GET.INVEST MARKET INSIGHTS

DEVELOPER GUIDE / MODEL BUSINESS CASE / CASE STUDY

GET.invest
Mobilising Renewable Energy Investments

Uganda: Captive Power

Developer Guide

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Registered offices
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GET.invest
Friedrich-Ebert-Allee 36 + 40
53113 Bonn, Germany

T +49 228 44601112
E info@get-invest.eu
I www.get-invest.eu
I www.giz.de

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EDITOR
Ilham Talab (GET.invest)

AUTHORS
Matthew Woods, Timothy Cowman, Kevin Kerigu (Carbon Africa Ltd)

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A NOTE TO THE READER

This Developer Guide is meant to be a 'reference document' to inform early market exploration. It is a relatively long document which summarises a wealth of details. It should best be read to obtain specific facts or information. The Guide is supplemented with Case Studies and Model Business Cases accessible at www.get-invest.eu.

ABOUT GET.INVEST MARKET INSIGHTS

The first series of GET.invest Market Insights are published in early 2019 covering four renewable energy market segments in three countries, namely: renewable energy applications in the agricultural value-chain (Senegal), captive power (behind the meter) generation (Uganda), mini-grids (Zambia) and stand-alone solar systems (Zambia).

Each Market Insight package includes **a)** a 'how to' Developer Guide, **b)** Model Business Cases and **c)** Case Studies. The Developer Guide enables the reader to navigate the market and its actors, to understand the current regulatory framework and lays down the step-by-step process of starting a new project/business. The Model Business Case analyses project economics and presents hypothetical, yet realistic, investment scenarios. It hence indicates the criteria for a viable project/business to enable the reader to identify the most cost-effective project/business opportunities. The Case Study analyses the viability of operational or high-potential projects/businesses to highlight lessons learnt and industry trends.

GET.invest Market Insights therefore summarise a considerable amount of data that may inform early market exploration and pre-feasibility studies. It is recommended to cross-read all three products to gain a comprehensive overview. The products are accessible at www.get-invest.eu.

ABOUT GET.INVEST

GET.invest is a European programme which supports investment in decentralised renewable energy projects. The programme targets private sector business and project developers, financiers and regulators to build sustainable energy markets.

Services include project and business development support, information and matchmaking, and assistance in implementing regulatory processes. They are delivered globally and across different market segments.

GET.invest is supported by the European Union, Germany, Sweden, the Netherlands, and Austria, and works closely with initiatives and industry associations in the energy sector.

FOREWORD

For meeting the challenges but also realising the opportunities of Sustainable Development Goals and climate change, a transformation of energy systems is paramount. As a key element, private sector needs to be mobilised, and scarce public resources need to be channelled into enabling and leveraging private sector investment. Through innovation, further reducing costs, a focus on low-carbon and resource-efficient solutions, the private sector will have a major role to play in the transformation towards an inclusive green economy and energy access for all.

One of the key barriers remains the access to capital, and how more projects and business ventures can successfully tap into the many existing financing options. Tackling this challenge has been the focus of the efforts of the European Union and its Member States.

In this context, the EU, Germany, the Netherlands, Sweden, and Austria jointly contribute to GET.invest, in a collaborative European effort to accelerate private investment in decentralised renewable energy projects.

Information about market opportunities as well as the country- and market-segment-specific "how to do business" is an important complementary tool to more tangible support provided by GET.invest to project and business development to access financing. We therefore expect that the Market Insights publication series will be useful to both national as well as international stakeholders in developing sustainable markets for decentralised renewable energy projects.

The Sustainable Development Goals show us what challenges still lie ahead. They also show us, however, that the current moment can be an opportunity. With everyone's commitment, bringing both public and private actors to the table, we can make a difference towards the transformation to an inclusive green economy.

Signed collectively,
the supporters of GET.invest

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ABBREVIATIONS

A	Ampere
AEEP	Africa-EU Energy Partnership
AECF	Africa Enterprise Challenge Fund
AFD	Agence Française de Développement
AGRA	Alliance for a Green Revolution Africa
AMR	Automatic Meter Reading
BMZ	German Federal Ministry for Economic Cooperation and Development
BIO	Belgian Investment Organisation
CAPEX	Capital Expenditure
CBA	Commercial Bank of Africa
CDC	Commonwealth Development Corporation
CHP	Combined Heat and Power
COC	Certificate of Conformity
DEG	Deutsche Investitions- und Entwicklungsgesellschaft
DFID	Department for International Development
DTB	Diamond Trust Bank
DWRM	Directorate of Water Resource Management
EAC	East African Community
EADB	East African Development Bank
EIA	Environmental Impact Assessment
EEP S&EA	Energy and Environment Partnership Southern & Eastern Africa
EPC	Engineering, Procurement and Construction
ERA	Electricity Regulatory Authority
ESCO	Energy Services Company
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUEI PDF	European Union Energy Initiative Partnership Dialogue Facility
FDI	Foreign Direct Investment
FIT	Feed-in Tariff
GDP	Gross Domestic Product
GHI	Global Horizontal Irradiation
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GoU	Government of Uganda
GWh	Gigawatt hour
IFC	International Finance Corporation
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
KIS	Kalangala Infrastructure Services
kV	Kilovolt
kVA	Kilovolt Ampere
kVArh	Kilovolt Ampere reactive
kW	Kilowatt
kWh	Kilowatt hour
LCOE	Levelized Cost of Energy
LIBOR	London Interbank Offered Rate
LRMC	Long Run Marginal Cost
MEMD	Ministry of Energy and Mineral Development
MWE	Ministry of Water and Energy
MW	Megawatt
MWh	Megawatt hour
NEMA	National Environment Management Authority
NIA	Notice of Intended Application
NOPEF	Nordic Project Fund
NORAD	Norwegian Development Agency

NSE	Nairobi Securities Exchange
O&M	Operations and Maintenance
OeEB	Austrian Development Bank
OPIC	Overseas Private Investment Corporation
PAYE	Pay-As-You-Earn
PAYG	Pay-As-You-Go
PPA	Power Purchase Agreement
PV	Photovoltaic
PVOC	Pre-export Verification of Conformity
RE	Renewable Energy
REA	Rural Electrification Agency
REACT	Renewable Energy and Adaptation to Climate Change Technologies
REFIT	Renewable Energy Feed-in Tariff
SE4All	Sustainable Energy for All
SIDA	Swedish International Development Cooperation Agency
SPV	Special Purpose Vehicle
SREP	Scaling-Up Renewable Energy Program
SUNREF	Sustainable Use of Natural Resources and Energy Finance
TIN	Tax Identification Number
T&D	Transmission and Distribution
UBOS	Uganda Bureau of Statistics
UDC	Uganda Development Corporation
UDB	Uganda Development Bank
UECCC	Uganda Energy Credit Capitalisation Company
UEDCL	Uganda Electricity Distribution Company Limited
UEGCL	Uganda Electricity Generation Company Limited
UETCL	Uganda Electricity Transmission Company Limited
UGX	Uganda Shilling
UIA	Uganda Investment Authority
UMA	Uganda Manufacturers Association
UNBS	Uganda National Bureau of Standards
URA	Uganda Revenue Authority
URSB	Uganda Registration Services Bureau
USAID	United States Agency for International Development
USE	Uganda Securities Exchange
USSIA	Uganda Small Scale Industries Association
V	Volt
VAT	Value Added Tax
W	Watt
WENRECO	West Nile Rural Electrification Company
Wp	Watt-peak
WHT	Withholding Tax

EXECUTIVE SUMMARY

Uganda has a welcoming investment climate and a promising market for solar PV and bioenergy captive power at the commercial and industrial scale in the range of 20 kW to a couple of MWs. This GET.invest Developer Guide provides comprehensive information on the captive power market in Uganda and regulatory steps and processes to develop a solar PV or bioenergy captive power project.

The Guide is part of a package of products under the first series of the Market Insights of GET.invest. Each package covers a certain renewable energy market segment and includes **a)** a 'how to' Developer Guide, **b)** Model Business Cases and **c)** Case Studies — all accessible online at www.get-invest.eu.

Information and data used in the preparation of the Guide was gathered from several sources in late 2017 and early 2018 including project site visits, in-country interviews with more than 30 key stakeholders and a careful review of available reports and legislation.

A captive power plant — also known as a self-generator, embedded generator, distributed generator or auto-producer — is a power generation facility that produces electricity solely or primarily for internal use. In other words, a dedicated, localized source of electricity for own consumption. The term captive power typically refers to self-generation in larger commercial, industrial or institutional facilities as opposed to domestic or small business usage.

The key takeaways are as follows:

- There is increasing interest in this market due to various reasons however, the overwhelming motivation is energy savings, improve the reliability of power supply and reduce exposure to electricity tariff fluctuations.
- Project commercial viability is very customer and site-specific. Generally, facilities in the higher priced commercial (code 10.2) and medium industrial (code 20) tariff categories have the most potential. For solar projects, the roof age and structure could be a limitation. Whereas for biomass, the availability and consistency of feedstock is usually a limitation.
- For larger users (code 30 and 40 customer categories) with lower tariffs, captive power may only be commercially viable where significant back-up power is used, feedstock is available for combined heat and power (CHP) to offset high process fuel costs, the system could be oversized for sale under the FIT and/or there are waste treatment or disposal requirements that come at a cost.
- The future evolution of electricity tariffs and exchange rates are important, as are any future reductions in technology costs. Retail tariff reduction would weaken the project bankability for captive power.
- For solar PV, self-generation is most likely to be commercially viable where there is consistent daytime demand. A solar PV levelised cost of less than EUR 0.13/kWh (USD 0.15/kWh) will be competitive against daytime grid consumption for code 10.2 and code 20 customers at current electricity prices.
- Users with larger quantities of biomass residues or waste water with higher organic loads suitable for economical generation will generally be larger customers in the code 30 tariff category. With lower tariffs, captive power potential will be highly specific to each case.
- Industrial heat needs are relatively high and production equipment and processes are not often optimized. This means that there may be competition for biomass feedstock and that direct heating and energy efficiency measures may be a better investment for certain users. In general, captive power projects are most effective and efficient when they are part of a holistic energy management strategy, including energy audits and energy efficiency improvements.
- Procedurally, there is a fairly clear process to implement a captive power project and there are a few examples already in operation.

— Most if not all current captive power projects in Uganda were found to be financed through corporate finance and self-owned by the property owner. The third-party ownership schemes (leasing or power purchase agreement) are yet to emerge as the market matures.

— There are currently no specific mechanisms in Uganda for the export (including sale) of surplus captive power to the national grid. However, in principle, some of the regulations that apply to distributed or embedded renewable energy generation independent power producers (IPPs) could be applicable to captive power, but only on an ad hoc case by case basis. In general, future policy developments bear watching, as they may impact the market.

SECTION 1

Introduction

This Developer Guide describes the opportunity for on-site power generation for self-consumption (captive power) in Uganda, with a focus on the private sector. The guide is for potential projects in the 20 kW to few MW range implemented by or for medium and larger-scale commercial, industrial and agricultural facilities. Solar PV, biogas and biomass energy sources and technologies are considered.

The Developer Guide is intended for use by companies, facilities and institutions that may wish to consider self-generation of electricity to achieve cost-savings, improved reliability or other benefits. It is also relevant for project developers, investors and financiers interested in captive power in Uganda. Policy makers may also gain insights into the market.

The Developer Guide is meant to provide a consolidated resource of key information for early stage market exploration. The Guide is not intended to substitute for on-the-ground market research activities. Indicative information is provided based on project site visits, in-country interviews with more than 30 key stakeholders and a careful review of available reports and legislation in late 2017 and early 2018.

This Guide is organized across six sections. Besides the Introduction, **Section 2** provides background on the country situation and **Section 3** the electricity sector in Uganda, with insights into renewable energy potential. **Section 4** describes captive power technical and economic considerations and implementation models and gives insights into the market opportunity in Uganda. A discussion on "how to" develop a captive power project and key regulatory requirements follows in **Section 5**. **Section 6** concludes with information on some financing options.

The Developer Guide is part of a package of products under the first series of the Market Insights of GET.invest. Each package covers a certain renewable energy market segment and includes **a)** a 'how to' Developer Guide, **b)** Model Business Cases and **c)** Case Studies. It is recommended to cross-read all three products to gain a comprehensive overview. The products are accessible online at www.get-invest.eu.

Exchange rates used in this guide are from October 2017:

UGX–USD	0.000273411
UGX–EUR	0.000234769

SECTION 2

Country Profile

The Republic of Uganda is a land-locked country in East Africa. It is bordered to the north by South Sudan, to the east by Kenya, to the south by Tanzania and Rwanda and to the west by the Democratic Republic of the Congo. The political map of Uganda is found in **Figure 1**.

2.1 GEOGRAPHY, TOPOGRAPHY AND CLIMATE

Uganda has a total area of 236,040 km² and a perimeter of 2,698 km. The White Nile has its source in Uganda at Lake Victoria, Africa's largest lake by area. The White Nile runs northward through Lake Kyoga and then Lake Albert in the west, from where it flows north to South Sudan.

FIGURE 1. Political map of Uganda[1]

1) United Nations (2003) Map of Uganda, UN Department of Peacekeeping Operations, Cartographic Department. Link: http://www.un.org/Depts/Cartographic/map/profile/uganda.pdf – accessed March 2019

Much of Uganda's topography consists of a plateau of 800 to 2,000 m in height. Mountain peaks include Margherita (5,109 m) in the Rwenzori Mountains in the west and Mount Elgon (4,321 m) in the east. By contrast, the Albertine Rift, which runs north-south in the west, dips as low as 621 m.

Lying at equator, the country has a warm climate. Average temperatures vary little throughout the year, ranging from 20–27 °C depending on location and altitude. Maximum and minimum temperatures exhibit a greater range, reaching for example a mean maximum of 33 °C and minimum of 12 °C at Arua at 1,204 m in the northwest. Temperatures are highest from December to March and lowest from June to October, as seen in **Figure 2**. Note that ambient temperature has an influence on the output of solar and biogas power systems.

