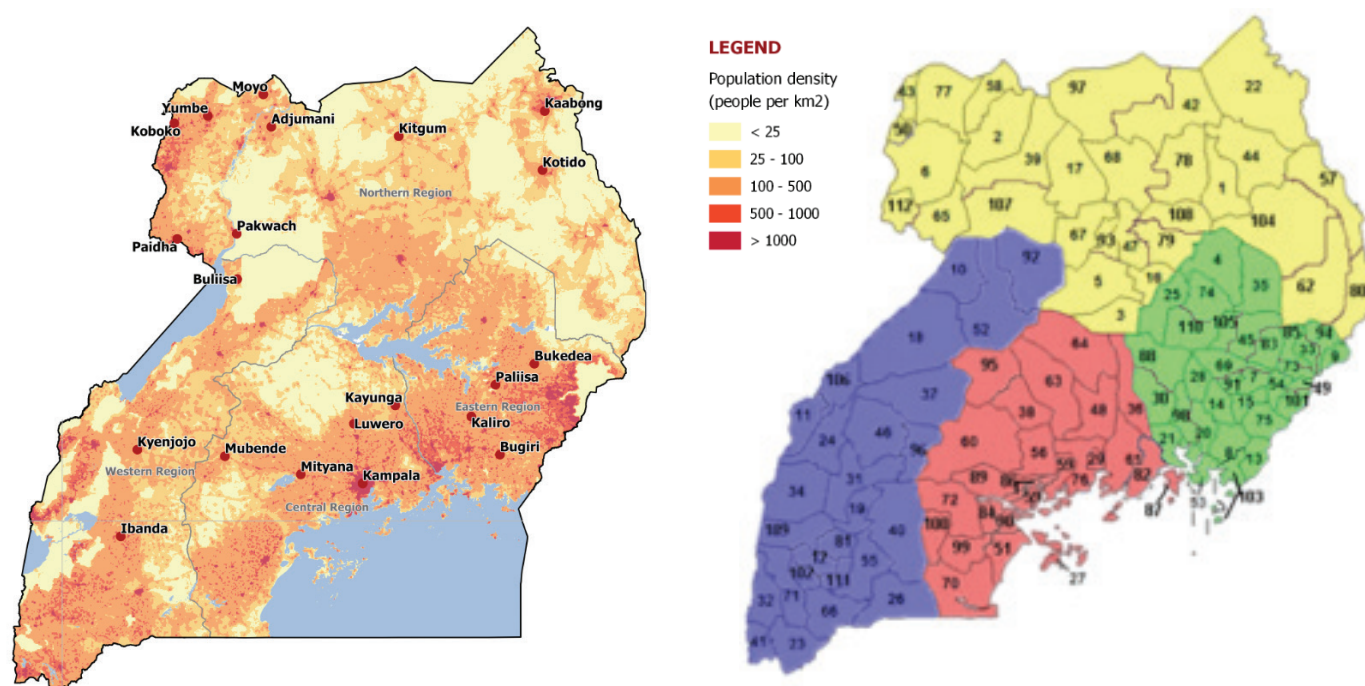
The development of clean energy mini-grids is also the primary objective of the Mini-Grid Partnership, for which the Bank is playing a lead role for Africa. The partnership seeks to galvanise action on the barriers facing the sector, with the engagement of public, private and civil society expertise and resources. The Mini-Grid Partnership (formerly an SE4ALL Clean Mini-Grids High Impact Opportunity), including the co-ordination group, secretariat and wider membership, is the established forum for discussion and coordination of the efforts of development partners to advance the adoption of GMGs. The MDP was designed from the beginning to be integrated and closely coordinated with the activities carried out in the framework of the partnership.

2. COUNTRY AND SECTOR OVERVIEW

2.1 COUNTRY OVERVIEW

Uganda is a landlocked country in East Africa with a total area of 241,038km², a population of circa 39 to 43 million people in 2018, and a current population growth rate of 3.3% annually (World Bank, 2017). Uganda is bordered by South Sudan to the North, the Democratic Republic of Congo (DRC) to the West, Rwanda to the Southwest, Tanzania to the Southeast, and Kenya to the East. The country is divided into four administrative regions: Northern, Eastern, Central and Western, which are further divided into 121 districts. The capital Kampala is located in the south of the country around 30km north of Lake Victoria. Uganda currently has one of the highest population growth rates in the world at 3.3% annually, with the vast majority of the population (>90%) living in rural areas outside of Kampala (Population Pyramid, 2018).

Figure 1: Administrative regions and population density within Uganda (Northern, Eastern, Central and Western)



Uganda lies on the great plateau of east-central Africa at an altitude of between 1,000m to 1,200m above sea level, and is characterised by a warm, temperate climate with average temperatures ranging between 20°C and 25°C. Despite the low temperature variation throughout the year, warmer periods are experienced between December and March and cooler periods between June and September. Mountainous areas are much cooler, including the Rwenzori Mountains which run along Uganda's Western border with the Democratic Republic of Congo (DRC), the Virunga Mountains on the border with Rwanda and DRC, and the Kigezi region in Southwest. The annual average rainfall for Uganda is between 1,000 and 1,500 millimetres, giving rise to a fertile, green country commonly referred to as the "Pearl of Africa". Heavy rain is typically between March and May, and September and November, often making road travel difficult. Uganda is situated within the African Great Lakes Region with several of the great lakes located within its boundaries. This includes Lake Victoria, the largest lake in Africa and second largest freshwater body in the world. Jinja, a town located on the shore of Lake Victoria, is considered the starting point of the River Nile, which traverses much of the country.

Uganda is already experiencing significant climate change impacts, including changing weather patterns, dropping water levels, and increased frequency of extreme weather events. Since 1960 mean annual temperatures have risen and annual and seasonal rainfall has decreased significantly across Uganda. Rainfall has become more unpredictable and evenly distributed over the year. Extreme events such as droughts, floods and landslides are increasing in frequency and intensity. Agriculture, water, health and human settlements have been affected, with climate change

related damage equivalent to an unaffordable 4.4% of the national budget in 2007 to 2008 (Uganda Ministry of Water and Environment, 2017). It is considered that the ongoing effects of climate change will disproportionately affect the most vulnerable populations, particularly in rural areas and urban slums.

Uganda has an extensive road network across the country, with around 21,000km of national roads, 30,000km of district or urban roads, and 35,000km of community access roads. However, the condition of the roads in Uganda is generally poor, with only 16% of the public road network having been paved (UNRA, 2017) despite 95% of freight being moved by road (Ministry of Works and Transport, 2017). National roads are managed by the Uganda National Roads Authority (UNRA), carrying approximately 80% of all traffic, with approximately 80% considered to be in good condition. The country has one major international airport (Entebbe) and three main domestic airports (Arua, Gulu and Moyo).

There are seven telecommunication network providers in Uganda and the country can be considered well connected compared to telecommunications elsewhere in Africa. Mobile network providers provide coverage for all urban and most rural areas, although signal quality varies significantly. Landline coverage in rural areas remains poor. Uganda has seen a high increase in the number of mobile phones owned due to service providers increasing their coverage, especially in rural areas. It is estimated that as of March 2018, 70% of Ugandans own mobile phones (National Information Technology Authority Uganda). Mobile network providers have installed 4G networks in and around Kampala while 3G networks are available in secondary urban areas. Quality internet access remains expensive and slow compared to international standards (US Export.gov, 2017).

Uganda is a Presidential Republic where the President of Uganda is both Head of State and Head of Government. President Yoweri Museveni and his National Resistance Movement have ruled Uganda without interruption since taking power in 1986 (most recently winning an election in 2016). Presidential elections occur every five years through a popular vote system, with the next election due in 2021. Opposition and independent observers have complained about the fairness and transparency of elections. Nonetheless, President Museveni has been credited with restoring relative stability and economic prosperity to Uganda following years of civil war and repression under former leaders Milton Obote and Idi Amin.

Uganda's Government is made up of three branches namely Executive, Legislative and Judicial. Executive power is exercised by the Government. The executive branch is comprised of the president, vice president, prime minister and cabinet. The Prime Minister's primary role is to assist the president with supervision of the cabinet. Legislative power is vested in both the Government and the National Assembly. The Judicial branch is an independent branch of government. It is comprised of the Magistrates Court, High Court, Court of Appeal and the Supreme Court. Uganda has a multi-party system. The multi-party system was reinstated in 2005 after a constitutional referendum cancelled a 19-year ban on multi-party politics. The ruling party is the National Resistance Movement (The State House of Uganda, 2018).

Uganda is a Least Developed Country (LDC) with GDP of \$25.9 billion and GDP per capita of \$600. The country is endowed with significant natural resources, including ample fertile land, regular rainfall, as well as mineral deposits including copper, gold and oil. Recent economic growth has been driven by the information and communications sector, and favourable weather conditions for the agricultural sector. The services sector comprises 50% of the economy, including retail, telecommunications, hospitality, transport and tourism sub-sectors (Government of Uganda, 2018). The industry sector includes manufacturing, construction and electricity provision, accounting for 25.5% of the economy. The agricultural sector accounts for the remaining 24.5% of the economy, employing approximately 70% of the population (Uganda Investment Authority, 2018). Cotton, tea and coffee comprise the bulk of agricultural exports and are the dominant sources of export revenue.

Since 1986, the Ugandan Government, with assistance from foreign countries, has acted to grow and stabilise the economy through various economic reforms. This has ushered in an era of strong economic growth, with the economy in Uganda growing by an annual average of 7% over the past decade. Poverty rates have steeply declined during the same interval, decreasing to below 20% in recent years (ICD-PS, 2016). A large public investment programme and the investment in oil is expected to drive economic growth in the coming years (Deloitte, 2016).

While the economic outlook for Uganda remains positive, this is tempered by a number of significant internal and external risks. Risks include instability in South Sudan (Uganda's main export market), high energy costs, a very high population growth rate, inadequate transportation and energy infrastructure, corruption, volatility in commodity prices, and slowdown in trading partner economies (PwC, 2017). Other internal risks that the Ugandan economy faces include slower than expected investment in oil production, adverse weather conditions affecting food supply and agricultural production, and volatility in the local currency (the Ugandan shilling depreciated 50% against the dollar between 2015 and 2017) (Central Intelligence Agency, 2017). These factors are currently inhibiting economic development and damaging investor confidence.

2.2 OVERVIEW OF THE ENERGY SECTOR

2.2.1 ENERGY MIX, EMISSIONS AND TRENDS

Uganda meets more than 93% of national energy demand with biomass fuel (firewood, charcoal, and crop residues), and a further 6% from imported fossil thermal fuel (mainly diesel and heavy fuel-oil). Total primary energy consumption is 14.9 Mtoe annually. Electricity only contributes around 1% to the national energy balance. Uganda currently has among the lowest per capita electricity consumption in the world with 215kWh per capita per year (Sub-Saharan Africa's average: 552kWh per capita, World average: 2,975 per capita), with hydropower accounting for 692MW of a total 822MW of electricity generation capacity (84% of total). The three largest hydropower stations are Kiira (200MW), Nalubale (180MW) and Bujagali (250MW). Several other smaller hydropower stations are additionally in operation. Other sources of electricity include two thermal power plants (50MW and 80MW) and two biomass cogeneration plants that run on bagasse (combined output of 30MW) (Energylopedia, 2018). In terms of renewable energy generation, solar photovoltaic (PV) technology is currently limited to the use of standalone solar home systems (SHS), with wind and geothermal energy remaining unexploited.

Categorised as a Least Developed Country (LDC) by the United Nations (UN), Uganda's contribution to global greenhouse gas (GHG) emissions and GHG emissions per capita are both very low when compared to global averages, estimated as 0.1% and 1.3tCO₂e respectively. Nonetheless, Uganda outlines a variety of emissions mitigation actions in its Intended Nationally Determined Contribution (INDC) document, submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. Prioritised mitigation actions include offsetting the use of wood and charcoal biomass (currently regarded as unsustainable due to deforestation rates) through electricity infrastructure development, as well as developing an enabling environment for both forestry and wetland management. Secondary mitigation actions include promotion of the rollout of energy efficient cook stoves and solar home systems, new regulations around building energy use and use of efficient fuels, and the deployment of 'smart' agriculture systems (Uganda Ministry of Water and Environment, 2017).

Given strong GDP growth of around 6% annually for the past two decades, electricity demand has been growing at around 10% annually. This increased demand, combined with erratic rainfall and droughts that has affected hydropower supply, has led to occasional load shedding in recent years. Two newly added heavy fuel-oil (HFO) power plants (50MW each) have reduced this load shedding to close to zero, with an excess of generation capacity now in operation in Uganda. Proportions of Uganda's energy and electricity demand by sector are illustrated in table 1 (Ministry of Energy and Mineral Development) (Energylopedia, 2018):

Table 1: Uganda's energy and electricity demand by sector (Ministry of Energy and Mineral Development)

Sector	Energy demand (%)	Electricity demand (%)
Residential	67.1	24.2
Commercial	13.4	11.2
Industrial	11.9	64.6
Transport	7.3	0
Agriculture	0.5	0
Total	100	100

Going forward, Uganda intends to significantly scale up renewable energy (RE) technology deployment, taking advantage of plentiful solar, hydro and biomass sources. Uganda's SE4ALL Action Agenda (AA) projects a renewable energy generation capacity scale-up to around 3,000MW to 2030, up from around 650MW today. This contribution will be dominated by large scale hydropower generation, with solar PV and biomass contributions around 2 to 3% of total.

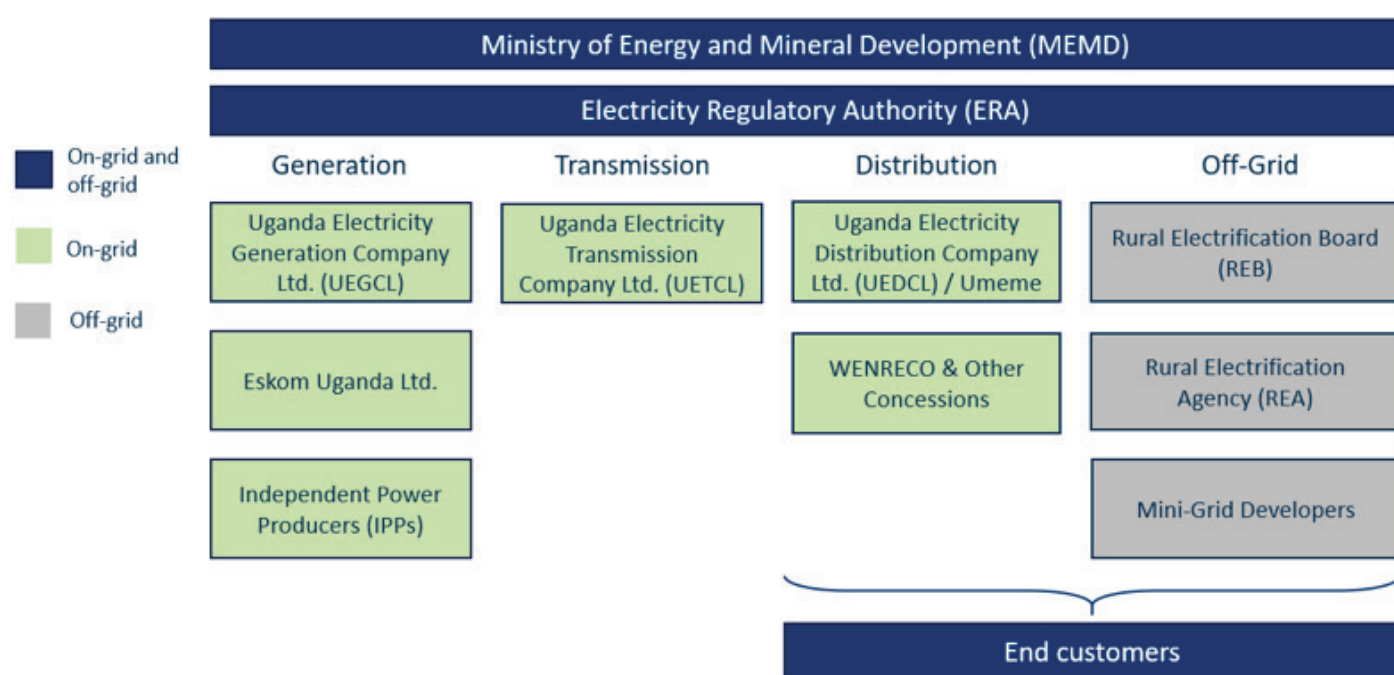
Table 2: Contribution of new RE projects to Uganda's electricity mix by 2030

	RE technology type	Intended installed capacity by 2030 (MW)	Estimated electricity generation annually (GWh)
On-grid	Large hydroelectric power	2,400	9,500 – 12,000
	Small hydroelectric power	380	1,250 – 2,000
	Solar PV (grid-connected)	20MWp	25 – 30
	Biomass cogeneration	20	100
Off-grid	Solar PV (mini-grid)	30	40 – 70
	Solar PV (streetlights)	50	10 – 15
	Solar PV (solar home systems)	140	100
	Total	3,000 – 3,100	10,750 – 14,500

2.2.2 KEY ENERGY AND ELECTRICITY SECTOR STAKEHOLDERS

Key government stakeholders in Uganda's energy and electricity sectors include the Ministry of Energy and Mineral Development (MEMD), the Electricity Regulatory Authority (ERA) and the Rural Electrification Agency (REA). MEMD is responsible for developing policies, initiating legislation, and inspecting, regulating, monitoring and evaluating the energy sector overall. ERA is responsible for issuing licences to project developers, investigating tariff changes, and reviewing, developing and enforcing performance standards for electricity generation, transmission and distribution. REA is the secretariat for the Rural Electrification Board (REB), with responsibilities including planning delivery of Uganda's Indicative Rural Electrification Master Plan (IREMP), implementing government rural electrification projects, and managing associated funds. A large government reorganisation was announced during the second half of 2018 under which REA would be absorbed into the MEMD and ERA would remain separate. The reorganisation is expected to take a few years to complete.

Figure 2: Key energy and electricity sector stakeholders in Uganda (both on-grid and off-grid)



Three state-owned enterprises are responsible for providing electricity across Uganda, delivering generation, transmission and distribution services respectively. These companies are the Ugandan Electricity Generation Company Limited (UEGCL), the Uganda Electricity Transmission Company Ltd. (UETCL) and Uganda Electricity Distribution Company Limited (UEDCL). UEDCL later concessioned UMEME Ltd to operate and maintain the distribution network. These three entities were created following the disbanding of the former Uganda Electricity Board (UEB) via the Electricity Act, 1999, with a view to liberalising the sector.

UEGCL is responsible for electricity generation and development of new power stations, with two of the largest hydropower stations (Nalubale and Kiira) currently being operated and maintained by Eskom Uganda Limited (EUL) under a 20-year concession to 2023. While Nalubale and Kiira power plants represent around 42% of national generation capacity, the remaining 58% is supplied by a number of different Independent Power Producers (IPPs).

The electricity generated by UEGCL and other IPPs is sold to UETCL (the authorised single buyer) for transmission across the country. UETCL is also responsible for importing electricity from neighbouring countries and publishing standardised tariffs for renewable energy generation of up to 20MW.

Finally, the bulk of electricity is sold to UMEME Ltd, a privately owned company with a 20-year concession for distribution and retail to consumers across the country. Umeme currently has a 97% market share across all electricity distribution nationally (effectively a monopoly), although there are two notable off-grid distributors and the West Nile Rural Electrification Company (WENRECo) (Electricity Regulatory Authority, 2017). Five other smaller companies (mostly co-operatives) have also been issued distribution licences (on the main or national grid) by ERA.

Other organisations involved in regulating the electricity sector include the National Environmental Management Authority (NEMA), the Directorate of Water Resource Management (DWRM), the Uganda Investment Authority (UIA), the Uganda National Bureau of Standards (UNBS), and the Electricity Disputes Tribunal (EDT).

NEMA regulates the environmental impact of power projects, including (1) reviewing and approving environmental project briefs, environmental impact reviews, environmental impact assessments, and resettlement action plans, and (2) issuing certificates of environmental clearance.

DWRM, an agency within the Ministry of Water and Environment, is responsible for managing the country's water resources in an integrated and sustainable manner. Its objective is to secure and provide water of adequate quantity and quality for all social and economic needs for the present and future. DWRM issues surface-water abstraction and construction permits to developers of hydropower projects; it is also in charge of water discharge and underground water abstraction permits.

UIA is a semi-autonomous government agency that operates in partnership with the private sector to drive national economic growth and development. As a one-stop shop for investors, UIA offers free services and enables investors to register their businesses and obtain all necessary licences under one roof.

UNBS is a statutory body under the Ministry of Trade, Industry, and Co-operatives. Its mandate is to formulate and promote the use of national standards and to develop quality control and quality assurance systems that will enhance consumer protection, public health and safety, industrial and commercial development, and international trade. As part of its responsibilities, UNBS develops and monitors standards for renewable energy technologies.

EDT reviews and determines all matters referred to it relating to the electricity sector. Its jurisdiction includes electricity disputes between consumers and the public bodies charged with generation, transmission, and distribution of electricity. In exercising its functions, it has the powers of the High Court of Uganda. The decisions of the ERA may be appealed to the EDT (NARUC, 2017).

Other international participants are equally active in electricity planning in Uganda, including USAID, GIZ, KfW, the EU and the World Bank. These organisations provide grants, financing and technical assistance in a variety of areas.

2.2.3 GOVERNMENT ENERGY POLICIES, STRATEGIES, TARGETS, ROADMAPS, PLANS AND PROGRAMMES

Uganda's main energy policy goal is “to meet the energy needs of the Ugandan population for social and economic development in an environmentally sustainable manner”. In the 2002 Energy Policy, the Government sets out a vision for increasing and improving modern energy supply, committing to use of renewable energy for both large and small-scale applications, while simultaneously diversifying the energy mix to avoid reliance on any one source (particularly following hydropower-linked electricity shortages due to droughts). More specific policy objectives include:

- Establishing the availability, potential and demand of the various energy sources in the country;
- Increasing access to modern, affordable and reliable energy services as a contribution to poverty eradication;
- Improving energy governance and administration;
- Stimulating economic development;
- Managing energy-related environmental impacts;
- Increasing the role of the private sector in power sector operations and future development.

There are also plans to introduce nuclear energy into the energy mix in the long term. Uganda's State energy minister recently signed a memorandum of understanding with the Russian state Atomic Energy Corporation (Uganda Business News, 2017). Oil has been detected in several basins within Uganda. Mention has also been made to use a portion of the oil for electricity generation. Exploration efforts are however still in their early stages (Energypedia, 2018).

Uganda's 2007 Renewable Energy Policy outlines a vision to make modern renewable energy (RE) a substantial part of national energy consumption, where modern RE is understood to mean the use of RE for provision of electricity services. The ultimate goal of the policy was to increase the use of modern RE from 4% to 61% by 2017. More specific policy objectives include:

- Creating a more favourable business environment with appropriately refreshed policies, regulations and business plans;
- Maintaining and improving the responsiveness of the legal and institutional framework to promote RE investments;
- Mainstreaming poverty eradication, equitable distribution, social services and gender issues in RE policies;
- Establishing a financing and fiscal policy framework for investments in RE;
- Increasing public awareness in RE and promoting investment in this area;
- Promoting Research and Development (R&D) as well as international co-operation in RE technologies;
- Utilising biomass energy efficiently and sustainably;
- Promoting the conversion of municipal and industrial waste to energy.

Since the inception of the RE policy, Uganda has developed a Power Sector Investment Plan (PSIP), a Renewable Energy Investment Plan (REIP), a standardised PPA and implementation agreement for hydro, bagasse, biomass and solar PV (either under development or finalised in all cases), and a biomass energy strategy (BEST). A series of studies have also been conducted on biofuels and other technologies, and RE-FIT and GET-FIT programmes have been implemented and are expected to drive additional small RE generation investment from 2014 to 2023.

Reinforcing Uganda's energy and renewable energy policy goals, Uganda's Vision 2040 document includes energy access as a key focus area, aiming for universal access by 2040 (National Planning Authority, 2007). Notably, electricity generation capacity targets included within this document are: hydropower (4,500MW), geo-thermal (1,500MW), nuclear (24,000MW), solar (5,000MW), biomass (1,700MW), peat (800MW) and thermal (4,300MW). It is unclear whether these 2040 targets are realistic, particularly given significant nuclear power ambition.

Uganda's Second National Development Plan (2015/16-2019/20) states that energy infrastructure investment will be focused on the exploitation of abundant renewable energy resources including hydropower and geothermal, so as to increase power generation capacity from 825MW in 2012 to 2,500MW by 2022; expansion of the national electricity power grid network; and promoting energy efficiency and use of alternative sources of energy. Infrastructure is among other priority development areas including agriculture, tourism, minerals, oil and gas, and human capital development (Government of Uganda, 2018).

Uganda's Poverty Eradication Action Plan identifies “significant returns to rural electrification in reducing poverty”. The plan discusses the Government of Uganda's strategy of subsidising investments rather than financing them outright (encouraging private sector activity), as well as benefits including increased employment and agricultural marketing opportunities. It also discusses the Energy for Rural Transformation (ERT) programme in Uganda, which has been developed to widen the access of rural areas to energy supplies through grid extension, independent power producers (IPPs) and solar or renewable energy. The Rural Electrification Fund (REF) is described as the source of subsidies to private energy suppliers.

Uganda has also opted-in to the United Nations (UN) Sustainable Energy for All (SE4ALL) initiative, a global initiative to deliver against UN Sustainable Development Goal No. 7, which calls for universal access to energy by 2030. A subsequent SE4ALL Action Agenda has been formally adopted by the Government of Uganda, with the goal of having more than 98% of the population with access to electricity by 2030, while achieving more than 90% renewable electricity production. The AA suggests a diversification of renewable technologies and that these should continue playing a good role in Uganda's energy mix in combination with micro and mini-grid technologies. Other SEforALL goals for Uganda include analysing energy savings potential in different sectors of the country's economy (households, commercial enterprises, industries and buildings), aiming to reduce national wood consumption by 40%, and improving energy efficiency of power users by a minimum of 20% by 2030. The Uganda focal point for SE4ALL is located in the Ministry of Energy and Mineral Development (SE4ALL, 2018).

Uganda's Rural Electrification Strategy and Plan (RESP) is led by the REA, outlining a large scale planning effort to determine which parts of the country will be served by off-grid versus on-grid services. The RESP is in its second phase, with the objective of accelerating coverage of consumer access to electricity while simultaneously replacing kerosene lighting and other forms of traditional cooking and heating. RESP II is running from 2013 to 2022, aiming to achieve 26% rural electricity access by 2022 by awarding concessions to single electricity providers in each of 13 different territories across Uganda. More detail is provided in section 2.4.1.

Numerous other renewable energy projects and programmes, via donors and private sector, are also being delivered in Uganda. Most of these programmes are being led by the Rural Electrification Agency (REA). The Uganda Energy Credit Capitalisation Company (UECCC) has put in place a *Power Connection Loan Refinance Facility* to enable residents in the West Nile region to access power from WENRECo's Nyagak 3.5MW hydropower plant. The World Bank (WB) is delivering an *Energy for Rural Transformation project (ERT)*, which includes various different aspects including grid extension, a *Solar Refinance Facility* for concessional finance for micro-lending for solar home systems, off-grid business development support and quality standards enforcement, and institutional strengthening and impact monitoring. UECCC also provides support for power generation project developers through an *Early Stage Support Programme* funded by KfW, with a range of services including pre-feasibility studies, technical design, business plan development and access to finance. The *Grid Expansion and Reinforcement Project* is a World Bank funded project that commenced in 2016. The project has three components: construction of transmission infrastructure to increase electricity transmission capacity and grid connectivity; support to UETCL to build capacity and operational effectiveness; strengthening of skills required in the sector (World Bank, 2016).