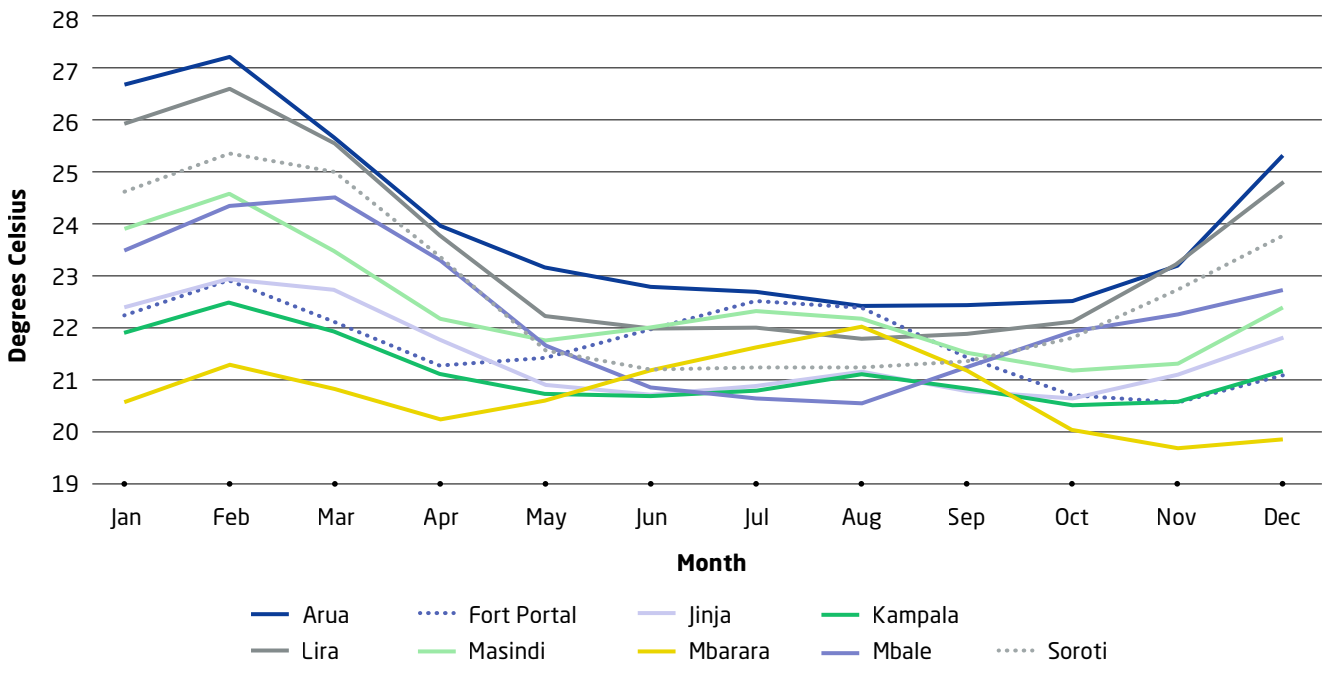
Most of Uganda receives an annual rainfall of at least 1,000 mm, but as with temperature this varies by location. At Entebbe, mean annual precipitation is 1,620 mm while in the northeast of the country it is only 690 mm. Uganda has a bi-modal rainfall pattern, with one rainy season in April–May and a second in September–November. Monthly precipitation is shown in **Figure 3**. Note that rainfall in Uganda can at times be heavy, leading to more frequent power blackouts and flooding.

2.2 DEMOGRAPHICS

Uganda had an estimated population of 42.9 million in 2017, which is expected to exceed 73 million by 2035. As of 2014, only 18.4% of the population lived in urban areas. Kampala, the capital city, had an estimated 1.5 million residents in 2014. Other major towns include Mbarara, Mukono, Gulu, Lugazi, Masaka, Kasese and Hoima. English is the official national language and Luganda is the most widely used native language.

The national poverty rate declined from 50.1% in 1995 to 19.7% (6.7 million people) in 2013. The official employment rate is high, at 84% of the working population of 13.9 million, with 72% being employed in agriculture. However, the majority of workers (53%) are self-employed in the informal sector, which is partially due to a lack of formal education — 75% of workers had none as of 2014.

FIGURE 2. Average monthly temperature in Uganda for 9 towns[2]



2) Authors derived from NASA (2008) Surface Meteorology and Solar Energy (SSE) Release 6.0 Data Set, January 2008. Link: https://eosweb.larc.nasa.gov/sse/ – accessed March 2019

2.3 POLITICAL AND ECONOMIC SITUATION

Uganda is a presidential republic that gained independence from the United Kingdom in 1962. The country has substantial natural resources, including fertile soils, small deposits of copper, gold, and other minerals and recently discovered oil. The service industry has the biggest impact on Uganda's GDP at 51.9%, followed by agriculture (25.4%) and the industrial sector (22.7%).

Average annual growth in Uganda was 4.5% in the six years to fiscal year 2017, compared to the 7% achieved in the previous two decades. The slowdown was mainly driven by adverse weather, unrest in South Sudan, weakening exports, inadequate transport and energy infrastructure, private sector credit constraints and the delayed execution of some public projects. Economic growth may increase to 5% in 2018 depending on weather conditions, Foreign Direct Investment (FDI) inflows, banking system stabilization and budgeted capital spending execution. Annual GDP growth is shown in **Figure 4**.

In 2015, the Ugandan Shilling (UGX) depreciated by 22% against the US Dollar (USD) while inflation rose from 3% to 9%. To limit inflation, the Bank of Uganda increased interest rates from 11% to 17%. Historic currency rates for Euro (EUR) and USD are presented in **Figure 10**.

FIGURE 3. Average monthly rainfall for Uganda, 1991-2015[3]

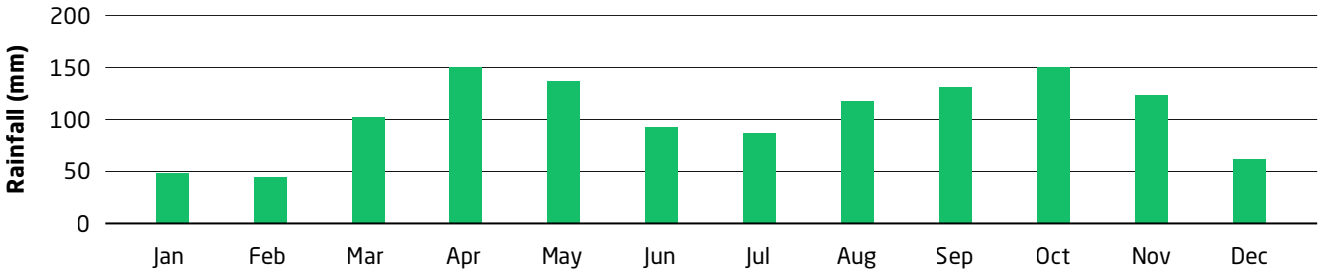
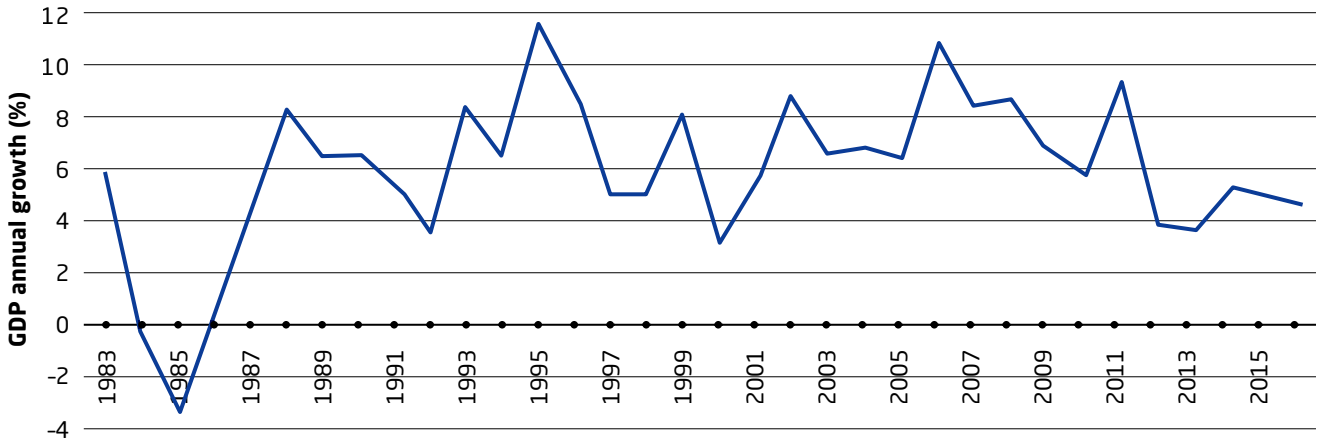


FIGURE 4. Uganda's annual GDP growth rate, 1963-2016 (%)[4]

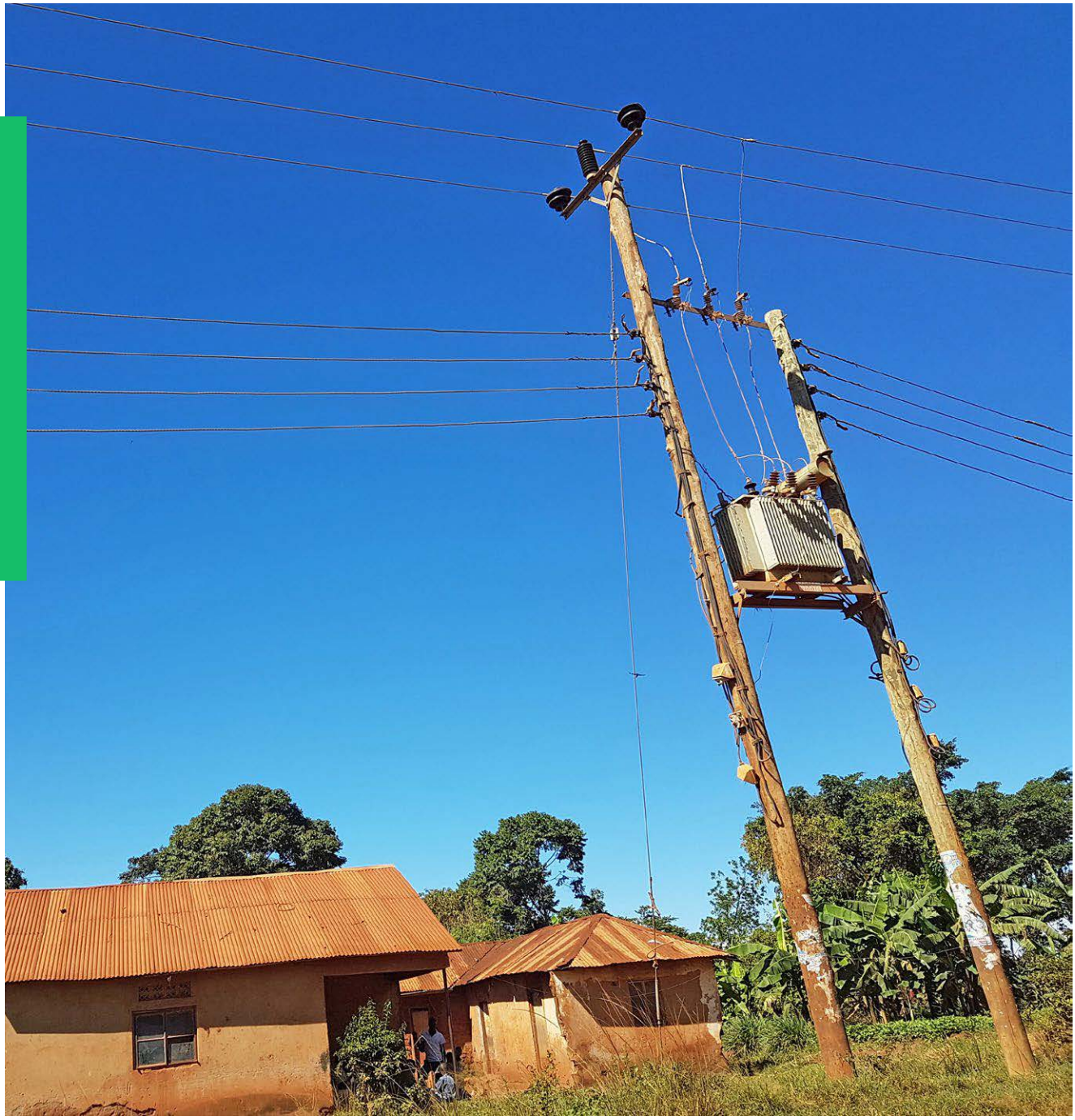


3) Derived from World Bank (2017) Uganda Climate Historical Records, Climate Change Knowledge Portal. Link: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=UGA – accessed March 2019

4) Authors derived from World Bank (2017) Uganda GDP growth (annual %) World Bank Open Data. Link: https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?end=2016&locations=UG&start=1983&view=chart – accessed March 2019

SECTION 3

Electricity Sector Profile



In 2001, Uganda's electricity sector was unbundled into generation, transmission and distribution, with private sector participation in the first and the latter. Power generation installed capacity of 916 MW is dominated by large-scale hydropower, provided by the state-owned utility as well as Independent Power Producers (IPPs), who are responsible for 60% of the electricity generated. In fact, after South Africa, Uganda has the largest number of IPPs in Sub-Saharan Africa.

Given its dependence on hydropower, Uganda's electricity sector is vulnerable to climate change, and poor hydrology has already had some impact on generation. At the same time, consumption has grown slower than expected. In 2018 and 2019 significant new capacity is expected to come online. The national electrification rate remains low at 18%. **Table 1** presents some key figures.

TABLE 1. Key electricity sector indicators in Uganda[5]

PARAMETER	VALUE
Installed generation capacity (2017), MW	916
Installed fossil fuel capacity (2017), % of total installed capacity	15
Hydro capacity (2017), % of total installed capacity	76
Other renewable energy capacity (2017), % of total installed capacity	9
Renewable electricity output as % of total electricity output excl. hydro (2017)	7
Avg. distribution and transmission losses as % of output (2016)	20.4
Net electricity imports (2015), GWh	–50
Electrification rate, total (2016) %	18
Electrification rate, urban (2016) %	52
Electrification rate, rural (2016) %	12
Peak demand, domestic (2017), MW	546
Per capita electricity consumption (2015), kWh	83.8

5) Data sources can be found in **Table 19**

3.1 ELECTRICITY POLICIES AND REGULATIONS

Electricity sector reforms in Uganda began in 1997 with a strategic plan that evolved into the 1999 Electricity Act. The reform and subsequent policies aimed to improve overall sector performance, foster energy security and open the sector to private investment, especially in generation and distribution.

Currently, there are no specific policies or dedicated regulatory framework for captive power in Uganda, although there is support for distributed generation, renewable energy and private sector investment.

The policies, plans and legislation most relevant for captive power are listed next. For an introduction to each, please see www.get-invest.eu[6].