A particularly notable recent success story in Uganda is the delivery of the Global Energy Transfer Feed-in Tariff (GET-FiT), a flagship clean energy policy launched as a joint initiative by the Ugandan authorities, the World Bank, KfW and a group of European member states in 2013. The aim of this programme was to reduce barriers to investment in RE by accelerating development of 20 RE projects from 1 to 20MW in size (170MW total), as well as delivering on wider energy policy objectives including: enhancing the overall private investor environment in renewable energy; adding least-cost generation capacity to stabilise the power sector; decentralising and diversifying the energy mix; improving the availability of long-term commercial finance for small-scale renewable energy projects. The GET FiT programme provides developers with top-up to existing clean energy FiT for the first five years of operation, as well as access to private financing and insurance against off-taker risk. This allows developers to receive higher payments during the most critical years of the project's operation. A standardised PPA and transparent permitting process were delivered as part of this programme. While the programme was considered successful, the Ugandan energy sector still needs to deal with a number of challenges to build on these successes, continuing to clear obstacles that have delayed GET-FiT projects (ClimateScope, 2016).

Finally, GIZ is currently leading a programme named “Promotion of Mini-Grids in Northern Uganda”, working to develop RE mini-grid strategies, transparent and efficient tender mechanisms and to ensure appropriate technology use and distribution of electricity to the intended user (GIZ, 2016). GIZ also have other ongoing projects such as to exempt RE projects with an output of less than 2MW from licensing.

2.3 OVERVIEW OF THE POWER SECTOR

2.3.1 CONTEXT

Uganda has one of the lowest electricity access rates in the world, with only 19 to 26% of the total population having some form of electricity access. Reports of urban versus rural electricity access vary, from 18.6% to 19.9% in rural areas, to 23.3% to 54.8% in rural areas (low end of range based on International Energy Agency energy access database; high end of range based on Uganda Bureau of Statistics) (IEA, 2016) (SE4ALL, 2015). Approximately 18% of the population live in urban areas versus 82% in rural areas.

Table 3: Estimated electrification status in Uganda (SE4ALL, 2015)

Population 2014			Electricity access rate	Population with access	Household size	Households with access	Households without access
Urban	6,426,000	18.4%	54.8%	3,521,000	4.7	749,000	618,000
Rural	28,431,000	81.6%	19.9%	5,658,000	4.7	1,204,000	4,845,000
Total	34,857,000	100%	26.3%	9,179,000	4.7	1,953,000	5,463,000

To achieve the SE4ALL AA target of 98% electrification access by 2030, Uganda needs to increase its rate of adding connections from 100,000 annually to more than 650,000 annually from 2015 to 2030. This is a tremendously challenging target, with difficulty exacerbated by the high population growth rate in the country. The Government of Uganda is therefore working with key stakeholders on interventions and strategies that will accelerate connection rates to a level consistent with the universal access target. According to SE4ALL Action Agenda analysis, more than nine donor programmes were in place to increase the number of connections in Uganda in 2016, with around 4.5 million added connections planned to 2030 (around 2.7 million on-grid and 1.8 million off-grid). REA, under the Rural Electrification Strategy and Plan (RESP), aims to achieve add 1.3 million new on-grid services connections by 2022. However, approximately 10 million connections are needed, leaving a gap of 5.5 million connections in a ‘base case’ scenario (SE4ALL, 2015).

A household connection projection and gap analysis for electricity access is shown in table 4.

Table 4: Household connection projection and gap analysis for electricity access 2015 to 2030 (SE4ALL, 2015)

	2015	2020	2025	2030	Gap by 2030	Connections 2015-30
Urban	1,404,000	1,585,000	1,832,000	2,204,000	1,455,000	97,000
Rural	6,213,000	7,011,000	8,104,000	9,752,000	8,549,000	570,000
Total	7,617,000	8,596,000	9,936,000	11,957,000	10,004,000	667,000

2.3.2 GENERATION

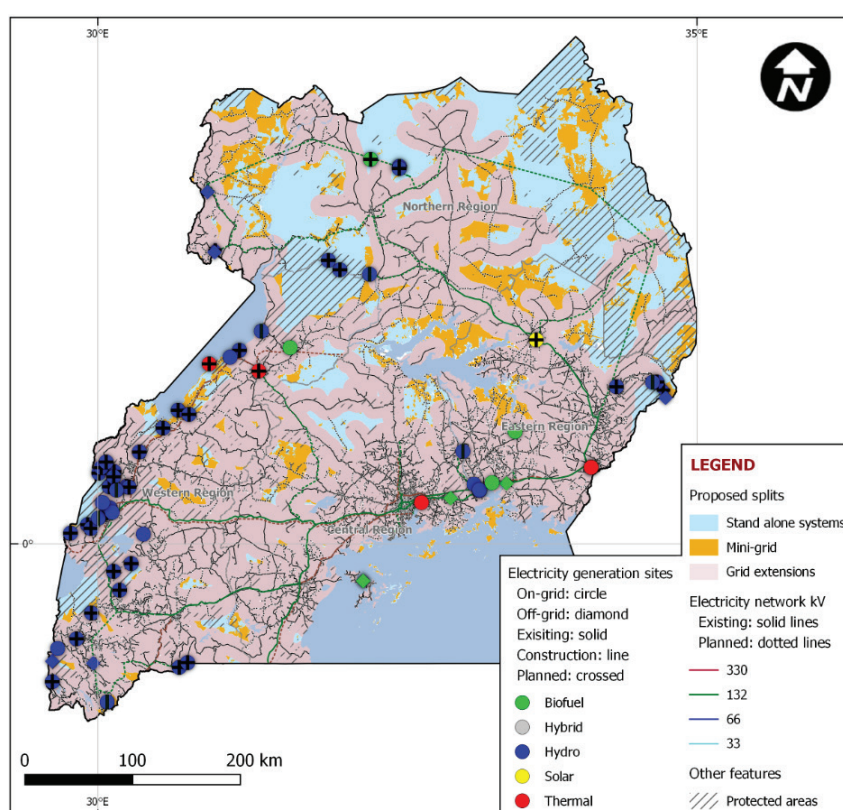
Uganda currently has 850MW of installed generation capacity, with effective generation capacity of approximately 710MW. Approximately 645MW of this generation capacity is hydro and 100MW is thermal (biomass and heavy fuel oil). The Government of Uganda is building additional large hydropower plants, including a 600MW hydro plant in Karuma and a 183MW hydro plant in Isimba Falls, which will be operated by UEGCL. All other large power generation plants belong to UEGCL, but are operated and managed by ESKOM (Nalubale and Kiira only), Aggreko and other companies. Uganda’s most important power stations are listed in table 5 below.

Table 5: Completed power stations in Uganda (2018)

Name of power station	Capacity (MW)	Type
Bujagali	250	Large hydro
Kiira	200	Large hydro
Nalubaale	180	Large hydro
Muzizi	45	Large hydro
Electro-Maxx-Tororo	80	Thermal (Heavy Fuel Oil)
Jacobsen-Namanve	50	Thermal (Heavy Fuel Oil)
Karkira Sugar Works	22	Bagasse cogeneration
Kinyara Sugar Works	7.5	Bagasse cogeneration
Kilembe Mines Ltd	5	Small hydro
Tronder Power Bugoye	13	Small hydro
Mpanga	18	Hydro
Mubuku III (KCCL)	9.9	Hydro
Ishasha	6.6	Hydro
Total	887	

Until 2009, much of Uganda's generation capacity came from Nalubaale and Kiira hydropower stations in Jinja in Southeastern Uganda. However, during droughts (such as in 2009), only around half of the installed capacity could be used as a result of the low water level of Lake Victoria. Continued strong annual growth in demand for electricity exacerbated this electricity supply problem, leading to load shedding and blackouts in previous years. A new 250MW hydro facility has subsequently been developed at Bujagali (north of Jinja), and has been operational since February 2012. Before Bujagali became operational, 150MW of thermal capacity was added as an 'emergency' measure to bridge the gap until the beginning of 2012. There now exists a generation capacity surplus on the grid (with consequent focus on grid expansion). Despite now having sufficient supply, the quality of the grid still remain a challenge. This is mainly due to a lack of proper load distribution management, which results in the grid occasionally becoming overloaded, causing component failure and blackouts (Energypedia, 2018).

Figure 3: Power plant locations across Uganda (Carbon Trust analysis)



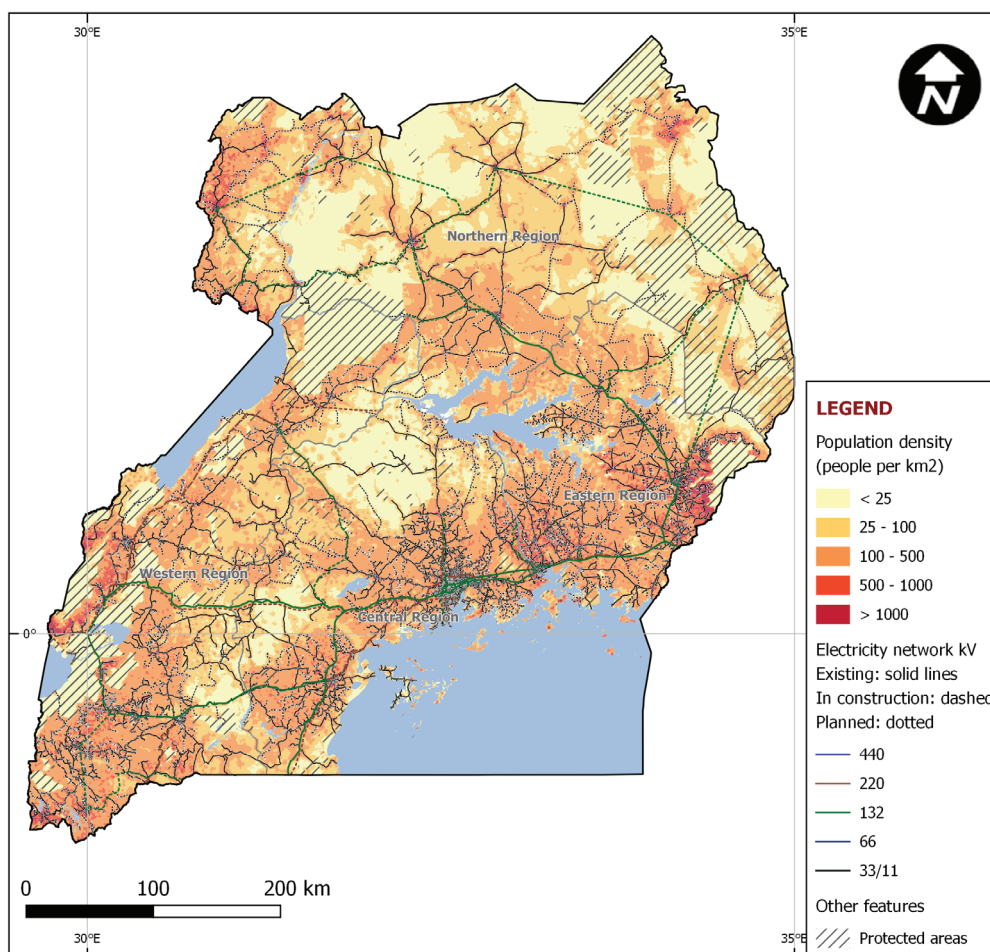
Another seven hydropower plants with combined capacity of 740MW are currently under construction. The most significant of these is the Ayago power station at 600MW, which is due to be completed in 2023. Together these power plants will nearly double Uganda's generation capacity, not including a number of other proposed thermal, solar PV and geothermal power plants. Other small and mini hydro sites are mainly located in the Eastern and the Western parts of the country which are hilly and mountainous. A total of 59 mini hydropower sites with a potential of about 210MW have been identified through different studies (either on-grid or off-grid).

2.3.3 TRANSMISSION AND DISTRIBUTION

Transmission and distribution assets in Uganda are state-owned. The Uganda Electricity Transmission Company (UETCL) owns, plans, procures and operates Uganda's medium and high voltage transmission infrastructures >33kV).

Uganda's electricity grid is comprised of transmission and distribution power lines ranging from 220kV to 11kV. Transmission lines include 150km of 220kV high voltage (HV) lines, 1,442km of 132kV HV lines and 35km of 66kV MV transmission lines (Electricity Regulatory Authority, 2017). There are plans to double the total length of transmission lines in the coming years. Distribution lines include >5,000 km of 33kV lines and >5,000km of 11kV lines. This network currently provides power to only 33 of the 54 districts in the country (Energypedia, 2018). Power lines are mainly located in the south of the country especially in the region of Kampala, with limited power lines running toward the north. Uganda's grid is illustrated in figure 3, mapped to population density.

Figure 4: The existing transmission and distribution grid in Uganda (from 11kV to 440kV), mapped to population density (Carbon Trust analysis)



Following publication of the 2011 Power Sector Investment Plan, Uganda has undertaken a series of investments to strengthen the transmission network. These include development of new hydro and thermal power plants and a new transmission line in the North East of the country, to serve growing energy needs in this region (SE4ALL, 2015). Other plans include upgrading existing lines and developing a 220kV “ring” around Lake Victoria in conjunction with Kenya and Tanzania (USAID, 2016). The planned transformation will change the shape of the grid topology from radial to circular, which should improve grid management and efficiency. Proposed grid expansion includes cross-border transmission lines to facilitate power exports and imports, with various 220kV interconnection projects with Kenya and Rwanda already under development. In addition, a feasibility study for interconnection with Tanzania has been completed, while the feasibility study for interconnection with the Democratic Republic of Congo is ongoing (SE4ALL, 2015).

National on-grid electricity tariffs are considered to be cost-reflective in Uganda; high enough for private sector Independent Power Producers (IPPs) to recover their costs. Therefore, these are some of the highest electricity tariffs in East Africa, ranging from \$0.20/kWh for households to \$0.08/kWh for large industrial customers (US Export.gov, 2017). An additional \$0.06/kWh ‘lifeline’ tariff is in place for the poor (monthly usage under 15kWh). Tariffs for 2018 (Q4) are shown in table 5.

Table 6: National on-grid electricity tariffs in Uganda, 2018

Cost per kWh	Domestic	Commercial	Medium Industrial	Large Industrial	Extra Large Industrial	Street Lights
Ugandan Shillings / kWh	770	686	614	382	313	750
US \$ cents/kWh	0.20	0.18	0.16	0.10	0.08	0.20

Source: Electricity Regulatory Authority 2018

The Uganda Electricity Transmission Company Ltd (UETCL) is the bulk supplier and single buyer of power for the national grid in Uganda. It purchases all independently generated power in the country and it also imports electricity from neighbouring countries. To promote the development and use of RE sources, UETCL is also responsible for publishing standardised tariffs for renewable energy generation of up to 20MW capacity based on the avoided cost principle (Energypedia, 2018). Currently applicable RE feed-in-tariffs payable by the UETCL, in consultation with the ERA, are illustrated in table 7 below (ERA, 2018):

Table 7: Renewable energy tariffs (RE FIT) paid by UETCL (transmission company) to on-grid RE IPPs (ERA, 2018)

Technology	Tariff (US\$ cents)/ kWh	O&M %age	Cumulative Capacity Limits (MW)				Payment Period (Years)
			2013	2014	2015	2016	
Hydro (9-20MW)	8.5	7.6%	30	90	135	180	20
Hydro (1-9MW)	Linear tariff ¹	7.2%	30	75	105	135	20
Hydro (0.5-1MW)	11.5	7.1%	1	2	2.5	5.5	20
Bagasse	9.5	22.7%	30	70	95	120	20
Biomass (MSW)	10.3	16.2%	5	15	25	45	20
Biogas	11.5	19.2%	5	15	25	45	20
Landfill gas	8.9	19.7%	0	10	20	40	20
Geothermal	7.7	4.3%	10	30	50	75	20
Wind	12.4	6.3%	25	75	100	150	20

Source: Electricity Regulatory Authority 2018

2.4 OVERVIEW OF THE OFF-GRID SECTOR

2.4.1 ENERGY ACCESS POLICY AND PLANNING

As previously discussed, rural electrification is a high policy priority in Uganda and is co-ordinated primarily through the REA. As described in section 1.2.2, Uganda's Vision 2040 aims to promote energy access through both grid extension and other rural electrification programmes. The Government aims to provide incentives to accelerate delivery of the required infrastructure, with a broad policy goal of "increasing access to modern, affordable and reliable energy services as a contribution to poverty eradication".

Uganda's Rural Electrification Strategy and Plan (RESP) is led by the REA, outlining a large-scale planning effort to determine which parts of the country will be served by off-grid versus on-grid services. The RESP is in its second phase, with the objective of accelerating coverage of consumer access to electricity while simultaneously replacing kerosene lighting and other forms of traditional cooking and heating. RESP II is running from 2013 to 2022, aiming to achieve 26% rural electricity access by 2022, by awarding concessions to single electricity providers in each of 13 different territories across Uganda. These awards will be made via a competitive bidding process. In off-grid areas, the RESP aims for private sector developers to provide either RE-based mini-grids or solar PV home systems (REA, 2013). The estimated cost of RESP II is \$950m, with over 90% projected to be spent on on-grid electrification (the remainder on either off-grid electrification, customer financing, technical assistance, or other areas). While this centralised approach to electrification may have merit, it relies on good data which is a clear issue in Uganda (and has led to errors in centralised planning in the past).

The RESP outlines a minor role for mini-grids: estimating 8,500 new service connections from mini-grids by 2022, compared with 130,000 new solar home systems and 1,276,500 new connections from grid extensions (REA, 2013). REA is in the early stages of amending the second RESP to better clarify the role of mini-grids and solar home systems in rural electrification. Given the current state of mini-grid policy and planning, much of the mini-grid regulatory regime is still under development.

To support the RESP, the Rural Electrification Agency (REA) has embarked upon a master planning process to distinguish between areas suitable for grid extension versus areas suitable for other off-grid solutions. This master plan will have a 10-year horizon and is due for publication in summer 2018, including development of detailed construction plans. Initial surveys are being undertaken by consultancy NRECA to identify population centres and collect the socioeconomic data necessary to undertake prefeasibility studies. It is likely that the master plan will advocate a certain split of regions within the country, as well as a particularly mini-grid delivery model. Potential models include (1) the 'Kenya' model, whereby the Government will install and own both generation and distribution equipment (i.e. either the REA, UEGCL or UETCL – or some combination), (2) a tender model whereby certain projects, areas or regions are tendered to developers with the highest bidder winning, (3) a concession model whereby areas with pre-specified conditions are again tendered to developers, or (4) a liberal model whereby developers are allowed to develop (with licences) projects charging cost-reflective tariffs. Stakeholders within the donor community argue that there may be no need to restrict mini-grid development to a particular type of model, and in fact that a 'Uganda+' model could simply build on the off-grid processes and regulations that are already in place.

To support both RESP and the master planning, the REA also administers the Rural Electrification Fund (REF), which funds and finances rural electrification projects through grants and subsidies. Funds for the REF come from a range of sources including parliamentary appropriations, surplus monies from the operation of ERA, a 5% levy on transmission bulk purchases of electricity from generation stations, and loans and grants from development partners such as GIZ, the World Bank/International Development Association, Swedish International Development Cooperation Agency (SIDA), Japan International Cooperation Agency (JICA), the Government of Norway, the Global Environment Facility (GEF), and KfW (NARUC, 2017).

There are a considerable number of other institutions involved in regulating the off-grid sector in Uganda, including the MEMD, ERA, UETCL, DWRM and NEMA. These are described in more detail in section 2.2.2, with key contact details listed in the renewable energy investment guide on the ERA website (Electricity Regulatory Authority, 2018). Given the large number of organisations involved, on the one hand this may serve to provide 'competition' in providing

the best regulation (which to date has worked in Uganda's favour, according to some stakeholders), yet on the other hand may lead to an unclear distribution of roles, weaker governance and slower decision-making (for example, ERA lacks the capacity for dealing with technical regulation, which could instead be handled by the National Bureau of Standards). Either way, government focus in Uganda remains on grid expansion rather than the mini-grid sector, with annual budget for grid expansion around an order of magnitude larger than for off-grid.

2.4.2 LICENCING

Presently, mini-grid projects in Uganda are regulated based on their capacity, with mini-grids greater than 2MW in capacity subject to the same regulations as national grid independent power projects (IPPs) including licensing, tariff approval, technical standards, and general oversight. In this case, licensing is a two-step process with the first step being a detailed preparation phase (business plans, Environmental Impact Assessment (EIA), clearances with multiple government departments, PPA, etc, and the second step being an application for the licence.

Mini-grids less than 2MW are regulated through a licence exemption process based on a Memorandum of Understanding (MoU) with the Electricity Regulatory Authority. An environmental 'brief' is required rather than a full EIA, and rules are provided around tariff approval, technical standards, reporting, customer service, dispute settlement, and upgrading generation capacity above 2MW. To be approved for licence exemption, a financial model which calculates the end tariff is required (including details of all loans, as any interest rates cannot be included within the tariff). A business model submission and technical brief is also required. Finally, the mini-grid must be in a location where the main grid is not due to arrive, with ERA checks using the RESP.

According to the ERA, the <2MW mini-grid licence exemption process takes approximately six months to complete (although the ERA is targeting three to four months going forward). However, other stakeholders report difficulties in navigating the process, and ERA is generally known to be understaffed/under capacity (despite good technical capability).

The licence exemption process requires community consultation, whereby local communities are required to review the application, and any objections are addressed. The application is sent to local leaders and placed in the national newspaper for 30 days. The next step is a public hearing, advertised on radio stations and newspapers, where all other issues, e.g. land, are to be resolved. All beneficiaries and stakeholders are invited and informed of the details of the project, the likely tariff, and their rights. Assuming no objections are raised, the licence exemption is then issued. There are quarterly reporting requirements attached to the licence, but no annual fees.

When mini-grids are approved via the existing licence exemption process, the REA will provide the distribution infrastructure, installing the network and connecting households free of charge. Developers are therefore typically expected only to provide the generation capacity and the ongoing operations and maintenance for the entire system (connections may or may not also be undertaken by the REA – less guaranteed). This arrangement has been used for all licenced mini-grids in Uganda to date, although local developers note that eligible projects must fall within those areas of current REA interest. Effectively, this represents an approximate 30% subsidy to each mini-grid project, and it is worth noting that REA will install grid compliant distribution infrastructure to avoid the risk of grid arrival going forward. However, this is expensive and results in over-engineering in some cases, given the small scale nature of mini-grid projects. There is a risk that this may not be financially sustainable for the REA in the longer term.

Autonomous mini-grids are specifically regulated under Electricity Order 2007 No. 39 (Electricity [Licence Exemption] [Isolated Grid System] Order 2007). While the rules are helpful, they provided limited detail. For example, the rules briefly discuss interconnection to the main grid, but do not provide any details on ownership or compensation following grid connection. This lack of detail has resulted in some misunderstandings among mini-grid developers. ERA is engaged in an ongoing process to update the regulations to better suit small-scale, autonomous applications.

According to ERA, there are currently nine mini-grids that have been granted licence exemptions in Uganda, ranging from 37.5 to 300kW in size. These are illustrated in table 8.

Table 8: Uganda's licence-exempt mini-grids (ERA, March 2018)

Location	Technology	Capacity	Developer	Tariff (USD/kWh)	Comments
SW Uganda	Hydro	300kW	Unknown	Unknown	
Unknown	Hydro	84kW	GIZ	0.11-0.12	O&M only
Eastern Uganda (Suam)	Hydro	40kW	Unknown	0.11-0.12	O&M only
Bwindi Community	Hydro	50kW	GIZ	Unknown	Hospital
Kisiizi Hospital Power Ltd.	Hydro	60kW	Kisiizi Hospital Power Ltd.	Unknown	Hospital
South Uganda (Ktibo Island)	Solar PV	230kW	Absolute Energy	0.4	
Bukosa Island	Solar PV	25kW	Unknown	0.27	
Western Uganda	Biomass	2x 37.5kW	Pamoja Energy	Unknown	
Mandulis Power	Biomass	50kW	Unknown	0.27	
Kasese	Solar	5kW	Remergy	unknown	
			Kirchner Solar		
	Solar PV	1MW	Konserve Consult/ Girasolar	Unknown	

An example of an existing licence-exempt mini-grid project is that of Pamoja Energy, a subsidiary of a Swedish company that develops biomass gasification projects in rural villages with agricultural trading centres. Pamoja's model is based on use of an anchor load, whereby they dry maize for a nearby food manufacturer, thereby receiving guaranteed payments for the drying system. Farmers sell the maize to a third party with a digester (effectively outsourcing interaction with the co-operatives that represent the farmers), with Pamoja using the resultant gas to generate electricity. Pamoja currently has 2x 37.5kW capacity, with half the capacity currently sitting in reserve. This spare capacity will be used to power the local community, although at the time of writing Pamoja Energy were still waiting for the REA to come and install the necessary grid. The vision of the Pamoja Energy's CEO is ultimately to create a revolving fund, whereby local communities can borrow money for equipment for productive use of electricity.

There are a further 20 mini-grid projects that have not been granted licence exemptions in Uganda; 75% of these are at concept stage. Only one to two licences have been issued since the GET-FiT programme closed in 2017, with ERA under less pressure to issue licences since issues have been resolved on large on-grid hydro projects. One example is Konserve Consult Ltd, which is developing a 300kW solar PV project on Kimi Island in Lake Victoria. After just over a year, Konserve is close to obtaining necessary approvals. Island projects in Lake Victoria are considered attractive as they negate the risk of grid arrival and can target dense settlements with potentially lower distribution costs (Absolute Energy on Ktibo Island is another example).

WENRECO has also developed 1.5MW thermal and 3.5MW hydroelectric plants in the West Nile region, as the only bidder for a generation and distribution mini-grid concession in 2003. However, this took possession of an existing mini-grid, meaning that WENRECO is responsible for constructing and maintaining distribution networks in the region. This is different from the licence exempt arrangement for other mini-grids in Uganda. WENRECO is still obliged to uphold ERA's technical requirements for the distribution grid, which it has had significant difficulty in delivering. WENRECO has also faced challenges in obtaining ERA approval for a tariff sufficient to cover its operating and capital costs, and in achieving enough demand to fully utilise its generating capacity. However, it has recently added a large industrial account, which accounts for roughly 30% of demand.

Going forward, the ERA is interested in testing new models around issuing licences, either by a 'cluster' approach whereby multiple villages are tendered for electrification at once, or by a liberal approach where developers propose tariffs. Studies by GIZ, ERA and REA have led to 25 villages in Northern Uganda being selected as a cluster, which have been tendered for electrification. Eighteen companies (most international, but which will also work with local companies) have put in expressions of interest for this programme (now narrowed to four companies). The project was

at full proposal stage as of March 2018. While support for this cluster approach will be provided by government, target numbers of connections will need to be met, and it is hoped that a low tariff can be delivered. The EU has registered interest in backing this approach for another 500 villages, if successful. The EU is additionally subsidising six mini-grids being installed by WWF, planned to be delivered by either one company or several, for a total capacity of 5MW.