6) You can find out more about the respective plans at:
- Uganda Vision 2040. Link: https://consultations.worldbank.org/Data/hub/files/consultation-template/materials/vision20204011.pdf – accessed April 2019
- Energy Policy for Uganda. Link: http://energyandminerals.go.ug/downloads/EnergyPolicy.pdf – last accessed September 2017, link no longer available
- Renewable Energy Policy for Uganda. Link: https://www.era.or.ug/index.php/tariffs/generation-tariffs/feed-in-tariff – last accessed September 2017
- Renewable Energy Feed-in Tariff. Link: http://www.era.or.ug/index.php/2013-12-14-14-58-04/guidelines/doc_download/383-uganda-renewable-energy-feed-in-tariff-phase-3-guidelines-2016 – accessed September 2017
- GET-FiT. Link: https://www.getfit-uganda.org/ – accessed April 2019
- Rural Electrification Strategy and Plan. Link: http://www.rea.or.ug/resources/strategy%20and%20plan%202013-2022.pdf – accessed April 2019
- Sustainable Energy for All Action Plan. Link: https://www.seforall.org/sites/default/files/SEFA-Action-Agenda-Final.pdf – accessed April 2019
- Scaling-Up Renewable Energy Program Investment Plan Uganda. Link: https://www.climateinvestmentfunds.org/sites/cif_enc/files/srep_14_8_srep_investment_plan_for_uganda_final_version.pdf – accessed April 2019
- Least Cost Generation Plan. Link: https://www.powerutilityleadership.com/wp-content/uploads/2018/03/Uganda_Future_Plans.pdf – accessed April 2019
- Electricity Act. Link: https://www.era.or.ug/index.php/resource-centre/regulatory-instruments/laws/86-the-electricity-act-1999/download – accessed September 2017

- **Uganda Vision 2040** (2013) operationalizes Uganda's development vision and has electricity sector targets.
- **The Energy Policy for Uganda** (2002) includes increasing the role of the private sector in power sector operations and future development.
- **The Renewable Energy Policy for Uganda** (2007) encourages power generation from different renewable sources including the conversion of industrial waste into energy.
- **The Renewable Energy Feed-in Tariff** (2007, revised 2013 and 2016. Another REFiT review is currently ongoing.) and a related support programme called GET-FiT enable the sale of electricity by IPPs.
- **The Rural Electrification Strategy and Plan** (2013) seeks to achieve universal access.
- **The Sustainable Energy for All Action Plan** (2012) incorporates — among others — targets for improved energy efficiency among larger power users.
- **The Scaling-Up Renewable Energy Program Investment Plan Uganda** (2015) has a component on testing net metering pilot projects and if needed preparing regulations.
- **The Least Cost Generation Plan** (2016) covers power demand scenarios to 2025.
- **The Electricity Act** (1999) is the framework legislation for the liberalisation of the electricity sector under which there are a number of subsidiary regulations.

The Renewable Energy Feed-in Tariff (REFIT) programme provides for power plants of up to 20 MW to enter into a 20-year Power Purchase Agreement (PPA) with the Uganda Electricity Transmission Company Limited (UETCL). GET-FiT, an external subsidy scheme that used to provide a tariff premium over the published REFIT rate, is now closed to new applicants. The REFIT rates for 2016–2018 are as per **Table 2**. There is no REFIT for solar or geothermal.

TABLE 2. Uganda REFIT 2016-2018[7]

TECHNOLOGY	TARIFF (USD/kWh)	O&M %	CUMULATIVE CAPACITY LIMITS (MW)		
			2016	2017	2018
Hydro 10–20 MW	0.094	10.96	30	60	80
Hydro 5–10 MW	0.107 (5.1 MW) – 0.094 (10.0 MW)	10.49	20	40	50
Hydro 0.5–5 MW	0.107	10.49	10	20	30
Bagasse	0.088	29.78	30	50	60
Wind	0.122	10.71	25	50	75
Biogas*	0.115	—	—	—	—
Landfill gas*	0.089	—	—	—	—
Waste/biomass*	0.113	—	—	—	—

* Note: tariff for these technologies is a ceiling subject to negotiation and a maximum return on equity of 18%

7) ERA (2016) Uganda Renewable Energy Feed-in Tariff (REFIT) Phase 3 Guidelines, pp. 19-21. Link: https://www.getfit-uganda.org/app/download/29325656/Uganda-REFIT-Guidelines-Phase+3-2016.pdf – accessed March 2019

Most captive power projects will not be well positioned to make use of the REFIT due to the absence of a tariff for solar projects, the regulatory burden and poor economies of scale. At the same time, under the Electricity Act, UETCL as the system operator is the only licenced buyer to purchase power from renewable energy generators selling to the national grid. In addition, there is currently no framework for net metering, although there are plans for a pilot programme. Taken together, these limit the options for the export of any surplus power from a captive plant.

Since 2015, a draft Electricity Act (Amendment) Bill has been under development, which may better enable the export of surplus captive power.

These matters are discussed in **Section 4.4**, while **Section 5.5** provides information on the different energy licencing options for a captive power generation.

3.2 INSTITUTIONAL ARRANGEMENTS

Shortly after the enactment of the Electricity Act in 1999, Uganda established an independent electricity regulator and a specialised government agency for rural electrification. As part of the sector unbundling, in 2001 the Uganda Electricity Board was split into three separate entities for generation, transmission and distribution. All three remain stated-owned, with certain areas of operations and asset management outsourced under long-term concessions agreements to private operators. A list of the main actors is provided next. **Figure 5** shows the institutional structure of the power sector.

- **Ministry of Energy and Mineral Development (MEMD)** oversees and guides the direction of the electricity sector.
- **Electricity Regulatory Authority (ERA)** regulates the generation, transmission, distribution, sale, export and import of electricity in Uganda, including licencing and tariff setting.
- **Rural Electrification Agency (REA)** is a semi-autonomous agency of MEMD set up to implement the rural electrification agenda under a public-private partnership.
- **Uganda Electricity Generation Company Limited (UEGCL)** is the stated-owned generation company with two existing large hydro plants and two more under construction.
- **Uganda Electricity Transmission Company Limited (UETCL)** is the state-owned transmission company, system operator and single buyer of electricity sold to the grid.
- **Uganda Electricity Distribution Company Limited (UEDCL)** is the government utility that owns the electricity distribution network.
- **Umeme Limited** is a private company that operates UEDCL's network under a 20-year concession starting in 2005 and serves 93% of the electricity customers in Uganda.
- At the end of 2017 there were **seven other private distribution companies and cooperatives** that provide electricity to end-users in on and off-grid areas.
- There are at least **15 operational IPPs** and 25 others with permits or licences in the pipeline.

More information on each of the main electricity sector actors is found in **Annex A**.

A number of other institutions in Uganda are also relevant for the development of a captive power project. These are covered in **Section 5**.

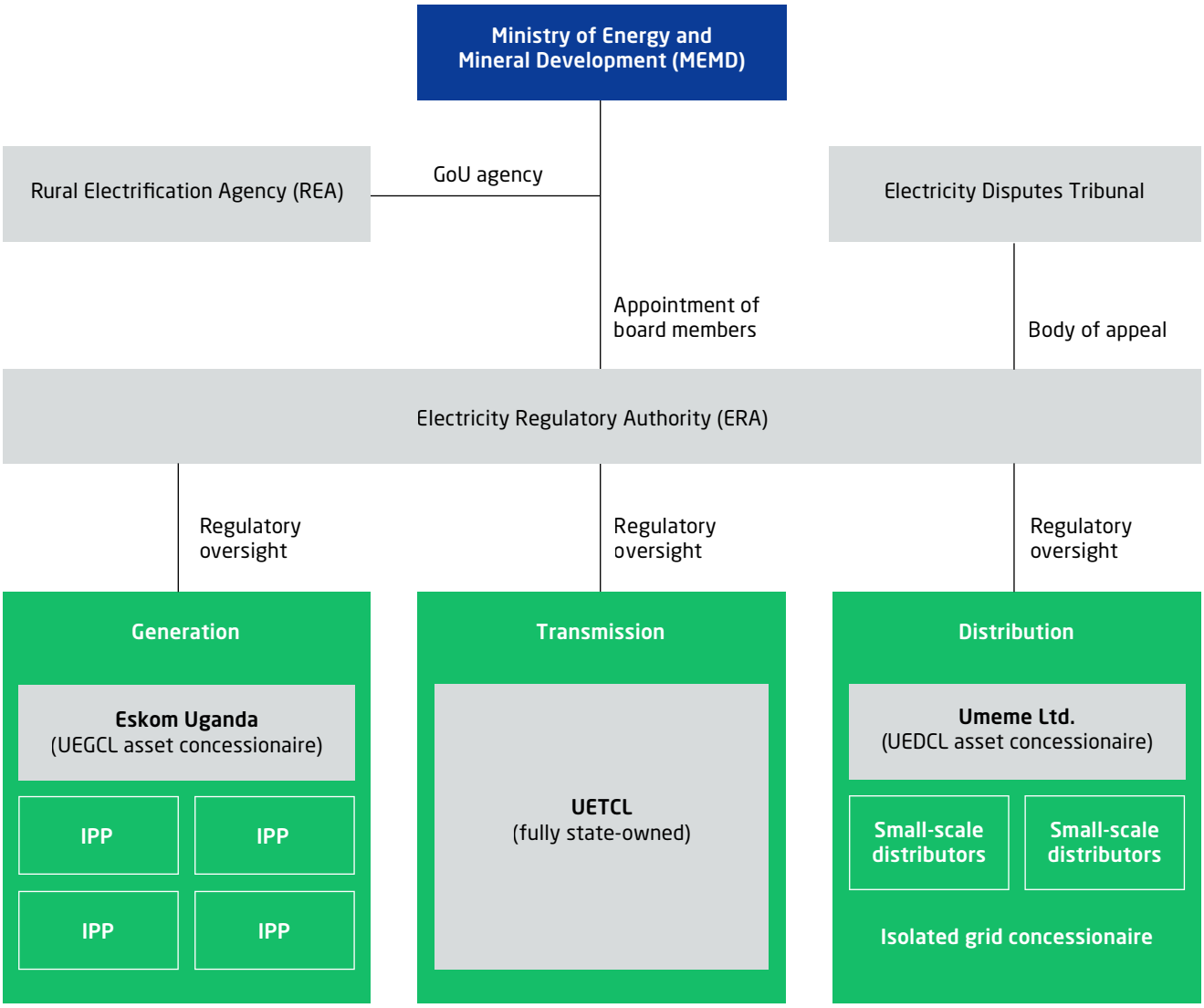
3.3 ELECTRICITY DEMAND

ELECTRICITY CONSUMPTION

According to the 2014 census, 15.5% of households were grid-connected countrywide, with a rate of 47.7% in urban areas and a significantly lower rate of 5.1% in rural areas. Uganda's per capita electricity consumption was 89 kWh/year in 2014. This was below the average for sub-Saharan Africa excluding South Africa at 153 kWh/year and the world average of 3,128 kWh/year in 2014.

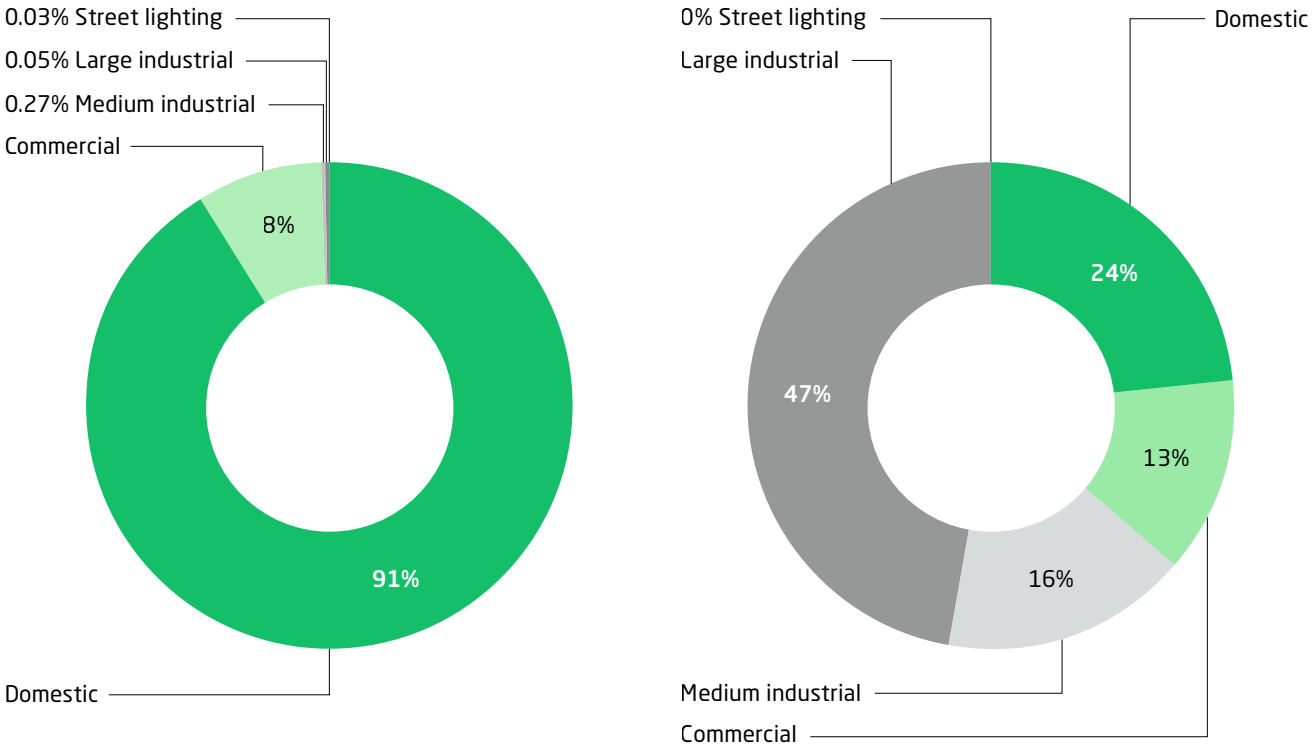
There were a total of 1,022,323 electricity customers at the end of 2016, which constituted a 17% growth in customer base over 2015, a slower rate than the 24% experienced between 2014 and 2015. Ninety-one percent of the customers were domestic and most of the remaining 9% were commercial and industrial. Electricity sales in 2016 amounted to a total of 2,597 GWh, an increase of 3.8% from 2015, with large industrial users responsible for the largest share of consumption, even though they only made up 0.05% of the customer base. **Figure 6** gives the breakdown.

FIGURE 5. Institutional structure of Uganda's power sector[8]



8) Eberhard, Anton, Katharine Gratwick, Elvira Morella and Pedro Antmann (2016) Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries, p. 228. Directions in Development. Washington, DC, World Bank. Link: https://openknowledge.worldbank.org/handle/10986/23970 – accessed March 2019. Note: UETCL is also the system operator and single buyer.