2.4.3 MINI-GRID TARIFFS

In theory, there is no restriction on allowable mini-grid tariffs in Uganda, although in practice around 1,000 Ugandan shillings per kWh (\$0.27/kWh) is the political upper limit (according to stakeholders). The Electricity Regulatory Authority reports that they have allowed \$0.3 to 0.5/kWh tariffs to be charged, although there is only one known example of this taking place (Absolute Energy, Ktibo Island).

At the moment tariffs for mini-grids are fixed rather than blended, which appears to be a missed opportunity in Uganda. Making use of blended tariffs can incentivise desirable behaviours, such as limiting consumption at certain times of day, or within certain segments of customer. Similarly penalties could be introduced where low quality power is provided. At the moment, blended tariffs are already used on-grid; extending this to off-grid represents a good regulatory opportunity.

It is worth noting that local people are currently paying up to \$3/day for diesel-generated electricity in rural areas – very low volumes, at very high costs, often for illegal installations. This indicates that Willingness to Pay (WTP) is there (at least during the early days of a project).

2.4.4 SUBSIDIES AND INCENTIVES

During the supply crisis of the late 2000s, the Government introduced an array of incentives to encourage power sector investments. These targeted both thermal and renewable energy power investments, including feed-in tariffs, take-or-pay arrangements (utility being bound to pay the contracted amount regardless of whether it takes it) and capacity payments. Additional supporting measures, such as sovereign guarantees and tax exemptions for general investments were also introduced.

For hydro, bagasse and wind projects with a capacity of one to 20MW, the ERA introduced a RE-FIT scheme offering off-take prices over the 20-year lifetime of the PPA (section 2.4.5), including fully cost-reflective tariffs from 2016. ERA's continued preference for RE-FIT is likely guided by the belief that small RE projects are not ideally suited for competitive tendering due to their small size, which limits investor interest. For solar PV, competitive tendering was made available under the GET-FiT programme until 2017 (Meyer et. al., 2017).

The GET-FiT programme was designed to encourage investment into small scale RE projects using a grant-based premium to close the gap between RE-FIT and the levelised cost of electricity for small hydro, bagasse, biomass and solar. The subsidy was calculated over the 20-year lifetime of the PPA, with a performance-based payment for the first five years of the project (enhancing the debt service profile). GET-FiT developed a full set of legal documents – including standardised technology specific and investor approved PPAs, implementation agreements, and direct agreements securing lender takeover rights. GET FiT also assisted the Government in streamlining approvals processes, as well as tax and customs exemptions for IPPs. An implementation consultant was used to run tenders and assess bids, with approvals made via an independent investment committee. Total funding capacity of \$90 million was completely committed to 17 IPPs with a total generation capacity of 157MW. It is expected that all will become operational. GET-FiT was a temporary facility designed to boost the small scale RE market, and is likely to succeed in achieving a track record for small scale IPPs and providing confidence to investors. However, the programme was focused on-grid, with no such incentives having yet been put in place off-grid. No further competitive tenders have been announced by the regulator since the programme ended (Meyer et. al., 2017).

A number of lessons have been learned from the RE FIT and GET-FiT programmes. These include the need to structure subsidy payments to incentivise performance, the need for robust paperwork/contracts made available upfront, the ability

to leverage private sector investment through grants/subsidies, the difficulty in attracting investment to small-scale projects (mini-grids in particular can cost at least \$500,000, and are therefore too large for small investors, but too small for large investors). Lack of debt finance is also an ongoing issue.

2.4.5 POWER PURCHASE AGREEMENTS

There are no PPA-eligible mini-grids currently in Uganda, with existing mini-grids being standalone systems typically in remote areas (either on islands or in hilly regions). However, a net import model for grid-tied mini-grids would be interesting in Uganda – for times when the grid is under pressure. This is something that UEGCL (the generation company) is interested in, according to stakeholders.

2.4.6 ARRIVAL OF THE GRID

In Uganda, there is currently no mechanism in place for compensating mini-grid developers or investors in the case of grid arrival. This is a clear issue, particularly when local political interests can cause unpredictable deviations from REA's electrification strategy and master plan. In Uganda, this has resulted in mini-grid developers typically targeting islands and mountains to mitigate grid arrival risk. It is also worth noting that the REA will install grid-quality distribution infrastructure for mini-grid projects that have been granted licence exemptions (effectively a 30% subsidy to a typical project), which allows for the mini-grid to be overtaken by the main grid. While this may be considered pragmatic, it is also expensive, and can result in over-engineering given the small scale nature of mini-grid projects. The risk with this approach going forward is that the REA will simply lack funds to sustainably scale this model.

2.4.7 TECHNICAL RULES

Autonomous mini-grids of less than 2MW are specifically regulated under Electricity Order 2007 No. 39 (Electricity [Licence Exemption] [Isolated Grid System] Order 2007). This regulation states that the holder of a certificate of exemption shall comply with the isolated grid technical standards, and shall annually update ERA with the compliance of the standards. However, details around the technical standards do not appear to be included in the regulation.

Mini-grids above 2MW are subject to the same technical standards as national grid independent power producers (IPPs). Primary Grid Codes are available through the ERA website, including systems operations codes, scheduling and dispatch codes, distribution and retail sales codes, and other general provisions (ERA, 2018).

2.4.8 MOBILE SERVICES

There are seven telecommunication network providers in Uganda and the country can be considered well connected relative to telecommunications elsewhere in Africa. Mobile network providers provide coverage for all urban and most rural areas, although signal quality varies significantly. Landline coverage in rural areas remains poor. Uganda has seen a high increase in the number of mobile phones owned due to service providers increasing their coverage, especially in rural areas. It is estimated that as of March 2018, 70% of Ugandans own mobile phones (National Information Technology Authority Uganda). This equates to around 24.8 million subscribers from a population of 39.6 million. Mobile network providers have installed 4G networks in and around Kampala while 3G networks are available in secondary urban areas. Quality internet access remains expensive and slow compared to international standards (US Export.gov, 2017).

2.4.9 BARRIERS TO MINI-GRID DEPLOYMENT

The mini-grid market in Uganda has seen a number of successes to date, including the establishment of several successful mini-grid projects. Cross-government co-operation has seen approval of multiple projects, with financial viability achieved through contributions through the Rural Electrification Fund (REF) through the REA. Developers have also received support from donors throughout the project planning, approval and development phases.

However, there remain a number of key barriers to mini-grid deployment in Uganda, including:

- A lack of an appropriately detailed masterplan (including a lack of clarity around the future roll-out model to be adopted);
- Difficulty obtaining a licence exemption, with licence exemption and environmental review (<2MW) processes considered difficult to navigate by stakeholders (potentially due to a lack of capacity within ERA);
- A lack of clarity around required standards;
- A lack of clarity around what happens when the grid arrives;
- A lack of finance (particularly debt finance);
- A lack of data, with consequent difficulty in identifying appropriate project sites (including a lack of data on RE resources, likely local demand, grid extension and existing of existing projects);
- Difficulty in obtaining permissions for a truly cost-reflective tariff where both generation and O&M costs can be comfortably recovered;
- Difficulty in accurately forecasting future project cash flows due to unpredictability of end customers (e.g. fee avoidance and successes/failures in encouraging productive use);
- Lack of skills and technology transfer to the off-grid sector;
- Insufficient stakeholder participation in planning and implementing projects.

Resolving these issues (many of which may be relatively quick wins) is likely to open up the off-grid sector further.

3. GREEN MINI-GRID POTENTIAL

3.1 DATA AVAILABILITY

Estimating the potential for mini-grids is a challenging task that requires substantial data and assumptions. Some physical factors, such as resource availability and geographic features, can be collected remotely through satellite data, but other factors require the availability of local datasets and surveys. Certain non-physical factors, such as demand and consumption patterns, require precise settlement-level data to be collected. This data is often unavailable, out of date, or is highly resource intensive to obtain. An opportunity assessment relies upon several assumptions and criteria that are driven by the business model and approach of the implementing agency for each case. For example, a private developer may consider purely financial metrics, whereas a community scheme could focus more on the level of services provided. A detailed assessment in this report will not address the needs of all stakeholders for which it is intended. Therefore, this report aims to capture available data and highlights general assessments that would be relevant to most mini-grid stakeholders. Raw data is provided with this report to allow stakeholders to conduct their own further analyses as required.

This high-level analysis defines grid and off-grid areas based on their distance from the power network. Grid regions are defined as those areas within 15km of the grid, in keeping with the methodology for all country reports under the Market Development Programme. Off-grid population centres are then mapped, enabling an analysis of the potential for mini-grid projects. Analysis has been conducted using both the current power network and planned power network.

The Energy Sector GIS Working Group was founded in 2011, with the aim of developing quality GIS data for decision-making in the Ugandan energy sector. The REA uses this data to support the development of electrification master plans, for example. The Working Group makes much of this data available publicly on their website (Energy Sector GIS Working Group, 2018). The working group is made up of GIS experts from government including REA, UETCL, MEMD and Umeme. GIZ co-ordinated the establishment of the GIS group, funded by BMZ through the Promotion of Renewable Energy and Energy Efficiency Programme (GIZ, 2017).

The Ministry of Energy and Mineral Development's Statistical Database has additional information related to the energy sector and planning, much of which can be linked to GIS software (MEMD, 2018).

The Uganda Bureau of Statistics has a number of useful and comprehensive data portals which are publicly available, and is a source of most demographic data, macroeconomic data, as well as standards. The latest population census data is from 2014 (UBOS, 2018).

The Uganda Off-Grid Energy Market Accelerator (UOMA) addresses barriers by providing data and analysis of the off-grid market. This non-profit was co-created in 2017 by the Shell Foundation and Open Capital Advisors, funded by DFID, with the aim of addressing key barriers and bottlenecks in the off-grid market in Uganda. At the time of writing, the website was still under construction (Shell Foundation, 2018).

For this analysis, the national grid has been inferred using a combination of high voltage (HV) line data and satellite mapping of night lights, which is a more comprehensive measure than only using HV lines. HV grid line data is commonly available for countries in SSA. HV lines are not a reliable indicator of electrification coverage however, as long medium voltage (MV) lines are often used to reach towns at distances exceeding 15km. This analysis combines HV grid lines and nightlights data, pre-processed by combining multiple nights of observations to remove noise, before buffering both by 15km to produce the grid extension area. Internal analysis found that the nightlights-inferred grid buffer zone covers a much greater proportion of the population than for the HV lines alone (46% compared with 27%), and that all HV buffered areas are encompassed within the area covered by nightlights buffer zones. This reinforces the conclusion that this is the more comprehensive measure.

3.2 MINI-GRID POTENTIAL ASSESSMENT

The latest available population figures for Uganda are available from the Uganda Bureau of Statistics (2014 National Census), with forecasts to 2017. Data is disaggregated by region, as shown in Table 9 below. With a density of 214 inhabitant/km² (World Bank, 2017), the Ugandan population is most concentrated in the southern parts of the Central and Eastern regions. According to the 2017 household survey, the average size of people per household was around 4.7 (UBOS, 2017).

Table 9: Population in Uganda by state and region, 2014 (UBOS, 2018)

Region	Density/km	Population Estimate 2017 (thousands)	Population Estimate 2018 (thousands)
Central	176	10,408	11,184
Eastern	226	9,832	9,430
Northern	65	7,817	8,324
Western	126	9,614	10,097
Total	593	37,671	39,029

Average household monthly energy spend for off-grid households in rural areas was estimated in a **Lighting Africa (World Bank) report in 2014** to be around **US\$7.37 per month, or \$88.44 per year, per household, or \$18.82 per person annually (Enclude, 2014)**. The 2016/17 household survey data suggests that rural households are spending 16% of their monthly expenditures on housing, water, electricity, gas and other fuels, compared to the national average of 18% (UBOS, 2017).

Based on current grid coverage, analysis of high voltage (HV) line data and satellite mapping of night lights estimates that **9% of the unelectrified population would be best served by mini-grid solutions, with the highest potential in the Northern Region**. Shown in Table 10, this corresponds to 3.6 million people (9% of total population) best served by mini-grids, and a further 0.6 million people best served by solar home systems. Twenty nine million people live within 15km of the grid and therefore have a higher likelihood of being grid electrified.

If we consider planned network coverage by 2025, then this analysis estimates that **mini-grid electrification would be 0.54 million people, or 1% of the unelectrified population**. This reduction in market size reflects current grid construction, and extensive planned grid extensions, which would take the proportion of the total population living within 15km of the grid to 98% (38.3 million people). The Northern region remains the highest potential state for off-grid solutions, with 0.32 million people best served by mini-grids and having the lowest electrification rate of the regions at 3%. Figure 5 shows existing and planned generation sites.