FIGURE 6. Electricity customers (left) and consumption (right) by sector in Uganda[9]



ELECTRICITY DEMAND-SUPPLY BALANCE

Uganda has in recent years moved from a position of electricity supply shortfall to surplus. This change was largely due to the commissioning of the 250 MW Bujagali Hydro Power Project in 2012.

Electricity supply

By end of 2017, power generation installed capacity of 916 MW in Uganda was dominated by large and small hydropower (76%), followed by thermal (15%) and biomass cogeneration power plants (7%). In 2016, almost 3,475,000 MWh of electricity were generated by the main grid-connected power plants, 85% of which came from large hydro, 9% from small hydro, 4% from thermal and 2% from bagasse co-generation.

As per the Least Cost Generation Plan of 2016, planned and candidate generation sources include UEGCL's large 83 MW Agago-Achwa, 183 MW Isimba, 392 MW Oriang and 600 MW Karuma hydropower projects as well as various small hydro stations, a smattering of solar, bagasse, wind and thermal IPPs and one peat power plant. This is expected to provide new capacity of between 1,724 MW and 2,583 MW by 2024.

Electricity demand

Domestic maximum demand in Uganda reached 546 MW in January 2017. The total system peak including power exports was higher at 596 MW in February 2017. Lower demand was then experienced during the following months, as shown in **Figure 7**.

Uganda's daily load curve varies by season but retains a consistent pattern over the year, with demand increasing until around lunch time, before dropping off in the afternoon and then peaking in the evening between 20:00–22:00 — as evident in **Figure 8**.

9) Authors derived from Electricity Regulatory Authority (2017), ERA Distribution Statistics Q4 2016. Link: http://www.era.or.ug/index.php/statistics-tariffs/2013-11-27-16-54-30/distribution-statistics – last accessed August 2017, link no longer available

FIGURE 7. Maximum power demand (MW) in Uganda, January 2016–August 2017[10]

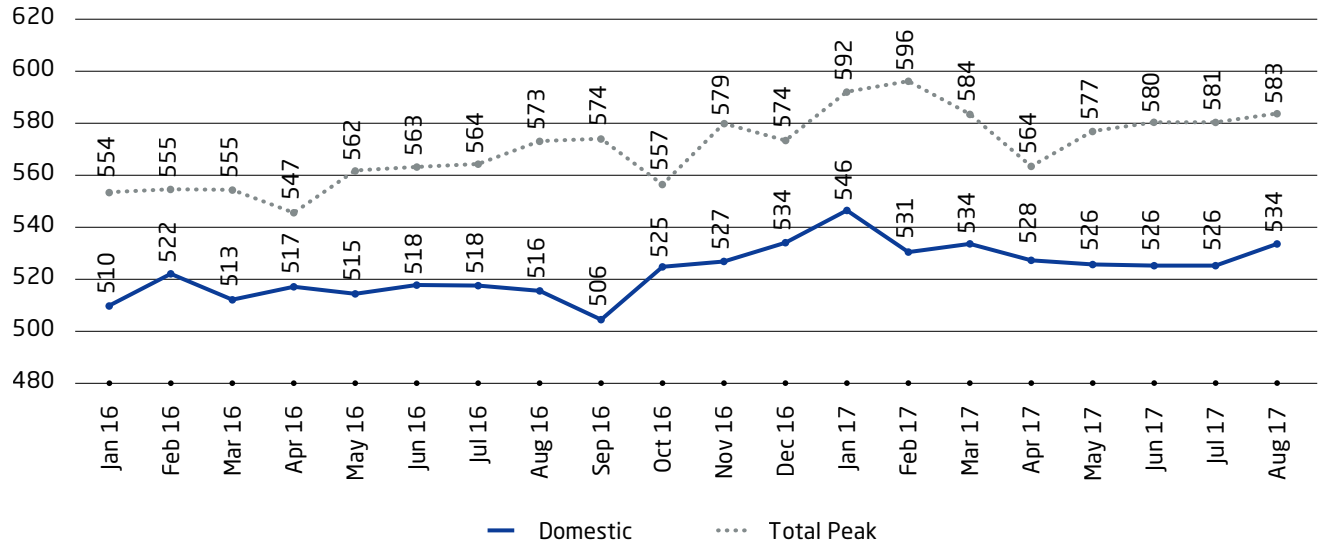
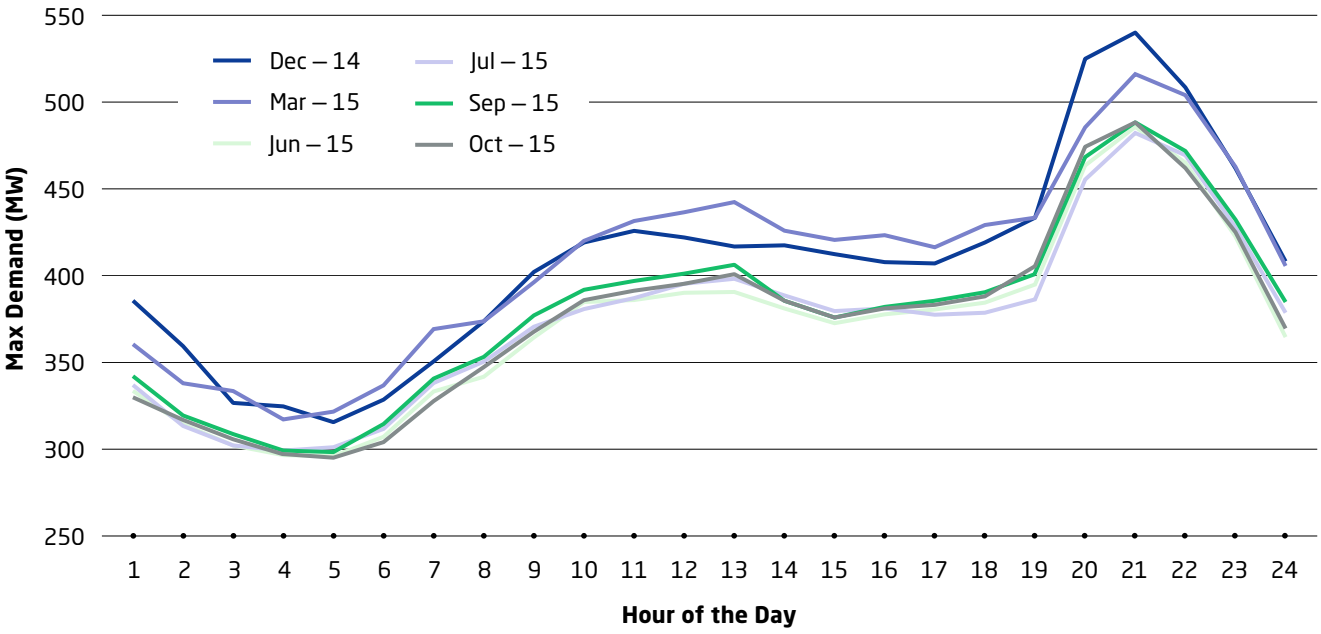


FIGURE 8. An illustration of the daily load curve[11]



10) ERA (2017) Electricity Regulatory Authority Determination of Tariff Adjustment Factors for the Fourth Quarter of 2017, p. 14.
Link: http://www.era.or.ug/files/Q4_2017_Tariff_Order_Paper_for_Publication.pdf – last accessed October 2017, link no longer available

11) Based on the average of selected months from 2014-2015 based on ERA (2016) The Least Cost Generation Plan 2016-2025, p. 36.
Link: https://www.era.or.ug/index.php/resource-centre/publications/plans – accessed March 2019

Demand-supply outlook

ERA forecasts annual electricity demand growth of 6.5%, 3.6% and 12% in base, low and high case scenarios, respectively. This is lower than previous projections and combined with new generation capacity would lead to a potential surplus[12] of around 1,200–2,300 MW by 2025. Much of the consumption is expected to come from large industrial customers. This is because domestic customers consume an average of 16 kWh/month, resulting in minimal impact on the growth despite the significant unmet demand due to low electrification rate.

The projections paint a picture of a short-term demand-supply equilibrium with a marginal amount of reserve until 2019 when significant capacity additions should come online. However, there is uncertainty around the timing and extent of the additional capacity and around growth in demand. On the supply side, these revolve around poor hydrology and delayed commissioning of some power plants that has already resulted in lower than expected generation, among other factors.

Due to the projected surplus, ERA has already suggested measures to address redundant capacity. These include: **a)** rescheduling of large power plant construction, **b)** stimulating industrial demand by improving the quality of service and supply, **c)** increasing rural electrification efforts and **d)** exploring power export options.

Overall, given the demand-supply balance, policy makers may not have an incentive to proactively support captive power in business and industry. At the same time, increasing renewables and a more competitive private sector are policy objectives, and captive power may help to improve grid stability and reduce T&D losses among other potential benefits (see **Section 4.1** for an indication).

The implications of the demand-supply balance for the future direction of the electricity tariff are discussed separately in **Section 3.4**.

3.4 ELECTRICITY TARIFFS

Until 2011, end-user electricity tariffs in Uganda were kept artificially low and supported by funding from the government. It was only in 2012 that the Electricity Regulatory Authority (ERA) was able to implement more financially sustainable end-user tariffs, with a weighted-average increase of 46% that year. However, the current tariff regime is not fully cost-reflective.

TARIFF STRUCTURE

Retail electricity tariffs in Uganda are made up of different cost components, not all of which are applicable to all customer types. These are **a)** an energy charge, **b)** a service (fixed) charge, **c)** a demand charge, **d)** a reactive power penalty or reward charge and **f)** Value Added Tax (VAT).

End-users are classified as domestic, commercial or industrial, with sub-categorization for industrial customers into medium, large and extra-large. All tariff categories pay an energy charge per kWh of consumption and all are subject to a monthly fixed service charge. Industrial users also pay a monthly demand charge, and a monthly reactive power penalty or reward charge may apply.

The applicable energy tariff depends on the distribution company responsible for electricity supply in a particular region. For commercial and industrial customers supplied by the main distributor, Umeme (with 93% of Uganda's customers), a time-of-use tariff is applied. The time periods are peak (18:00–00:00), off-peak (00:00–06:00) and shoulder (06:00–18:00).

The Umeme end-user tariffs in the commercial and industrial categories — being those relevant for captive power — for Q4 of 2017 are presented in **Table 3**.

Energy charges

ERA sets end-user base energy tariffs annually based on power system costs, inflation and other factors. Adjustments to the base tariff to account for fluctuations in power system generation fuel and foreign exchange costs and inflation throughout the year are then made on a quarterly basis and published on the ERA website. Therefore, in a given quarter, the actual energy charges may be more or less than the base tariff. In Q2 2017 for example, the actual energy tariff post adjustment was 1.3–1.6% less than the base tariff published in January 2017.

12) Efforts are ongoing by the relevant entities in Uganda to mitigate and manage this risk.

TABLE 3. Umeme commercial and industrial energy tariffs, Q4 2017[14]

TARIFF CODE	TARIFF CLASS	TIME OF USE		ENERGY CHARGE/kWh		
	By connection voltage and demand	**Period**	**Hours**	**UGX**	**EUR**	**USD**
10.2	Commercial 415 V Max 100 A	Peak	18:00–00:00	806.0	0.18922	0.22037
		Shoulder	06:00–18:00	618.1	0.14511	0.16900
		Off-peak	00:00–06:00	381.6	0.08959	0.10433
		Average	**—**	**619.1**	**0.14535**	**0.16927**
20	Medium industrial 415 V Max 500 kVA	Peak	18:00–00:00	738.0	0.17326	0.20178
		Shoulder	06:00–18:00	565.9	0.13286	0.15472
		Off-peak	00:00–06:00	345.7	0.08116	0.09452
		Average	**—**	**568.0**	**0.13335**	**0.15530**
30	Large industrial 11/33 kV 500–1,500 kVA	Peak	18:00–00:00	490.0	0.11504	0.13397
		Shoulder	06:00–18:00	375.3	0.08811	0.10261
		Off-peak	00:00–06:00	236.3	0.05548	0.06461
		Average	**—**	**368.1**	**0.08642**	**0.10064**
40	Extra large industrial 11/33 kV >1,500 kVA	Peak	18:00–00:00	484.9	0.11384	0.13258
		Shoulder	06:00–18:00	371.4	0.08719	0.10154
		Off-peak	00:00–06:00	325.1	0.07632	0.08889
		Average	**—**	**364.6**	**0.08560**	**0.09969**

2019 electricity retail base tariff rates can be found on Umeme website[13].

The retail tariffs can be compared against estimated captive power generation costs in the GET.invest Model Business Cases and example GET.invest Project Cases Studies.

The end-user tariffs for other grid-connected and cooperative-owned distribution companies tend to be slightly less than the Umeme tariff. The opposite is true for the two larger mini-grid concessionaires that generate their own power — West Nile Rural Electrification Company (WENRECO) and Kalangala Infrastructure Services (KIS). Weighted-average tariffs for the other distribution companies are available online at www.get-invest.eu.

13) Link: https://www.umeme.co.ug/file/Tariffs.pdf – accessed March 2019

14) ERA (2017) Electricity Regulatory Authority Determination of Tariff Adjustment Factors for the Fourth Quarter of 2017, p. 32. Link: http://www.era.or.ug/files/Q4_2017_Tariff_Order_Paper_for_Publication.pdf – last accessed October 2017, link no longer available

Service and demand charges

Umeme monthly service and demand charges have remained constant since 2015[15]. The monthly fixed service charge is shown in **Table 4**. **Table 5** shows the demand charges in kVA/month for code 20 and 30 industrial customers.

TABLE 4. Umeme commercial and industrial customer monthly service charges[16]

TARIFF CODE	TARIFF CLASS	SERVICE CHARGE/MONTH		
		UGX	EUR	USD
10.2	Commercial	3,360	0.79	0.92
20	Medium Industrial	22,400	5.26	6.12
30	Large industrial	70,000	16.43	19.14

TABLE 5. Umeme medium and large industrial customer monthly demand charges[17]

TARIFF CODE	TARIFF CLASS	DEMAND CHARGE kVA/MONTH		
		UGX	EUR	USD
20	Medium Industrial	16,644	3.91	4.55
30	Large industrial — up to 2,000 kW	11,096	2.61	3.03
30	Large industrial — beyond 2,000 kW	5,548	1.30	1.52

15) The charges were maintained in 2018 and ERA is undertaking a Cost of Service study that is expected to inform any adjustment to the monthly service charges and maximum demand charge going forward. ERA (2018) Tariff Review Report, p. 43, 62. Link: https://www.era.or.ug/index.php/tariffs/tariff-reviews – accessed March 2019

16) ERA (2015) Statement on the Electricity End-User Tariffs for the Year 2015, p. 6. Link: http://www.era.or.ug/index.php/2013-12-14-14-58-04/guidelines/doc_download/202-statement-on-the-electricity-end-user-tariffs-for-the-year-2015 – accessed March 2019

17) ERA (2016) ERA Tariff Review Report for 2016, p. 24. Link: http://www.era.or.ug/files/ANNUAL_TARIFF_REVIEW_REPORT_2016_3.pdf – last accessed August 2017, link no longer available

Reactive power penalty/reward charges

A reactive power penalty charge of UGX 40/kVArh/month (EUR 0.0094) and energy reward compensation of UGX 20/kVArh/month (EUR 0.0047) is applied to medium & large industrial consumers.