Figure 5: Existing electricity grid with planned network up to 2025 (dotted lines)

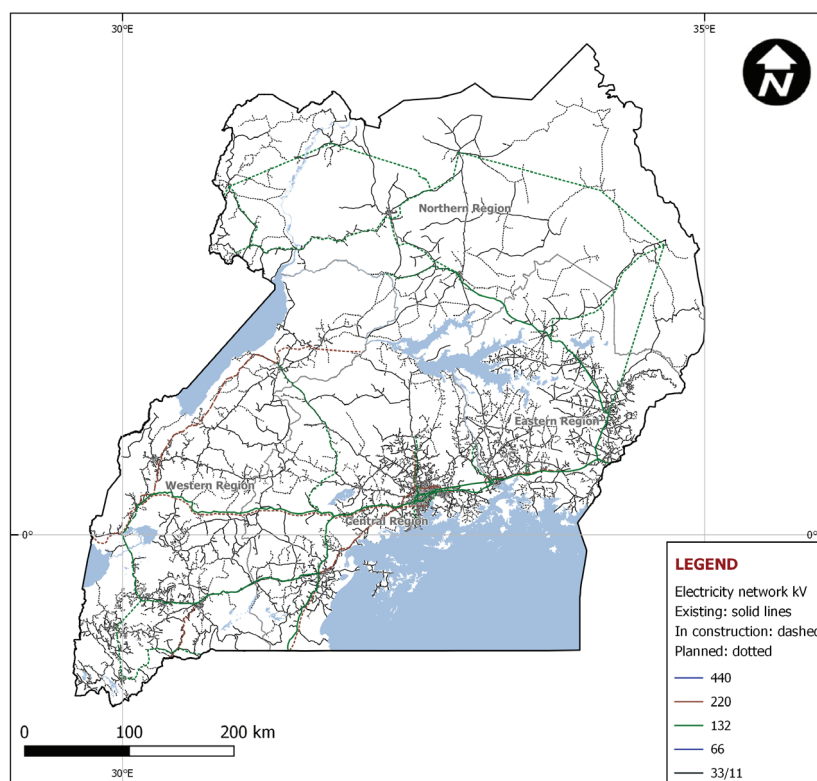
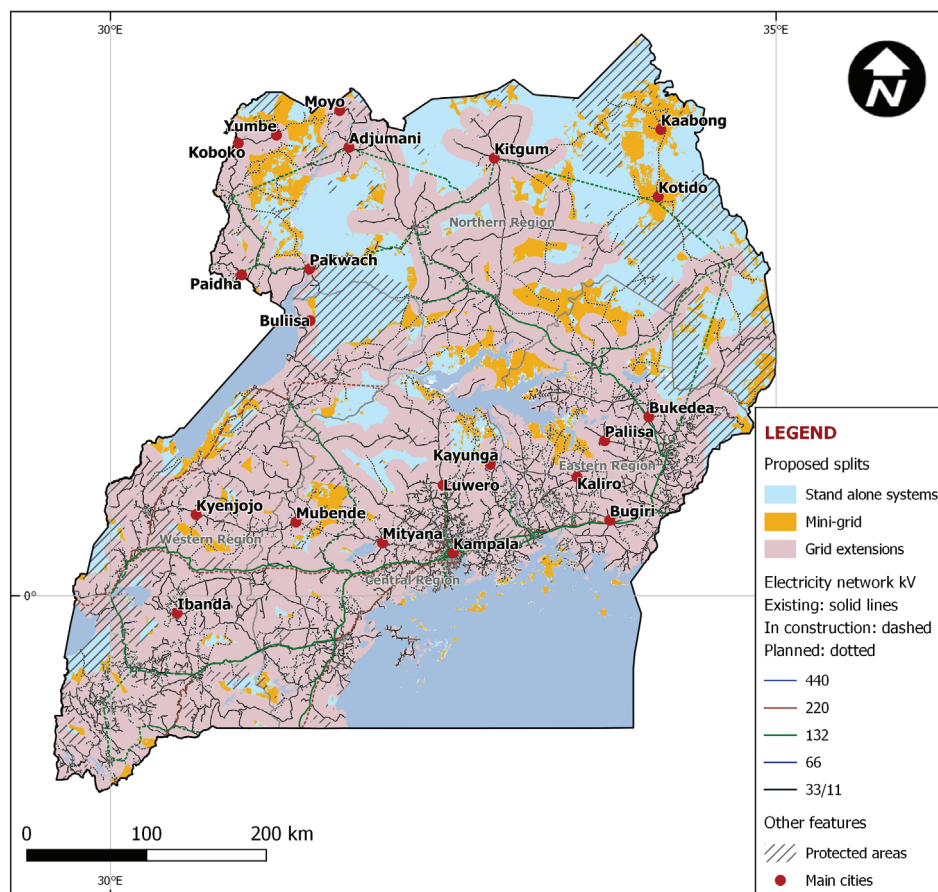


Figure 6: Regions best served by grid extension, mini-grid and standalone systems, shown with major and minor population centres. Dotted lines are planned grid extensions up to 2025 (Carbon Trust analysis).



Under the present grid, the analysis estimates a total annual revenue market size of \$68 million (for mini-grids).

The highest potential region is the Northern region, with an estimated market size of \$39 million and just over two million people most economically served through mini-grids. This reduces to a total market of \$10 million when including planned network extensions up to 2050, an 85% reduction compared to the market for mini-grids under the current grid. The largest market reduction when including these extensions is in the Western region, with a 91% reduction. The largest market remains in the Northern region at \$6 million. The actual market size may be greater than the estimates given here considering decentralised solutions could also be feasible in areas in grid proximity.

The market size estimate shown in Table 10 assumes an average annual household expenditure in rural areas on energy of US\$7.37 per month, or \$88.44 per year, per household, or \$18.82 per person annually as estimated in a Lighting Africa (World Bank) report in 2014 (Enclude, 2014). The latest Ugandan Bureau of Statistics data from the 2016/17 Household Survey estimates the average household size as being 4.7 people (UBOS, 2017). This works out at a chargeable tariff of \$0.28/kWh, which is likely to be the upper feasible political limit in Uganda (see section 2.4.3).

Table 10: Estimated household market size for off-grid solutions. Analysis using the existing and planned network up to 2025

Region	Current grid network				
	Electrification rate	Population (thousands)			Mini-Grid Market (\$m)
		< 15km of grid	Mini-Grid	SHS	
Central Region	40%	10,758	363	62	6.84
Eastern Region	6%	8,769	622	40	11.71
Northern Region	3%	5,787	2,059	478	38.75
Western Region	8%	9,472	575	43	10.82
Total		34,786	3,620	623	68
Region	Planned grid network to 2025				
	Electrification rate	Population (thousands)			Mini-Grid Market (\$m)
		< 15km of grid	Mini-Grid	SHS	
Central Region	40%	11,095	76	13.17	1.43
Eastern Region	6%	9,331	93	6.92	1.75
Northern Region	3%	7,808	322	194.21	6.06
Western Region	8%	10,029	53	8.58	0.99
Total		38,262	544	223	10

3.3 RENEWABLE ENERGY POTENTIAL FOR MINI-GRIDS

3.3.1 HYDRO

Hydropower is Uganda's dominant generation source with potential over 2,000MW of a total estimated renewable energy production potential of 5,300MW(RECP, 2018). Large-scale hydropower potential is along the White Nile, the flow of which is controlled by the Owen Falls Dam, connected to the Nalubaale Power Station (formerly the Owen Hydropower Station), which has installed capacity of 180MW. Nalubaale, and the 200MW Kiira Power station are owned and operated by UEGCL (UEGCL, 2018). UEGCL projects under construction, or proposed include:

- 183MW Isimba Power Station (expected completion in 2019)
- 600MW Karuma Power Station (expected completion in 2019)
- 48 Muzizi Power Station (proposed, expected completion 2021)
- 600MW Ayago Power Station (proposed, expected completion 2023)

Other currently operational hydropower projects include the Mubuku I, II and III Power Stations (five, 14 and 10MW capacities respectively), the Kanungu (6.6MW) and Mpanga (18MW) power stations, and outside of the UEGCL projects, a number of large-scale sites have been identified with potential of greater than 1,500MW (RECP, 2018). The World Bank has recently agreed to help finance the 250MW Bujagali Hydroelectric plant, which was commissioned in 2012 and accounts for 45% of the annual electricity generation (IFC , 2018).

A small number of small hydropower projects, some of which are being developed under GET-FiT have been approved (RECP, 2018), and there are 59 mini-hydropower sites, with potential of around 210MW, which have been identified (USAID, 2016).

3.3.2 BIOMASS

Nearly 90% of the energy generated in Uganda, mostly in heat generation, is from biomass. More than 90% of the population depends on non-sustainable biomass as the primary source of fuel for cooking (SE4ALL, 2015), (MEMD, 2014). The Government has made the investment in efficient biomass energy technologies a priority, with the publication of the 2013 Biomass Energy Strategy (MEMD, 2014).

Biomass is used for cooking and heating in households, and for limited small-scale industrial applications. Firewood tends to be used in rural areas, whereas urban households tend to use charcoal. Bioenergy technologies tend to be traditional and inefficient in Uganda (Okello, Pindozi, Faugna, & Boccia, 2013). It is used in small-scale industrial processes, such as the production of briquettes, in tea, the tobacco, cement and food industries, though production of electricity from biomass is mostly in the sugar industry, (SE4ALL, 2015) (RECP, 2018). Total standing biomass stock was estimated at 284 million tonnes, though sustainable, and accessible, wood biomass supply in 2014 stood at 26 million tonnes, or around 59% of total annual demand (MEMD, 2014).

Uganda's first biomass power plant is under construction, with AfDB supporting the 20MW plant with a US\$1 million grant (AfDB, 2016).

3.3.3 SOLAR

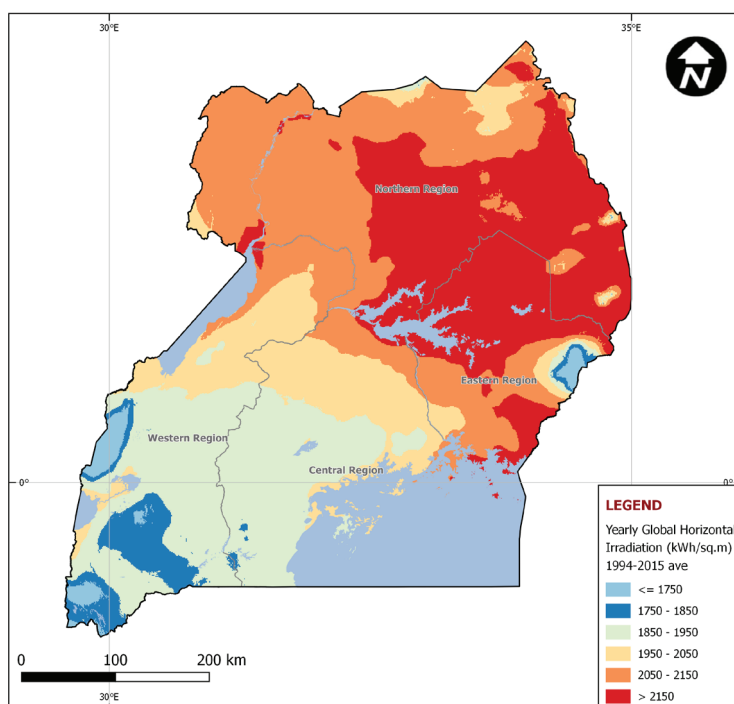
Uganda has an average of 5.1 KWh/m²/day solar radiation, which has relatively little variation throughout the year due to its equatorial location (UNREEEA, 2018). The north-east experiences the highest insolation (see Figure 7). Annually, the solar irradiation ranges from 1,825 kWh/m² to 2,500 kWh/m². However, the use of solar energy is still relatively low in Uganda, and projects do not get off the ground without significant government and donor support.

There are two large-scale solar PV plants in Uganda: the Soroti 10MW PV plant, inaugurated in 2016, the first PV project to benefit from the Get-FiT scheme. (RECP, 2018). A 10MW solar power plant, funded by the EU was opened in Tororo in late 2017 (EU, 2017). A number of other solar power stations have been proposed, including the 20MW Kabulasoke Solar Power Station, due to be completed late 2018 (Government of Uganda, 2018), and the 10MW Mayuge

Solar Power Station (due to be completed at the end of 2018) (Tryba Energy , 2018). Building work was meant to have started on a 500MW plant, split into four parks of 125MW each, in 2014. However, there have been no publicly announced updates on the progress of this project in recent years.

Uganda is the fifth largest country market in volumes of off-grid lighting products sold (cash), with a total volume of products at more than 100,000, and newly installed capacity of 0.12MW. Portable lanterns represent the majority of the products sold, which is why the ratio of volume of products to installed capacity is so high (GOGLA, 2018). Uganda also has a growing market of solar home systems, with estimated annual sales at around 10,000 for both residential and productive uses (RECP, 2018).

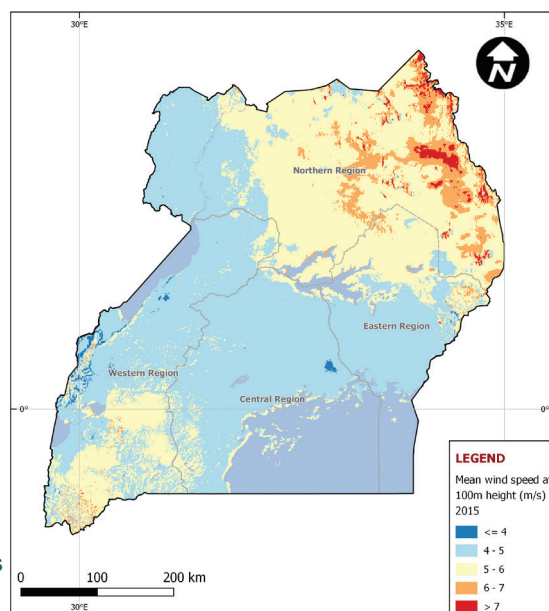
Figure 7: Horizontal Solar Irradiation in Uganda (Annual)



3.3.4 WIND

Wind resource assessment studies in Uganda have found average wind speeds of 3.7m/s at 20m, which is considered too low for large-scale generation (RECP, 2018). However, it is possible wind could prove useful for smaller scale applications including water pumping and generation in mountainous areas. There have been preliminary investigations in the areas of the Karamoja region in the North East, which have suggested potential for production at a medium scale (UNREEEA, 2018).