Value Added Tax

Value Added Tax (VAT) at a rate of 18% is added to the total electricity bill. For electricity customers who cannot balance out their input and output VAT on purchases and sales, this tax adds a significant component to electricity costs.

It can be noted that the tariff structure in Uganda creates an incentive for captive power because **a)** for some customers tariffs are relatively high and **b)** monthly service and demand charges are low compared to total energy charges, which represent the major portion (85–95%) of a customer's electricity bill.

TARIFF TRENDS AND INFLUENTIAL FACTORS

As noted earlier, ERA adjusts the end-user retail tariff quarterly based on macro-economic factors. The trends in these adjustment factors can help provide an indication of the likely direction of electricity tariffs in the future, which is very important for the competitiveness of captive power.

Inflation

After falling from extreme highs in 2012, since January 2013 the annualized inflation rate has ranged between under 2% to above 8%. The trend up to September 2017 is found in **Figure 9**.

Annual inflation is expected to continue at a rate of around 5% per annum. Inflation leads to increases in power sector annualized revenue requirements, and hence higher tariffs.

Foreign currency exchange rate

More than 70% of electricity generation costs in Uganda are denominated in foreign currency — the US Dollar (USD). Therefore, any fluctuation in the exchange rate of the Uganda Shilling (UGX) against the US Dollar has a strong impact on costs and end-user electricity tariffs. In recent years, the UGX has generally depreciated against the USD, and against the Euro (EUR). **Figure 10** presents the trend.

For power sector planning, the government forecasted an average annual depreciation of 5% of the UGX against the USD, although in EUR terms the UGX may have slowed its depreciation.

FIGURE 9. Uganda annualized inflation rate trend 2013-2017 (%)[18]

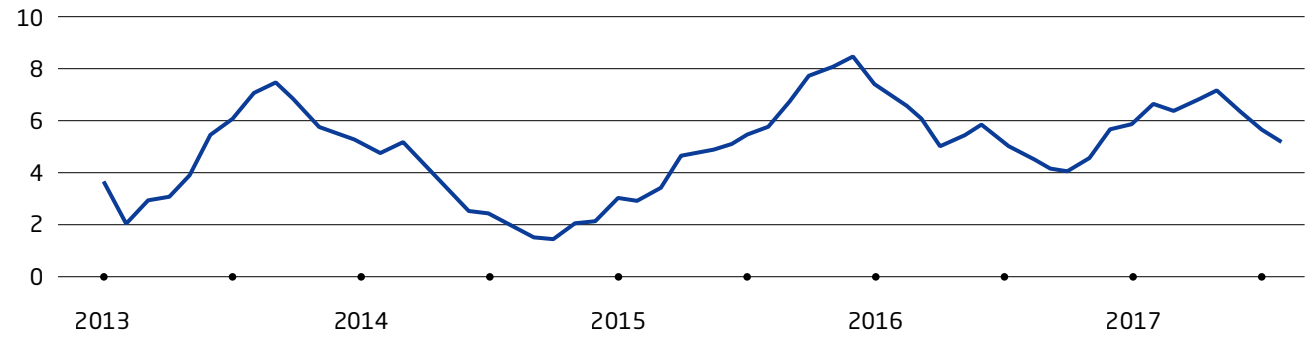
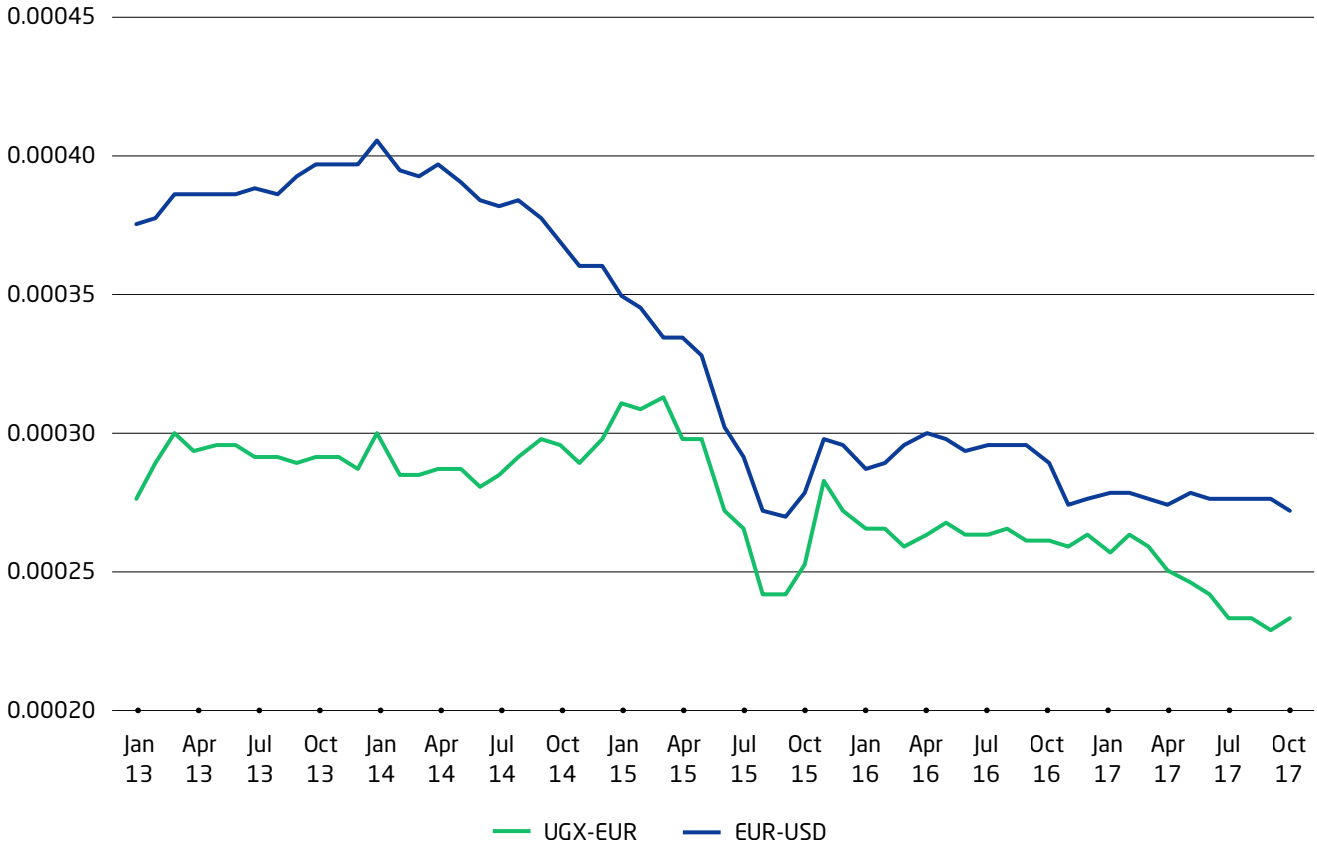


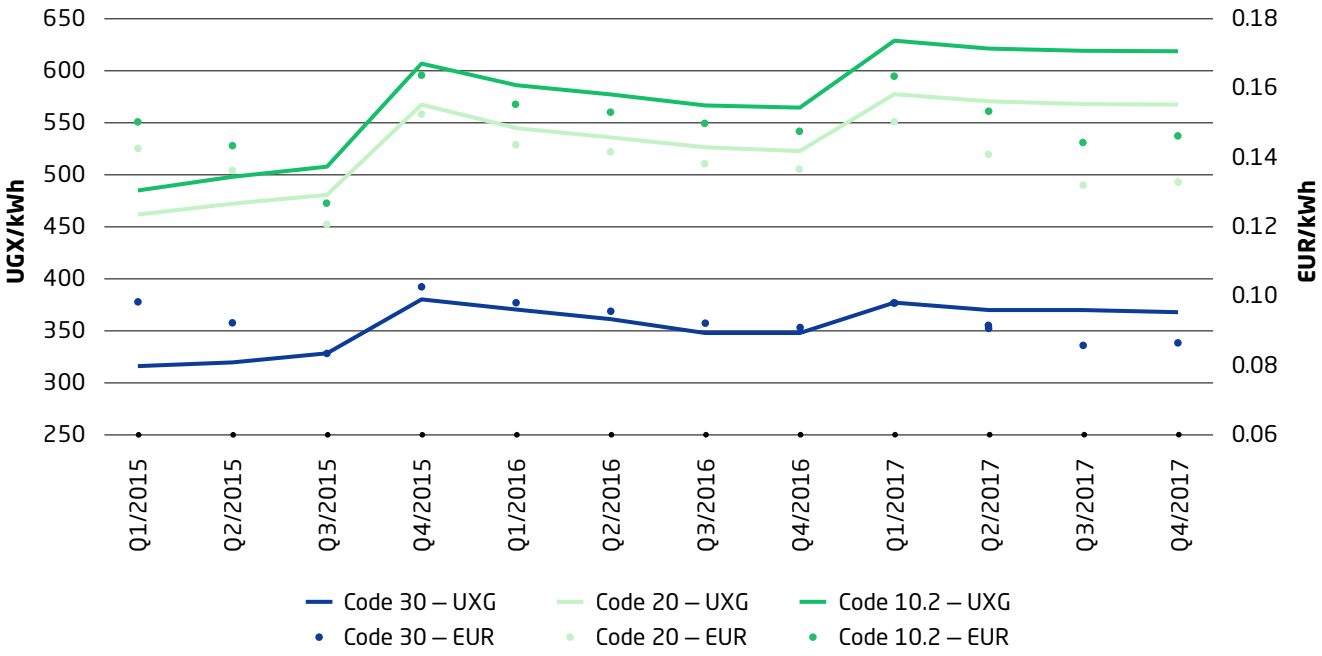
FIGURE 10. Performance of UGX against USD and EUR 2013-2017[19]



18) Trading Economics (2017) Uganda Inflation Rate, 1 January 2013 - 29 September 2017, based on Uganda Bureau of Statistics data. Link: https://tradingeconomics.com/uganda/inflation-cpi – accessed March 2019

19) Historic exchange rate data for UGX/EUR and UGX/USD taken from Investing.com (Fusion Media Limited). Link: https://www.investing.com/currencies/eur-ugx-historical-data, https://www.investing.com/currencies/usd-ugx-historical-data – accessed March 2019

FIGURE 11. Umeme average retail tariff trend 2015-2017[20]



Evolution in retail tariff rates

The evolution in Umeme's retail tariffs for commercial and industrial users in codes 10.2 (commercial), 20 (medium industrial) and 30 (large industrial) over the 2015–2017 timeframe reveals an upward trend. The average retail tariff increased in UGX by 17–28% between Q1 2015 and Q4 2017 depending on the customer category. This was due primarily to inflation and currency depreciation factors. In EUR terms, however, a decrease of EUR 0.005/kWh to EUR 0.01/kWh was experienced due to local currency depreciation. Using the average instead of the time-of-use bands, the retail tariffs for the period in UGX and EUR are shown in **Figure 11**.

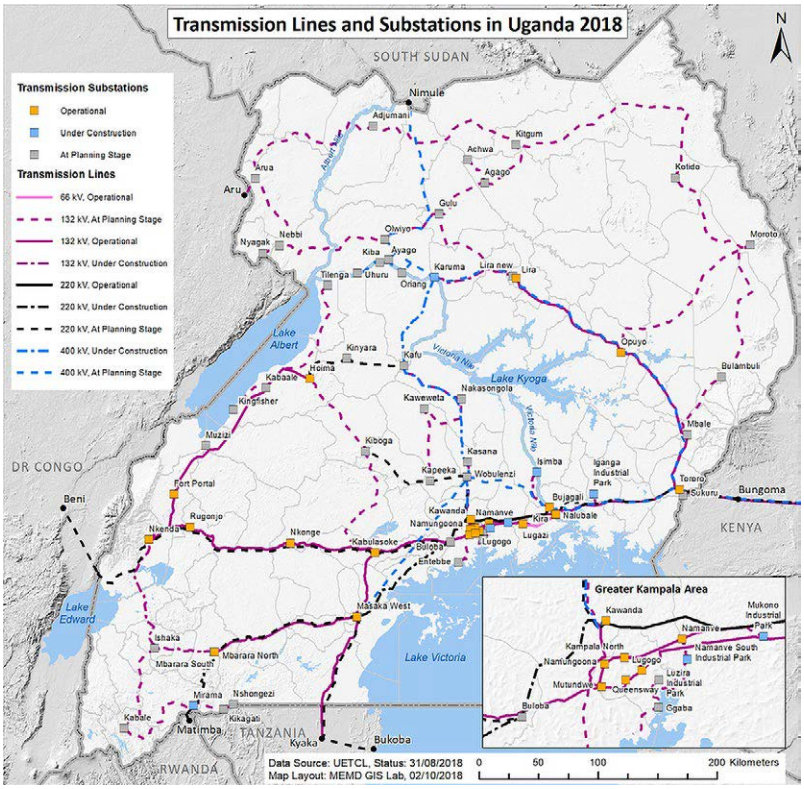
3.5 TRANSMISSION AND DISTRIBUTION NETWORK

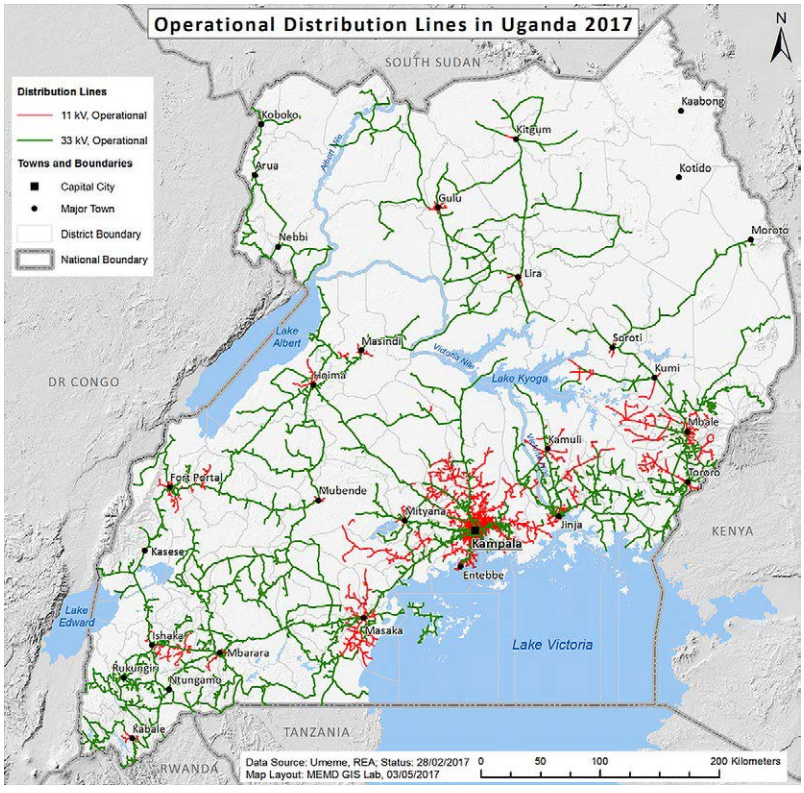
By 2015, the national transmission grid infrastructure was comprised of 150 km of 220 kV lines 1,443 km of 132 kV lines, 32 km of 66 kV lines and 18 sub-stations. The transmission backbone runs from Jinja, where the Nalubaale, Kiira and Bujagali hydropower plants are situated, to Kampala and through to parts of western Uganda. The 132 kV network extends to Tanzania and Kenya. The transmission network is being rehabilitated, upgraded and expanded to improve the reliability and quality of supply. Transmission losses were 3.78% in 2017.

The distribution network at voltages of 33 kV and 11 kV supplies power to 14 service territories, with losses of 19.1%. While much of the centre, east and southwest of the country are covered, the west, northwest and northeast still have significant gaps (see **Figure 12**).

20) Authors derived from ERA annual and quarterly schedules of electricity retail tariffs for end users, 2015-2017. Available for download on ERA tariffs webpage: http://www.era.or.ug/index.php/statistics-tariffs/tariffs – last accessed August 2017, link no longer available

FIGURE 12. Uganda transmission (2018) and distribution network (2017)[21]





21) Energy Sector GIS Working Group Uganda. Link: http://www.energy-gis.ug/gis-maps/ – accessed March 2019

3.6 RENEWABLE ENERGY RESOURCE POTENTIAL

Uganda has significant renewable energy resources, including hydro, biomass, solar, geothermal and potentially wind. A 2015 report estimates the potential as: large-scale hydro (2,000 MW), mini-hydro (200 MW), geothermal (450 MW), 460 million tonnes of biomass standing stock with a sustainable annual yield of 50 million tonnes and typical solar irradiation of between 1,800–2,300 kWh/m² per year (see **Figure 13**). Wind resource potential is undergoing assessment.

This developer guide presents information on solar and bioenergy resources. An introduction to the hydro, wind and geothermal potential of Uganda can be found online at www.get-invest.eu.

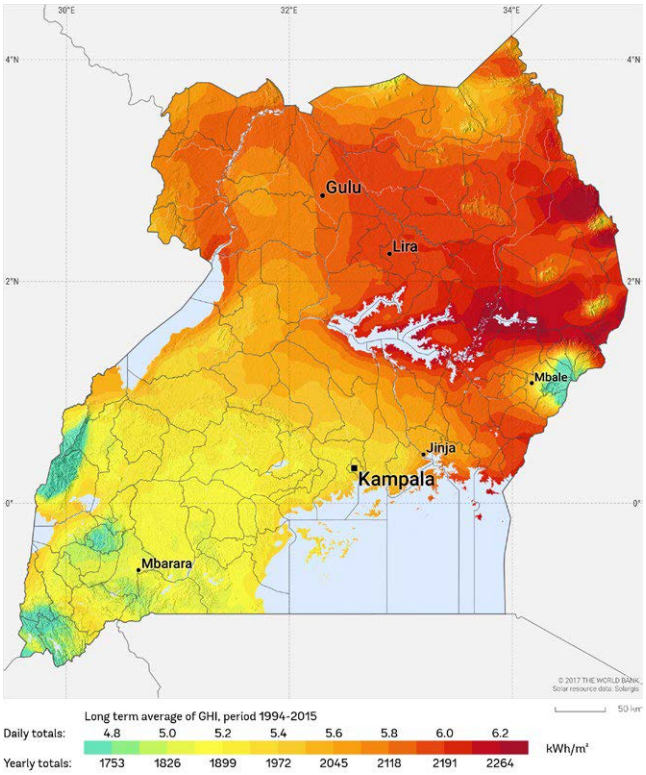
SOLAR

Uganda is endowed with favourable solar irradiation of between 1,800 kWh/m² and 2,300 kWh/m² per year depending on location. Over 200,000 km2 of Uganda's land area may have solar radiation exceeding 2,000 kWh/m²/year, which would provide projects with a relatively high energy yield. Some of the areas with the highest solar global horizontal irradiation (GHI), in the north and northeast of the country, however, do not coincide with the location of many of the commercial, medium industrial and agro-industrial facilities, which are the potential customers for captive power. **Figure 13** gives the annual average solar irradiation.

Average daily solar irradiation is not consistent throughout the year, with a noticeable decrease during the rainy seasons from April-June and October-November. The seasonal variation is shown for 10 major towns in **Figure 14**. This impacts the amount of electricity that a solar system can generate in a given month.

With Uganda's position being close to the equator, there is almost no change in daylight hours during a year, with an average of twelve at Entebbe. Daily average sunlight hours for the same location do vary, ranging from six hours at the height of the rainy season in April to 7.5 hours in January.

FIGURE 13. Solar global horizontal irradiation in Uganda[22]



BIOENERGY

The recoverability and usability of biomass feedstock and substrates is determined by their location and distribution, type of material, other uses (including for soil and other ecological functions) and other factors. For the most part, only potential bioenergy resources where the collection and processing is or can be centralised at scale should be considered for captive power. In Uganda, this precludes many crop residues such as those of banana, cassava and potatoes.

Typical biomass feedstock and substrates in Uganda may be:

— **Wood and woody material** containing lignin, including bagasse, husks and straw

22) SolarGIS (2013) Global Horizontal Irradiation Uganda. Link: http://solargis.com/products/maps-and-gis-data/free/download/uganda – accessed March 2019

- **Oil fruits** with high biomass content such as palm fruits and sunflower
- **Agricultural residue** such as dung from zero-grazed animals, leaves & stems from plants and discarded produce, including from woody material
- **Agri-industrial wastewater** with high organic or sugar content
- **Industrial residue**, by-products and wastewater, e.g. fruits or vegetable processing, sugar, breweries, slaughterhouses and others
- **Municipal waste** such as market, household or commercial organic waste
- **Wastewater sludge** from sewage treatment plants

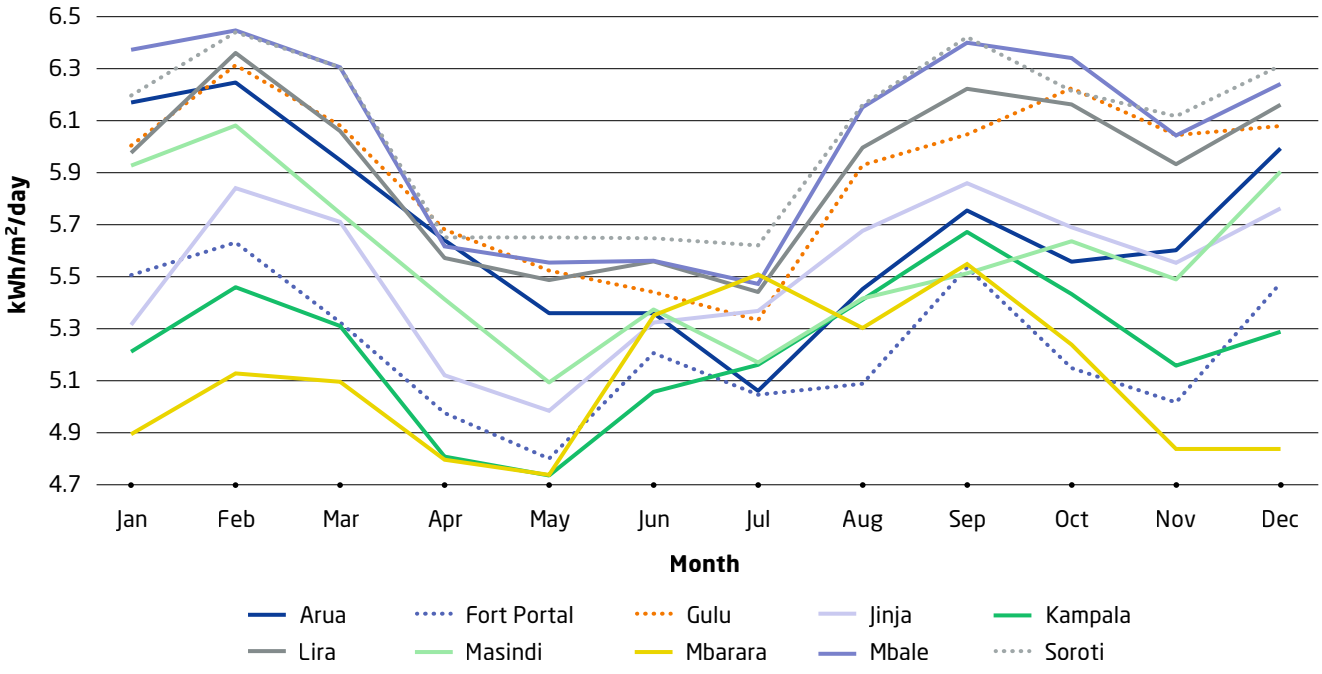
For biomass combustion, suitable crop residues in Uganda include coffee husks, rice husks, bagasse and wood waste. On the biogas side, municipal waste, breweries, abattoirs, leather industries, agro-processing industries, commercial dairy farmers and piggeries may present opportunities.

Bioenergy resources are categorized into three types for this developer guide based on applicability for electricity generation: wood residues, agriculture residues and agro-industrial wet waste.

Wood residues

Wood biomass (trees and woody plants such as shrubs) is abundant and diverse in Uganda due to the variety of vegetation and land use types. The central and northern part of the country has the highest density per hectare (see **Figure 15** for the distribution of biomass resources). The total standing wood biomass stock was stated to be 284 million tonnes in 2014. Approximately

FIGURE 14. Average daily solar irradiation (GHI) for 10 towns in Uganda[23]



23) Derived from: National Renewable Energy Laboratory (2017), SWERA Beta, GHI NREL Moderate Resolution. Link: https://maps.nrel.gov/swera/#/?aL=0bbQf-G%255Bv%255D%3Dt&bL=groad&cE=0&lR=0&mC=0.7745125438579877%2C33.134765625&zL=7 – accessed March 2019

44 million tonnes of this is harvested each year for all uses, which is 18 million tonnes more than what is a sustainable yield based on natural regeneration and re-planting.

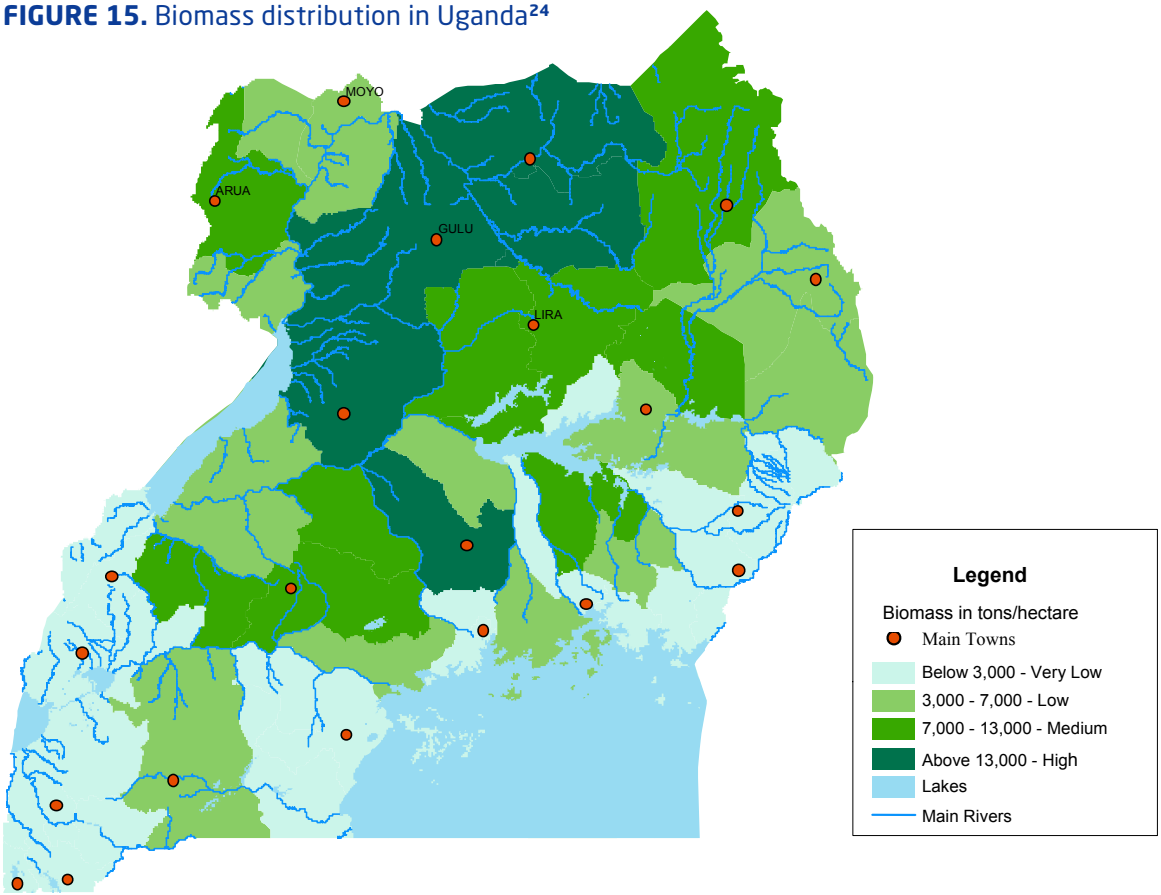
In 2014, approximately 73,000 ha of forested land were plantation – a significant increase from 58,000 ha in 2010 – from which 166,000 tonnes of timber was harvested. The main species grown are both hardwood broadleaf (eucalyptus) and softwood conifers (pine and cypress). Round wood production has been increasing, from 41,161 tonnes in 2011 to 48,581 tonnes in 2015. Estimated quantities of wood residue at the processing level are as shown in **Table 6**.