Figure 8: Mean wind speed at 100m height (m/s)



4.1 ENERGY SECTOR POLICIES AND REGULATORY FRAMEWORKS DIRECTORY

Electricity Act, 1999

<http://energyandminerals.go.ug/downloads/Elecact99.pdf>

The Electricity Act came into force in 1999 which repealed the Electricity Act, Cap 135 and the Uganda Electricity Board (Special Provisions) Act, Cap 136. The purpose of the act was to provide for the establishment of the ERA and its functions, powers and administration, and to provide a successor Company to the disbanded Uganda Electricity Board.

The Energy Policy for Uganda, 2002

<http://energyandminerals.go.ug/downloads/EnergyPolicy.pdf>

The main objective of the Energy Policy is to meet the energy needs of Uganda's population for social and economic development in an environmentally sustainable manner. The policy provides the Government's vision for increased and improved modern energy supply for sustainable economic development, as well as improving the quality of life of the Ugandan population.

Rural Electrification Strategy and Plan (RESP), 2013 to 2022

<http://www.rea.or.ug/resources/strategy%20and%20plan%202013-2022.pdf>

The RESP for 2013 to 2022 is the updated document of the first RESP that was published for the years 2001 to 2012. The primary objective is to accelerate the national coverage of consumer access to electricity and to meet national development goals. A secondary objective is to ensure that, progressively, the programme facilitates access to all forms of modern energy services to replace kerosene lighting and other forms of traditional cooking and heating by 2030. During this 10-year planning period, the Government's strategy is to achieve a rural electrification access of 26%. The policy has plans to use off-grid electricity solutions to provide energy access to rural areas. The pace of acceleration anticipated in the RESP also projects access to be at 51% by 2030 and 100% by 2040.

Renewable Energy Policy for Uganda, 2007

<https://eaenet.org/wp-content/uploads/2017/02/The-Renewable-Energy-Policy-for-Uganda-2007-2017.pdf>

The Renewable Energy Policy reinforces the Government's commitment to the development of renewable energy sources. The Government's vision is to make modern renewable energy a substantial part of the national energy consumption. The overall policy goal is to increase the use of modern renewable energy, from the current 4% to 61% of the total energy consumption. The policy supports the development of decentralised, off-grid electricity to supply electricity to remote areas.

<http://npa.ug/wp-content/themes/npatheme/documents/vision2040.pdf>

Uganda's vision for the year 2040 is to transform the country from a peasant to a modern prospering country. To achieve economic growth, good energy access is required. Therefore, to achieve the goal, the country will have to increase energy access. The goal is to achieve universal electricity access by 2040.

4.2 DATA SOURCES DIRECTORY

This methodology was developed during the second phase of this project, the Green Mini-Grids Market Development Programme - Market Intelligence business line, which is also available via the African Development Bank.

This analysis, the results of which are provided in Section 3, considers the potential for mini-grids by segmenting the countries into two areas: grid and off-grid areas. This split is based on the distance of 15km from the power network. We have used the planned power network for up to 2050. The GIS sources used in this analysis are detailed below.

Electricity Transmission Network (Medium and High voltage)

File name: Transmission_Lines_2016_Operational.shp; Transmission_Lines_2016_Under_Construction.shp; Transmission_Lines_2016_Planned.shp; Distribution_Lines_2016_Operational.shp; Distribution_Lines_2016_Under_Construction.shp; Distribution_Lines_2016_Planned.shp;

Source age: 2016

File type: ESRI Shapefile, lines

Description: Shapefiles of the electricity transmission network of Uganda

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: Ugandan Energy Sector GIS Working Group

Link: <https://energydata.info/dataset/transmission-lines-2016-operational>

Electricity Power Plants

File name: Generation_Sites_2016_Operational.shp; generationsitesunderconstruction.geojson; generation-sites-planned.geojson

Source age: 2016

File type: ESRI Shapefile, points; GEOJSON

Description: A shapefile of power plants in Uganda – on-grid and off-grid, operational, under construction and planned

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: Ugandan Energy Sector GIS Working Group

Link: <https://energydata.info/dataset/generation-sites-2016-operational>

Population density

File name: National_Boundary_2014.shp; Region_Boundaries_2014.shp; Towns_2014.shp

Source age: 2014

File type: ESRI Shapefile, polygons and points

Description: Shapefiles of State and Local Government Area boundaries, main cities

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: Ugandan Energy Sector GIS Working Group

Link: <https://energydata.info/organization/5046d84c-08f7-4722-982f-528921cda2c9?tags=Uganda>

Nightlights

Source: Earth Observations Group at NOAA

Administrative Boundaries

File name: National_Boundary_2014.shp; Region_Boundaries_2014.shp; Towns_2014.shp

Source age: 2014

File type: ESRI Shapefile, polygons and points

Description: Shapefiles of State and Local Government Area boundaries, main cities

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: Ugandan Energy Sector GIS Working Group

Link: <https://energydata.info/organization/5046d84c-08f7-4722-982f-528921cda2c9?tags=Uganda>

Wind: Mean Wind Speed at 100m Height

File name: MD_wind100m.tif

Source age: 2015

File type: Raster

Description: Mean wind speed at 100m height

Co-ordinate system: WGS_1984 (EPSG: 4326)

Source: DTU, IRENA

Solar: Annual Total Global Horizontal Irradiation (GHI)

File name: MD_GHI.tif

Source age: 2015

File type: Raster

Description: Annual total Global Horizontal Irradiation (GHI) (kWh/sqm) averaged over 1994-2015

Co-ordinate system: WGS_1984 (EPSG: 4326)

Source: DTU, IRENA

4.3 STAKEHOLDER DIRECTORY

4.4.1 GOVERNMENT AND AGENCIES

Ministry of Energy and Mineral Development (MEMD)

Contact: Email: memd@energy.go.ug

Telephone: +256- 414- 311111

Link: <http://www.energyandminerals.go.ug/>

Brief description: MEMD is responsible for designing and providing policy guidance for the development and exploitation of energy and mineral resources in Uganda. It seeks to attract investment and regulate private sector activities in the energy and mineral sectors. The ministry is involved in the development of power projects and is supporting the establishment of power generating infrastructure using hydropower, thermal power, solar power and nuclear power.

Rural Electrification Agency (REA)

Contact: Email: rea@rea.or.ug

Telephone: + 256 312 318100

Link: <http://www.rea.or.ug/>

Brief description: The REA was established in 2002 by the Minister of Energy and Mineral Development to support the Government's goal to achieve a rural electrification rate of 22% by 2022. It operates under a public-private partnership and is a semi-autonomous agency that acts as the Secretariat of the Rural Electrification Board. Its main activities include project planning and implementing the Government's priority electrification projects for public funding. The agency has designed a Rural Electrification Masterplan to provide some guidance in designing appropriate energy services, the master plan also seeks to prioritise projects that generate value in supporting the economy, social wellbeing, education, health, water supply and local administration.

Electricity Regulatory Authority (ERA)

Contact: Email: info@era.or.ug

Telephone: +256 414 341852; +256 393 260166

Link: <http://www.era.or.ug/>

Brief description: ERA is the regulatory body of the electricity sector of Uganda. Activities involve regulating and controlling the generation, transmission, distribution, sale, exports and imports of electrical energy in Uganda. The Authority is also mandated to control tariffs and issue licences for ownership or operation of transmission systems, as well as for generation, transmission, distribution and sales of electricity.

Ugandan Electricity Generation Company Limited (UGECL)

Contact: Email: Info@uegcl.com

Telephone: +256 312 372165

Link: www.uegcl.com

Brief description: UEGCL is a parastatal company that took over the now defunct Uganda Electricity Board activities in 2001. Its main purpose is to operate power stations owned by the Government, it also expanded its activities to the development of hydropower stations and renewable energy projects. UETCL is the only system operator responsible for the purchase of electricity from independent power producers. UEGCL is the implementing agency for two Hydropower Projects and associated transmission lines and sub stations of the Government.

Uganda Electricity Transmission Company Limited (UETCL)

Contact: **Email:** Transco@uetcl.com

Telephone: +256 -417- 802 000; +256-414-233433/4

Link: <http://www.uetcl.com>

Brief description: UETCL is the operator of the transmission system of the country. It is a parastatal company owned by the Ministry of Finance, Planning and Economic Development and its mandate is to purchase power in bulk and manage the operation of high voltage transmission system at the national scale. It is also the counterparty to power purchase agreements.

Umeme

Contact: **Email:** info@umeme.co.ug

Telephone: +256 312 360600

Link: <https://www.umeme.co.ug/>

Brief description: Umeme is an electricity distribution private company that operates the 20-year electricity distribution concession, effective since March 2005. Its mandate includes the operation, maintenance and upgrade of electricity distribution infrastructure. Umeme supplies energy to around 45,000 customers.

Uganda Bureau of Statistics (UBOS)

Contact: **Email:** ubos@ubos.org

Telephone: +256 414 706000

Link: <https://www.ubos.org/>

Brief description: UBOS is a semi-autonomous agency of the Ministry of Finance, Planning and Economic development responsible for data collection and analysis and also co-ordinates the National Statistical System. It has been mandated to monitor the progress towards achieving the National Development Plan 2015/16 to 2019/20 of Uganda, as well as tracking the country's advancements towards its commitment to the United Nations Sustainable Development Goals.

4.4.3 BILATERAL AND MULTILATERAL DONOR ORGANISATIONS

Uganda has a large community of international development partners in the energy sector. Activities are co-ordinated through the Energy and Mineral Development Partners Group (EMDPG) which Germany has had the lead in

since November 2010. Following institutions and countries are represented in this working group: KfW, GIZ, USAID, DFID, EIB, EU-Commission, France, Ireland, IWF, AdDB, JICA, Norway and World Bank. NORAD, IAEA, USTDA, IDB, UNDP, UNIDO, NDF and SIDA are also involved in the energy sector through technical assistance or project development.

USAID Power Africa Uganda Electricity Supply Accelerator

Contact: **Email:** powerafrica@usaid.gov

Telephone: + 414 250 0314

Link: <https://www.usaid.gov/powerafrica/uganda>

Brief description: USAID leads international development and humanitarian efforts to save lives, reduce poverty, strengthen democratic governance and help people progress beyond assistance. Through Power Africa, USAID seeks to improve African population connectivity to the electricity grid by conducting several interventions such as the development of masterplans, transaction advisory services, supporting off-grid organisations, and the development of digital finance services. In Uganda, Power Africa has succeeded in finalising master electrification plans for two rural territories where opportunities for utility and off-grid companies were identified, as well as the potential for 100 mini-grids. It has also supported, with transaction advisory services, to help generation projects come to a financial close.

TetraTech

Contact: **Email:** africa@tetrattech.com

Link: <http://www.tetrattech.com/en/projects/power-africa-transactions-and-reforms-program>

Brief description: TetraTech is an American engineering services and consulting company. In 2014, USAID selected TetraTech to serve as a contractor for the Power African Transactions and Reform Programme to assist sub-saharan countries including Uganda with technical assistance, capacity building and transaction support services.

GIZ

Contact: **Email:** giz-uganda@giz.de

Telephone: +256 414 30 39 01

Link: <https://www.giz.de/en/worldwide/310.html>

Brief description: The German Development Agency (GIZ) is a provider of international co-operation services for sustainable development. GIZ is leading three key energy-related projects in Uganda including the Promotion of Mini-Grids for Rural Electrification (Pro-Mini Grids), maximising the benefits of access to energy, and the Promotion of Renewable Energy and Energy Efficiency Programme. These programmes involve the promotion of the use of mini-grids for rural electrification to support the development of rural areas in Uganda, as well as improving electricity services planning.

World Bank

Contact: **Email:** skulubya@worldbank.org

Telephone: +256 414 302 408

Link: <http://projects.worldbank.org/P133312/?lang=en&tab=overview>

Brief description: The World Bank has been supporting Uganda with Rural electrification projects that involved grid expansion activities such as in the Grid Expansion and Reinforcement Project. It has also supported off-grid energy access with Uganda Energy for Rural Transformation Programme Project to increase access to electricity in rural areas of Uganda.

This project is divided in two components, on-grid energy access and on-grid energy access. The second component involves covering the installation of solar PV systems for public institutions in rural areas; business development support; provision of credit facilities and quality standards enforcement support.

Shell Foundation (SF)

Link: <https://shellfoundation.org/learning/off-grid-energy-country-focus-uganda>

Brief description: SF is a UK charity founded by Shell in 2000. Its operations in Sub-Saharan Africa seek to enhance access to energy and serve low-income communities by supporting innovators to test new technologies and enterprises models. In Uganda, SF with Open Capital Advisors are operating the Scaling Off-Grid Energy Grand Challenge for Development in partnership with USAID, Power Africa, DFID and AfDB. This includes scaling off-grid energy access through the Uganda Off Grid Energy Market Accelerator that supports solar operators to access finance, reach unserved populations, expand productive use technology, strengthen government policy, and target and facilitate communication and co-ordination.

KFW

Contact: **Email:** kfw.kampala@kfw.de

Telephone: +256 204 348860

Link: <https://www.getfit-uganda.org/partners/kfw/>

Brief description: The division for Energy and Environment in Sub-Saharan Africa of KfW has provided technical assistance and capacity building measures to sub-saharan countries for improving energy access. KfW is involved in the GET FIT Programme by financing feed-in tariffs in Uganda to overcome barriers for private investment for small renewable energy projects between one and 20MW. So far, the programme has supported 17 energy generating projects.

European Investment Bank (EIB)

Contact: **Email:** press@eib.org

Telephone: +352 437 922 000

Link: <http://www.eib.org/en/projects/loan/loan/20161001>

Brief description: EIB is the European Union's bank that brings financial support for the sustainable development of countries. EIB has recently announced its support towards financing off-grid solar kits to provide energy access to reach 10 million solar installations within five years. In Uganda, EIB has invested over €4 billion.

4.4.2 MINI-GRID PRACTITIONERS AND PROJECT DEVELOPERS

Name: Tronder Power Ltd.