TABLE 6. Wood waste quantities at processing level in Uganda (2014)[25]

CROP	ANNUAL PRODUCTION (TONNES)	ESTIMATED RESIDUE (%)	WASTE RESIDUE (TONNES)*
Saw dust, wood shavings	350,000	5	17,500
Forestry operations	560,000	30	168,000
Total	—	—	**185,500**

* Note: other sources have reported different figures, e.g. 359,000 tonnes of sawn timber processing residues

FIGURE 15. Biomass distribution in Uganda[24]



24) The Republic of Uganda (2007), The Renewable Energy Policy for Uganda, p. 36. Link: https://eaenet.org/wp-content/uploads/2017/02/The-Renewable-Energy-Policy-for-Uganda-2007-2017.pdf – accessed March 2019

25) Ministry of Energy & Mineral Development (2015), Biomass Energy Strategy (BEST) Uganda, p. 70. Link: http://www.undp.org/content/dam/uganda/docs/UNDPUg2014%20-%20Biomass%20BEST%20Strategy(compressed).pdf – accessed March 2019

Agricultural residues

Major agricultural crops in Uganda include plantain bananas, cereals (millet, maize, sorghum and rice), root crops (potatoes and cassava), pulses (beans and peas) and oil crops (groundnuts, soya beans and sesame). Wheat has also been gaining in importance in recent years. Significant non-food and cash crops for export are tea, coffee, tobacco, flowers and cotton, with cocoa production slowly re-emerging. Sugar cane is another major crop.

Agricultural residues at the processing level from selected main crops in Uganda — maize cobs, coffee husks, ground nut shells, rice husks, sunflower, palm shells and cotton seed — is estimated to be about one million tonnes per annum (**Table 7**). Other figures have also been reported.

TABLE 7. Agricultural waste quantities from selected crops at processing level (2014)[26]

CROP	ANNUAL PRODUCTION (TONNES)	ESTIMATED RESIDUE (%)	WASTE RESIDUE (TONNES)*
Maize cobs	2,400,000	30	720,000
Coffee husks	200,000	50	100,000
Ground nut shells	245,000	20	49,000
Rice husks	191,000	20	38,200
Sunflower	50,000	20	10,000
Palm shells	210,000	20	42,000
Cotton seed	25,000	140	35,000
Total	—	—	**994,200**

* Note: other sources give different figures, e.g. 46,600 tonnes for coffee husk and 212,000, 49,000 and 638,000 tonnes, respectively, for coffee husks, cotton residue and maize cobs. Additional sources report varying amounts. The differences may depend partly on whether residues in general or only recoverable residues are considered. Bagasse (450,000 tonnes) is not shown as the sugar sector is already producing captive power. Rice husk estimates may be on the lower side — production in Uganda has increased since 2014

For some sectors production is seasonal (e.g. coffee, 6–7 months/year) while there is biomass from year-round processing at others (e.g. rice). Feedstock seasonality is important to understand for captive power.

Agro-industrial wastewater and wet waste

Annual wastewater (sewage) volumes in Uganda have been estimated to be at least 7.6 million m^3/year, almost 50% of which is from Kampala. There are only a select number of facilities that have wastewater discharge permits, and not all meet the compliance standards. Some of the largest wastewater dischargers include the National Water and Sewerage Corporation, sugar factories, leather tanning industries, beverage companies, fish processors, abattoirs and milk processors. Coffee and fruit processors may also have significant wastewater.

Estimated wastewater volumes and composition from 13 selected fish processors and abattoirs is presented in **Table 8**. Total wastewater quantities from all such facilities would be much higher.

TABLE 8. Estimated wastewater from fish processing and abattoirs[27]

AGRO-INDUSTRY	TYPICAL COD (mg/l)	TYPICAL SUSPENDED SOLIDS	WASTEWATER VOLUME (m^3/year)
Entebbe, Kampala, Jinja fish processors	12,400	4,500	964,000
Kampala abattoirs	5,800	3,250	146,000
Total	—	—	**1,110,000**

26) Ministry of Energy & Mineral Development (2015), Biomass Energy Strategy (BEST) Uganda, p. 70. Link: http://www.undp.org/content/dam/uganda/docs/UNDPUg2014%20-%20Biomass%20BEST%20Strategy(compressed).pdf – accessed March 2019

27) Ministry of Water & Environment (2013) Proposal for Nationally Appropriate Mitigation Action (NAMA) Seeking Support for Implementation: Integrated Bio-Wastewater Treatment for Agro-Process Wastewater, pp. 3-4. Link: http://www.lowemissiondevelopment.org/lecbp/docs/countries/Uganda/Uganda_NAMA_Integrated_Wastewater_Treatment.pdf – accessed March 2019

The only sub-sector that utilizes biomass residues for electricity production at present is the sugar industry. In addition, there are a small number of agro-processors and educational institutions that have gasifiers fed by wood, maize cob and other residues (see list in **Table 13**). Other uses of biomass in industry are highlighted next.

BOX 1. Competing Uses for Biomass

There are many examples of biomass use in significant quantities in the commercial and industrial sectors in Uganda, often for direct heating and non-energy related purposes:

- **Cement:** Hima Cement uses biomass to fuel its kiln and dryer. Most of this comes from coffee and rice husks. Over half of the thermal energy for the kiln is from biomass rather than heavy fuel oil. 80,000–100,000 tonnes of biomass residues are used annually. Empty returning cement trucks are sometimes used for biomass transport
- **Coffee:** A large coffee processor makes and sells briquettes from coffee husks and is considering to use these for its own process heat (drying) directly without power production. Coffee husks are also used as bedding material in poultry housing
- **Textiles:** Southern Range Nyanza Limited, a textile fabric and paper product company, has been phasing out use of fuel oil in its boilers through modifications to enable the use of biomass. The agro-waste feedstock includes coffee and cotton husks, maize cobs and groundnut shells. In 2014, biomass consumption stood at 17,000 tonnes annually. Maintaining regular supplies of the agro-waste is a major challenge. There is also a plan to use biodegradable process effluent to generate biogas for power to minimize losses and equipment failure risks caused by frequent power cuts/fluctuations. In 2017 another textile manufacturer, Fine Spinners, shifted from a fuel to a biomass-fired boiler
- **Rice:** At a rice mill in Jinja, there is demand for rice husks from farmers in the area.
- **Brick making:** Brick making facilities use 6 million tonnes of wood per annum
- **Tea:** The tea industry uses about 71,000 tonnes of wood for drying processes, with larger companies meeting 70% of their requirements from their own forest plantations
- **Lime production:** An inefficient industry uses about 270,000 tonnes of wood annually
- **Tobacco:** The tobacco sector uses 200,000 tonnes of biomass each year for drying
- **Food industry:** Fish smoking requires an estimated 22,400 tonnes of wood per year. The vegetable oil industry producing 40,000 tonne of oil uses 170,000 tonnes of agricultural waste and 70,000 tonnes of wood annually. Fuel wood consumption in the confectionary sector is estimated at 313,000 tonnes.

In some cases when assessing the potential for captive power, an owner or developer may find that direct heating is a more appropriate option than electricity or co-generation. This is especially true where energy efficiency measures, including load shifting and power factor correction, can be implemented in parallel to reduce electricity bills at lower cost.

SECTION 4

The Market Potential and Implementation Models for Captive Power in Uganda

There are several options for captive power plants serving different market needs in Uganda. This section introduces the concept of captive power and provides brief information on existing activities in the country. Selected design and implementation model considerations for captive power are also reviewed. Market segment opportunities and the potential market size are finally discussed.

While captive power encompasses self-generation from all energy sources, this developer guide only considers three that are renewable: solar photovoltaic (PV), biomass (combustion and gasification) and biogas.

4.1 OVERVIEW OF CAPTIVE POWER

WHAT IS CAPTIVE POWER?

A captive power plant — also known as a self-generator, embedded generator, distributed generator or auto-producer — is a power generation facility that produces electricity solely or primarily for internal use. In other words, a dedicated, localized source of electricity for own consumption. The term captive power typically refers to self-generation in larger commercial, industrial or institutional facilities as opposed to domestic or small business usage. In Uganda, most captive plant sizes will be in the range of 20–25 kW to low MW.

WHY CAPTIVE POWER FROM RENEWABLE ENERGY?

Companies and institutions may implement renewable energy captive power systems for a variety of reasons.

Electricity cost savings. A reduction in electricity bills is a main motivating factor for many captive power users. Cost savings are possible when the cost of self-generation is less than the cost of electricity from existing sources, be it the grid or diesel generators.

Improved power reliability and quality. Self-generation can in some cases help ensure continuous operations and provide voltage and frequency support in a localized grid area for security of supply.

Increased revenue. Where there is surplus power available for export to the grid and an enabling regulatory environment, electricity sales can provide additional income.

Efficiencies and fuel cost savings. This may be achieved where it is feasible to install a combined heat and power (co-generation) system. Co-generation recovers waste heat from electricity production to use directly or as steam to offset fuel use for process requirements. Co-generation can provide total efficiencies of up to 80%, versus 30-40% for electrical efficiency alone.

Reduced waste disposal costs. A bioenergy plant that converts waste to electricity can save money where there would otherwise be a disposal cost. There may also be valuable by-products.

Environmental compliance. Biogas systems can help treat some effluents to ensure adherence to regulations, such as for wastewater discharge.

Climate benefits. Switching to renewable energy use often results in greenhouse gas emission reductions. In some cases the climate mitigation benefit can be leveraged or monetized.

Corporate social responsibility. Some companies and institutions in Uganda, in particular those with an international clientele or outlook, may see investing in renewable energy as a clear signal of their commitment to environmental and social responsibility.

For **policy makers**, the cost-benefits of captive power from renewable energy can be:

- **Potential benefits:** market development, technology innovation, job creation, increased competitiveness in industry, avoided investment in new utility generation, avoided energy & capacity purchases, avoided transmission & distribution (T&D) investments and lower operations and maintenance costs, avoided T&D losses, improved system reliability and energy freed up for rural electrification and export sales

- **Potential costs:** regulation development and administration, power system planning adjustment, impact on tariff cross-subsidy, non-recovery of utility fixed costs, loss of utility revenue under certain schemes, government VAT revenue losses, time-of-use cost mismatch and connection assessment and approval costs (some of these are only relevant where captive power also feeds the grid)

4.2 TECHNOLOGY PREVIEW

SOLAR PV

Solar photovoltaic (PV) systems range from micro to large-scale and can be roof or ground-mounted. A solar PV system for a larger user can power single- or three-phase loads, offsetting electricity from the grid or a diesel (back-up) generator. Solar systems can be coupled with battery storage for use in the evening, in the event of grid failure or in off-grid areas.[28] The GET.invest Model Business Case on solar PV has information on technical considerations.

BIOENERGY

Three bioenergy conversion technologies were reviewed for application in this developer guide: biomass combustion, biomass gasification and anaerobic digestion (biogas).

Biomass combustion systems for electricity production are almost always large-scale (e.g. 1 MW or more), although some micro-scale applications exist. Biomass combustion is likely to have most potential in the rice milling, wood processing and sugar sectors.

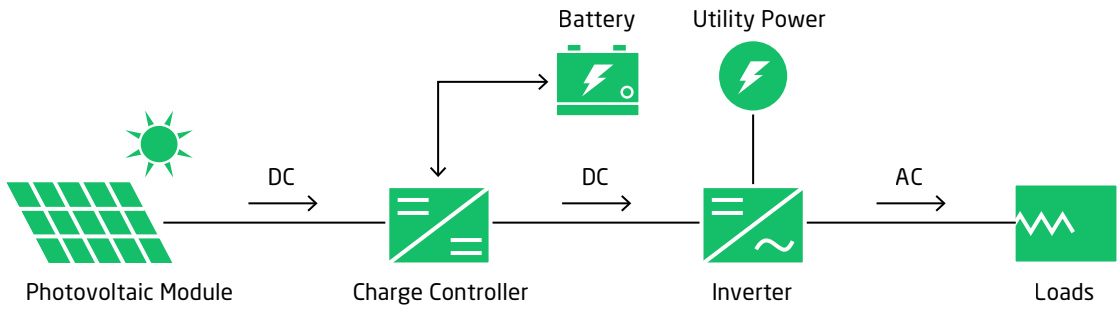
Biomass gasification systems are available as smaller units in the range of 10–250 kWel and are found in off-grid areas. Feedstock includes wood, rice husks, maize cobs and other agro-processing residues. Experience in Uganda shows that operating constraints can limit electricity production and commercial viability, and some systems are not functional or able to run at optimal capacity.

Anaerobic (biogas) digesters can range in size from micro to large-scale. For electricity generation, biogas system capacities of at least 25–50 kW and often larger are the norm. Usually wet biomass waste or wastewater substrates with low lignin and high organic or sugar content are used.

4.3 MARKET OPPORTUNITY

Uganda's captive power market – apart from the sugar sector — is in the "proof-of-concept" stage of development. This is the stage at which pilot projects and first movers are used to showcase technical and financial feasibility. Policy makers and potential project owners need insights from such projects to help envisage implementation models and market size and inform investments. Implementation issues are revealed that once addressed can facilitate scale-up.

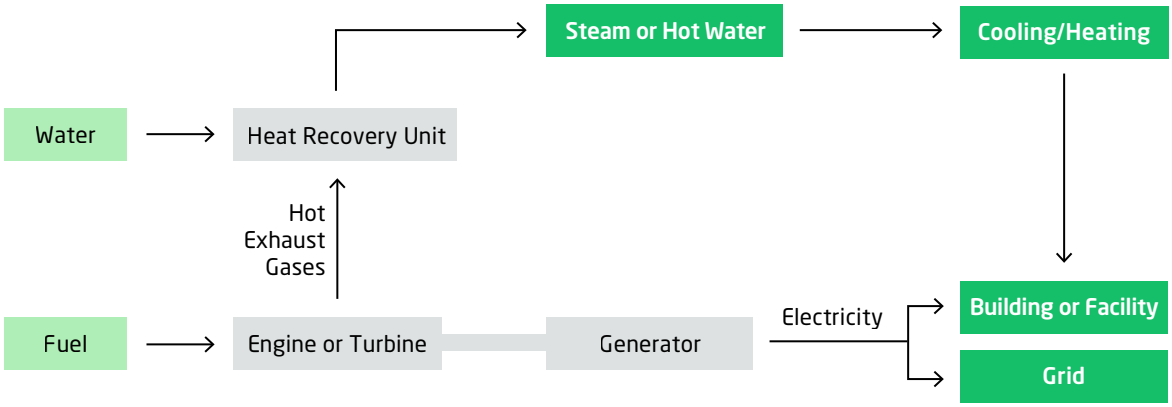
FIGURE 16. Layout of a grid-tied solar system with battery storage[29]



28 A grid-tied PV captive plant (i.e. one that is synchronized with the grid) will not be able to supply electricity when the mains power is out (except for small loads in some cases) due to lack of black start/ need for a grid frequency, unless it is integrated with a battery or diesel generator of sufficient size to allow it to operate in autonomous "island" mode.