Contact: **Email:** post@tronderpower.com

Telephone: +256 414232 159

Link: <https://web.archive.org/web/20140208091117/http://www.tronderpower.com>

Brief description: Tronder Power Ltd is owned by the Norwegian companies Tronder Energi and Norfund. The company developed the Bugoye Hydro Power Plant on the Mubuku River in 2009 with a capacity of 13MW, providing electricity to around one million people in the area. The plant feeds its energy into the main grid at the Nkenda Substation. This project was conducted in partnership with local authorities and the Emerging Africa Infrastructure Fund.

WWF

Contact **Email:** wayik@wwfuganda.org

Telephone: +256 414540 064

Link: http://wwf.panda.org/wwf_offices/uganda/

Brief Description: WWF is currently active in promoting access to sustainable and renewable energy in Uganda. Through the Energy and Climate Programme, WWF is conducting a series of projects to improve rural livelihoods by providing access to solar PV energy for domestic use and to stimulate productive use of energy.

Energy4Impact (E4I)

Contact: **Email:** info@energy4impact.org

Telephone: +44 207 242 8602

Link: <https://www.energy4impact.org/what-we-do>

Brief Description: E4I supports Sub-Saharan countries in providing solutions for delivering energy access to communities. The programmes developed are tailored to address energy sector business development gaps such as capacity building or access to finance. In Uganda, It also supports mini-grid developers with advisory services to develop productive use of electrified in electrified villages.

Pamoja Energy

Contact: **Email:** uganda@pamojacleantech.com

Link: http://www.pamojacleantech.com/business-model/mini_grid/

Brief description: Pamoja Cleantech is a Swedish social enterprise established in 2010 that provides and manages decentralised renewable energy power units to empower local energy companies for power generation. The company has implemented a hybrid energy system that combines PV and biomass gasification technologies that produces 10 to 40kW of electricity for rural community power and small industrial applications. It has also set up a biomass gasification unit with a micro-grid that connects more than 45 households.

BIBLIOGRAPHY

- ADER. (2016). *Le secteur de l'énergie a Madagascar*. Ambassade de France a Madagascar. Retrieved from http://ader.mg/pdf_files/infos/Energies_Renouvelables/Etudes/Etude_L'%C3%A9nergie_%C3%A0_Madagascar_enjeux_et_opportunit%C3%A9s_d'affaires_-_Version_FINALE_290816.pdf
- AfDB. (2016). *SEFA Funds preparation of first-ever Biomass Gasification Project in Uganda*. Retrieved from <https://www.afdb.org/en/news-and-events/sefa-funds-preparation-of-first-ever-biomass-gasification-project-in-uganda-16582/>
- Central Intelligence Agency. (2017). Retrieved from https://www.cia.gov/library/publications/resources/the-world-factbook/geos/print_ug.html
- ClimateScope. (2016). *The Success of Uganda's 'GET FiT' Policy*. Retrieved from <http://global-climatescope.org/en/blog/2016/03/15/climatescope-update-Uganda-GetFit/>
- Deloitte. (2016). *Uganda Economic Outlook*.
- Electricity Regulator Authority. (2014, March 14). Retrieved from <http://www.era.or.ug/index.php/statistics-tariffs/tariffs/2014-09-08-13-29-51/feed-in-tariff>
- Electricity Regulatory Authority. (2017). Retrieved from Electricity Transmission Statistics: <http://www.era.or.ug/index.php/statistics-tariffs/2013-11-27-16-54-30>
- Electricity Regulatory Authority. (2017). Retrieved from Electricity Generation Statistics: <http://www.era.or.ug/index.php/statistics-tariffs/2013-11-27-16-54-30>
- Electricity Regulatory Authority. (2018). *Renewable Energy Investment Guide*. Retrieved from <https://www.era.or.ug/index.php/opportunities/renewal-energy-investment-guide>
- Enclude. (2014). *Market assessment of moden off-grid lighting systems in Uganda*. Washington DC: World Bank. Retrieved from <https://www.lightingafrica.org/wp-content/uploads/2016/12/Uganda-2.pdf>
- (2017). *Energy Access Outlook*.
- (2002). *Energy Policy*.
- Energy Sector GIS Working Group. (2018). *GIS Maps*. Retrieved from <http://www.energy-gis.ug/gis-maps/>
- Energypedia. (2018). Retrieved from https://energypedia.info/wiki/Uganda_Energy_Situation
- Energypedia. (2018). *Uganda Energy Situation*. Retrieved from https://energypedia.info/wiki/Uganda_Energy_Situation
- ERA. (2018). *Electricity regulations and code*. Retrieved from <https://www.era.or.ug/index.php/resource-centre/regulatory-instruments/regulations-codes>
- ERA. (2018). *Feed-in tariffs*. Retrieved from <https://www.era.or.ug/index.php/tariffs/generation-tariffs/feed-in-tariff>
- EU. (2017). *10 MW EU funded Tororo Solar Power Plant Opens*. Retrieved from Delegation of the European Union to Uganda : https://eeas.europa.eu/delegations/uganda/34013/10-mw-eu-funded-tororo-solar-power-plant-opens_en

- Fashing, A., & al., e. (2018). The Drivers and Barriers of Renewable Energy Applications and Development in Uganda: A Review. *Clean Technologies*.
- FSD Uganda. (2017, September 27). Retrieved from Uganda's rural households will be energy deprived unless swift action is taken: <http://fsduganda.or.ug/ugandas-rural-households-will-be-energy-deprived-unless-swift-action-is-taken/>
- Fulbright, N. R. (2015). *Investing in the electricity sector in Uganda*. Retrieved from <http://www.nortonrosefulbright.com/knowledge/publications/126133/investing-in-the-electricity-sector-in-uganda>
- GET FiT Uganda. (2018). Retrieved from <https://www.getfit-uganda.org/about-get-fit/>
- GIZ. (2016). *Clean, reliable electricity for rural communities*. Retrieved from <https://www.giz.de/en/worldwide/61359.html>
- GIZ. (2017). *GIZ Portfolio: Renewable Energy and Hybrid Mini-Grid Systems*. Bonn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Retrieved from https://energypedia.info/images/f/ff/GIZ_%282017%29_Mini-grid_Portfolio_Overview.pdf
- GOGLA. (2018). *Global Off-Grid Solar Market Report*. GOGLA.
- Government of Uganda. (2018). Retrieved from <http://gou.go.ug/about-uganda/sector/economy>
- Government of Uganda. (2018). *Kabulasoke Solar Power Station to be ready in November*. Retrieved from Office of the Vice President of Uganda: <http://vicepresident.go.ug/index.php/vp-news/291-kabulasoke-solar-power-station-to-be-ready-in-november>
- ICD-PS. (2016). *ICD-PS*. Retrieved from <https://www.icd-ps.org/en/country/overview/UGANDA>
- IEA. (2016). *Energy Access Database*. Retrieved from <https://www.iea.org/energyaccess/database/>
- IFC . (2018). *World Bank Group Support for Uganda's Bujagali Hydropower Project*. Retrieved from IFC: https://www.ifc.org/wps/wcm/connect/38159c82-2a75-41c5-a5f6-c7d1ce239e82/20180308_Bujagali-factsheet.pdf?MOD=AJPERES
- (2016). *Least Cost Generation Plan*.
- MEMD . (2018). *Ministry of Energy and Mineral Development*. Retrieved October 2018, from <http://www.energyandminerals.go.ug/>
- MEMD. (2014). *Biomass Energy Strategy (BEST) Uganda*. UNDP.
- MEMD. (2014). *Strategic Investment Plan 2014/15 to 2018/19*. Ministry of Energy and Mineral Development.
- Meyer et. al. (2017). *Uganda's Power Sector reform: there and back again?* Retrieved from <https://www.sciencedirect.com/science/article/pii/S0973082617307810>
- Ministry of Works and Transport. (2017). Retrieved from <http://www.works.go.ug/key-summary-statistics/>
- NARUC. (2017). *Practical Guide to the Regulatory Treatment of Mini-Grids*. Retrieved from <https://pubs.naruc.org/pub/E1A6363A-A51D-0046-C341-DADE9EBAA6E3>

- National Planning Authority. (2007). *Uganda Vision 2040*. Retrieved from <http://npa.ug/wp-content/themes/npatheme/documents/vision2040.pdf>
- Okello, C., Pindozi, S., Fugna, S., & Boccia, L. (2013). Development of bioenergy technologies in Uganda: A review of progress. *Renewable and Sustainable Energy Reviews*, 55-63.
- Population Pyramid*. (2018). Retrieved from <https://www.populationpyramid.net/uganda/2017/>
- PwC. (2017). *Uganda Economic Outlook: First Edition*.
- REA. (2013). *Rural Electrification Strategy and Plan (RESP)*. Retrieved from <http://www.rea.or.ug/resources/strategy%20and%20plan%202013-2022.pdf>
- RECP. (2018). *Market Information: Uganda*. Retrieved from Africa–EU Renewable Energy Cooperation Programme, (RECP): <https://www.africa-eu-renewables.org/market-information/uganda/>
- (2007). *Renewable Energy Policy*.
- (2007). *Rural Electrification Strategy and Plan*.
- SE4ALL. (2015). *SE4ALL Action Agenda, Ministry of Energy and Mineral Development*. Retrieved from https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/Uganda_AA_EN_Released.pdf
- SE4ALL. (2018). *Country Data: Uganda*. Retrieved from <https://www.se4all-africa.org/seforall-in-africa/country-data/uganda/>
- Shell Foundation. (2018). *Uganda Off-Grid Energy Market Accelerator (UOMA)*. Retrieved October 2018, from <https://shellfoundation.org/portfolio/uganda-off-grid-energy-market-accelerator-uoma/>
- The State House of Uganda*. (2018). Retrieved from About Uganda: <http://www.statehouse.go.ug/about-uganda>
- The World Bank*. (2014). Retrieved from Access to electricity: https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=UG&name_desc=true
- The World Bank*. (2018). Retrieved from <http://projects.worldbank.org/P133312?lang=en>
- Tryba Energy. (2018, March). *The construction of a 10MWP solar power plant in Uganda is moving ahead rapidly*. Retrieved from Tryba Energy News: <http://www.tryba-energy.com/en/2018/03/30/construction-of-a-10-mwp-solar-power-plant-in-uganda-is-moving-ahead-rapidly-it-will-be-connected-to-the-grid-and-operational-at-the-end-of-the-year/>
- UBOS. (2017). *Uganda National Household Survey 2016/17*. Kampala: Uganda Bureau of Statistics.
- UBOS. (2018). *Uganda Bureau of Statistics: Explore Statistics*. Retrieved October 2018, from <https://www.ubos.org/explore-statistics/0>
- UEGCL. (2018). *Business Operations*. Retrieved from UEGCL: <https://www.uegcl.com/business-operations/power-plants>
- Uganda Business News*. (2017, October 18). Retrieved from <http://ugbusiness.com/4217/russia-likely-to-win-bid-for-ugandas-nuclear-energy-plans>

- Uganda Investment Authority*. (2018). Retrieved from Agriculture and agribusiness: <http://www.ugandainvest.go.ug/priority-sectors/agriculture-agribusiness/>
- Uganda Ministry of Water and Environment. (2017). *Uganda's Intended Nationally Determined Contribution (INDC)*. Retrieved from <http://www4.unfccc.int/ndcregistry/PublishedDocuments/Uganda%20First/INDC%20Uganda%20final%20%2014%20October%20%202015.pdf>
- (2015). *Uganda's Intended Nationally Determined Contribution*.
- Umeme. (2018). *2018 Tariffs*. Retrieved October 2018, from <https://www.umeme.co.ug/file/Tariffs.pdf>
- UN Environment. (2017). *Energy Profile: Madagascar*. Retrieved from <https://www.unenvironment.org/resources/fact-sheet/energy-profile-madagascar>
- UNRA. (2017, July 20). *National Road Infrastructure Development Programme*. Retrieved from <https://www.icpau.co.ug/assets/pdf/EconomicForumPresentation/Economic%20Forum%20Presentations/Infrastructure%20Development-Bottlenecks%20and%20Solutions%20-%20UNRA.pdf>
- UNREEEA. (2018, October). *Overview of the Ugandan Energy Sector*. Retrieved from Ugandan National Renewable Energy and Energy Efficiency Alliance (UNREEEA): <https://unreeea.org/resource-center/overview-of-the-ugandan-energy-sector/>
- US Export.gov. (2017). *Uganda Energy* . Retrieved from <https://www.export.gov/article?id=Uganda-Energy>
- US Export.gov. (2017). *Uganda Telecommunications Industry*. Retrieved from <https://www.export.gov/article?id=Uganda-Telecommunications-Industry>
- USAID. (2016). *Power Africa in Uganda*. Retrieved from https://www.usaid.gov/sites/default/files/documents/1860/UgandaCountryFactSheet.2016.09_FINAL.pdf
- USAID. (2018). *Uganda: Power Africa Fact Sheet*. Retrieved from Power Africa: <https://www.usaid.gov/powerafrica/uganda>
- (2007). *Vision 2040*.
- World Bank. (2016). *Uganda Grid Expansion and Reinforcement Project (GERP)*. Retrieved from <http://projects.worldbank.org/P133305?lang=en>
- World Bank. (2016). *Uganda Grid Expansion and Reinforcement Project (GERP)*. Retrieved from <http://projects.worldbank.org/P133305?lang=en>
- World Bank. (2017). *World Bank open source data (Ugandan population)*. Retrieved from <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=UG>
- World Bank. (2018). *Madagascar Electricity Sector Operations and Governance Improvement Project*. Retrieved from <http://projects.worldbank.org/P164318?lang=en>
- World Bank. (2018). *Madagascar Power Sector Operations Improvement Project* .

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