29) Adapted from Synergy Enviro Engineers (2017) Solar Photovoltaic Systems. Link: http://www.synergyenviron.com/resources/solar-photovoltaic-systems – accessed March 2019

FIGURE 17. Co-generation system block diagram[30]



TYPE OF CAPTIVE POWER PROJECTS BY USER PROFILE

Generally, captive power projects fall under two broad categories: utility-driven and customer driven. While there are captive power opportunities in the public sector, these are usually accessed through competitively tendered procurement or specialized PPP programmes. Such opportunities are not covered in this guide. Instead, the focus is on private and non-profit electricity users as the potential market for captive power.

Industry in Uganda largely consists of small and medium enterprises in agro-processing and light manufacturing, with a smaller number of larger industrial factories and producers. The commercial sector is wide ranging from retail shops and shopping centres, transportation and telecommunication providers to restaurants, bakeries and service businesses. Non-profits include NGO offices, some health, education and care facilities and religious centres among others. For a third-party developer or investor, accessing this market first of all depends on the attractiveness of captive power for the customer's particular case, but also on factors such as **a)** whether or not they are actively looking to reduce energy costs, **b)** responsiveness to unsolicited proposals and **c)** income, currency and ability to pay.

INDICATION OF POTENTIAL MARKET SIZE FOR SOLAR PV

A rough estimation of the potential total market size (in MW) for solar PV captive power and possible uptake by 2025 was made. This was done as follows:

— First, the type of electricity customers in each tariff category (see **Table 20**) was broken down into hypothetical sub-categories for more granularity.

— Then, data from an old (2006) ERA report and the 2011 Uganda Bureau of Statistics (UBOS) census of businesses was used to estimate potential numbers in each sub-category, because a disaggregation of customer sizes (e.g. by kWh consumption or kVA demand) beyond the commercial and medium and large industrial categories was not publicly available.

— Next, back-up generator sizing as derived from the 2006 report and estimated for commercial users was used as a proxy for non-coincident maximum demand (in kVA) by customer sub-class.

— A power factor adjustment of 0.9 and a PV under-sizing factor of 40% (to avoid the possibility of any spillage into the grid) were then applied. The results were checked against potential PV capacity based on 2016 total energy sales and found to be roughly in line (after under-sizing).

30) Center for Climate and Energy Solutions (2016) Co-Generation/ Combined Heat and Power, Climate Techbook. Link: www.c2es.org/technology/factsheet/cogenerationCHP – last accessed October 2017, link no longer available

Finally, potential market uptake was determined qualitatively based on expected financial attractiveness vis-à-vis current electricity costs, market access, segments likely to be targeted by solar developers and financiers and availability of funds or financing for investment. The results are shown in **Table 9**.

Smaller commercial customers are not considered as potential captive power users for the purposes of this guide and the market is likely to be served by existing solar distributors and Pay-As-You-Go (PAYG) companies.

TABLE 9. Rough estimate of potential captive PV uptake by 2025[31]

CODE	POSSIBLE CATEGORY BREAKDOWN	ESTIMATED CONNECTION SIZE (kVA)	CUSTOMERS	OWN OR SHARE GENSET	AVERAGE GENSET SIZE	TOTAL MAX PV DEMAND (MW)	POTENTIAL MARKET UPTAKE BY 2025 (%)	UPTAKE CAPACITY PV (MW)
10.2	Commercial A	<10	78,047	7,805	5	140	10%	14.0
	Commercial B	10–41	6,279	3,033	30	68	10%	6.8
	Commercial C	41–100	1,451	701	70	37	15%	5.5
20	M-industrial A	<50	532	362	50	10	10%	1.0
	M-industrial B	51–200	978	665	156	55	15%	8.2
	M-industrial C	201–500	1,212	824	500	218	10%	21.8
30 & 40	L-industrial A	500–1000	264	171	667	63	2%	1.3
	L-industrial B	>1000	263	171	1556	147	0%	0.0
	Total	—	**89,026**	**13,731**	—	**738**	—	**58.6**

Notes:

a) M-industrial and L-industrial is short for medium and large industrial customers, respectively
b) Connection size breakdown derived from ERA (2006) for medium and large users, estimated for commercial
c) Even though 100 A service at 415 V (code 10.2) gives a three-phase capacity of 72 kVA, some commercial customers are known to have higher peak demand and so the higher value of 100 kVA is used
d) Very rough approximation for commercial customer breakdown, based on company size from UBOS (2011) and number of commercial electricity connections. Medium & industrial customer figures derived from ERA (2006). The figures are not likely to be highly accurate as breakdown of public institutions was not considered
e) Number of back up diesel generators based on percentages from World Bank (2014), with commercial adjusted and estimated based on size of business from UBOS (2011) and consideration of shared generators
f) Average generator size from ERA (2006) for industry. Estimated for commercial based on connection kVA
g) Maximum PV demand approximated from estimated total non-coincident demand in kVA based on generator size adjusted by 0.9 power factor and conservative sizing of typical PV system to 40% of max load to avoid any surplus feed-in to the grid. Use of generator size is a weak proxy for PV sizing as generators can be under or oversized and capacity may be shared

31) Authors estimated and derived from ERA (2006) A Study on the Impact of the Electricity Sector on the Industrial Sector, Final Report, p. 37, 43; Uganda Bureau of Statistics (2011) Report on the Census of Business Establishments, 2010/2011, p. 159. Link: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2010%20COBE%20Report.pdf – accessed March 2019; World Bank (2014) Enterprise Survey Uganda 2013. Link: http://www.enterprisesurveys.org/data/exploreeconomies/2013/uganda#infrastructure – accessed March 2019 and ERA (2017), ERA Distribution Statistics Q4 2016. Link: http://www.era.or.ug/index.php/statistics-tariffs/2013-11-27-16-54-30/distribution-statistics – last accessed August 2017, link no longer available

If the rough estimate is by any means a reasonable approximation, it would imply a total investment size of about EUR 67 million for 44.6 MW (excluding 14 MW small commercial) assuming a 2018 average cost of EUR 1,500/kWp installed in Uganda. This is a potential market volume for grid-connected commercial and industrial captive power of about EUR 8.5 million and 5.6 MWp per year from 2018–2025.

4.4 DESIGN AND IMPLEMENTATION MODEL OPTIONS

CAPTIVE POWER DESIGN OPTIONS

Captive power plants can be designed for different purposes and in different configurations depending on the needs and specific circumstances of the user, the regulatory framework, technology and technical and commercial considerations. **Table 10** has the different design variations.

CAPTIVE POWER IMPLEMENTATION MODELS

Typical implementation models for solar PV and bioenergy captive power plants are shown in **Figure 18**. There are different possibilities for the use of any excess generation but their applicability depends on both the regulatory environment and the project circumstance.

There are currently no specific mechanisms in Uganda for the export (including sale) of surplus captive power to the national grid. However, in principle, some of the regulations that apply to distributed or embedded renewable energy generation IPPs could be applicable to captive power, but only on an ad hoc case by case basis. Therefore, only **1)** self-owned without feeding into the grid and **2)** third-party-owned without feeding into the grid models are described in detail.

1) Self-owned without feeding into the grid: own-operate

Overview

Some larger-scale facilities and industry have the internal capacity to develop, build, maintain and operate a captive power plant, even if they outsource some activities (such as construction and maintenance).

TABLE 10. Variations in captive power project design due to site-specific characteristics and needs

On or off-grid	Technical considerations and project economics are quite different if the facility is connected (or expects to be) to the main grid or not
Operations in parallel to the electricity grid only or ability to run independently in "island" mode	A grid-connected customer will continue to make use of mains power supply with the captive plant meeting some of the demand while synchronized to the grid. When there is a blackout, whether or not and to what extent the captive unit keeps supplying power depends on the technology and how the system is designed. For example, to operate in island mode the system needs to be able to disconnect itself from the grid safely, have black-start capability or be able to maintain a grid frequency and re-connect itself to the grid with synchronicity, all automatically. There are cost, technology, safety and regulatory considerations
Electricity with or without battery storage	Battery storage capacity and maintenance and replacement come at an additional cost. Where storage is needed, some captive power users size the battery only to meet critical loads
Electricity-only or combined heat and power (co-generation)	Where feasible, using waste heat from electricity generation greatly increases the efficiency of a captive power plant. A system may also be designed for tri- (cooling) or quad-generation (use of CO_2)
Fuel-saver mode	This refers to the design of a captive power system specifically to displace expensive power from diesel generators

FIGURE 18. Implementation models for captive power[32]

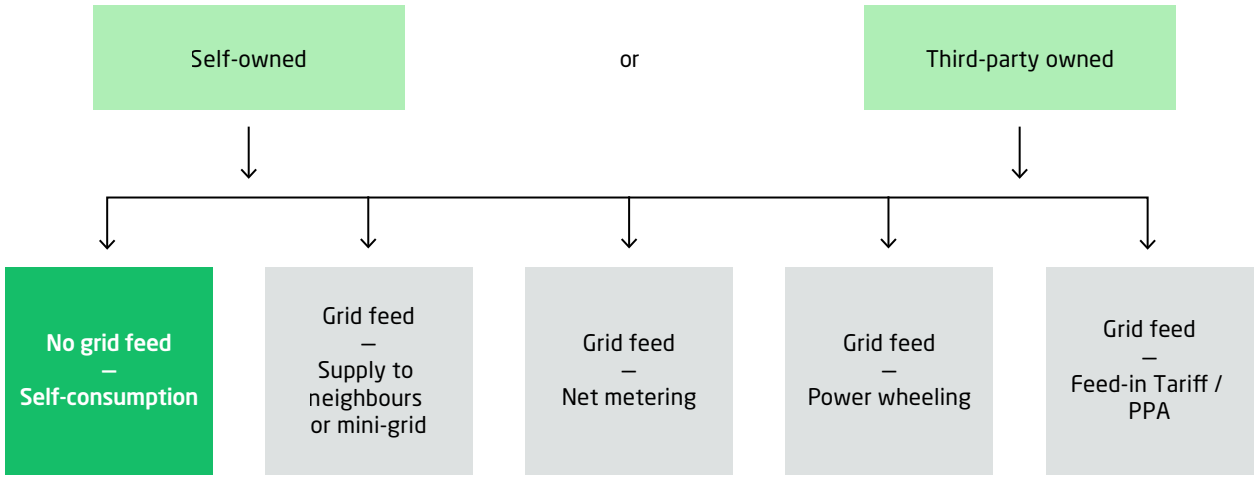
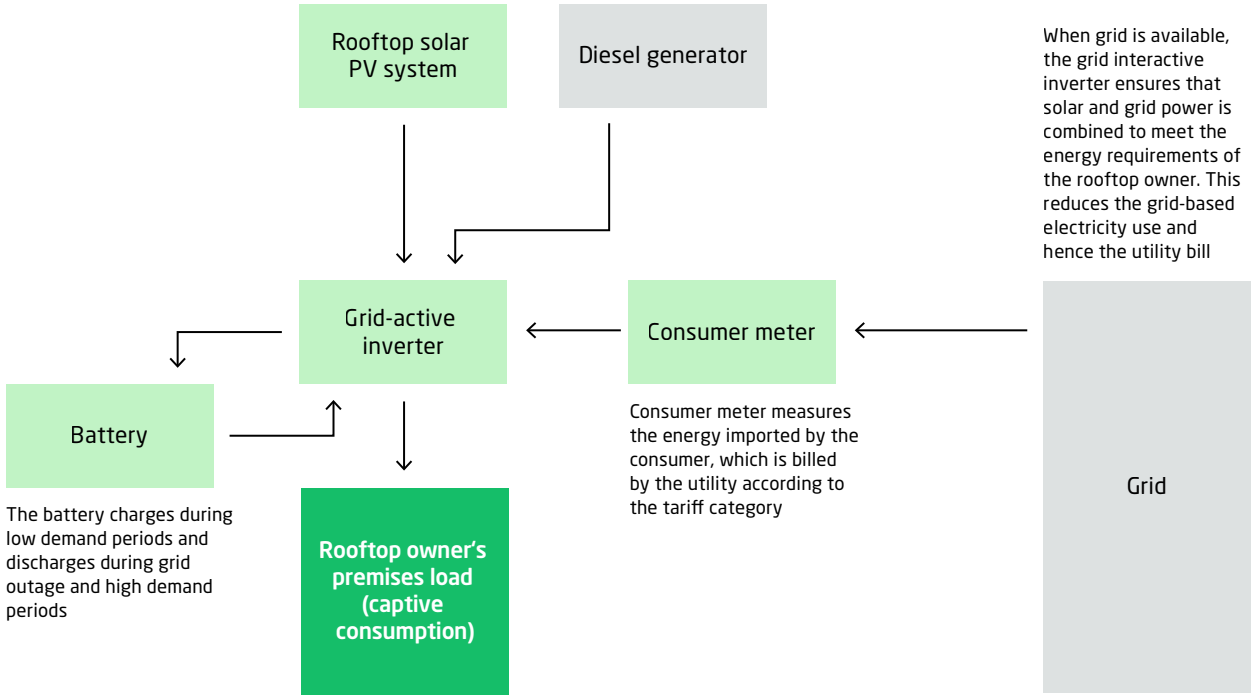


FIGURE 19. Self-owned rooftop PV – captive generation and consumption (no grid feed)[33]



32) Adapted from International Finance Corporation (2014) Harnessing Energy from the Sun: Empowering Rooftop Owners. White Paper on Grid-Connected Rooftop Solar Photovoltaic Development Models, p. 53. Link: http://www.ifc.org/wps/wcm/connect/8bb2a280479cb7248b0fff299ede9589/Harnessing+Energy+-From+The+Sun_Final.pdf?MOD=AJPERES – accessed March 2019

33) Adapted from International Finance Corporation (2014) Harnessing Energy from the Sun: Empowering Rooftop Owners. White Paper on Grid-Connected Rooftop Solar Photovoltaic Development Models, p. 55. Link: http://www.ifc.org/wps/wcm/connect/8bb2a280479cb7248b0fff299ede9589/Harnessing+Energy+-From+The+Sun_Final.pdf?MOD=AJPERES – accessed March 2019

Figure 19 shows a typical configuration for a captive solar PV system. Note that the battery component is optional and depends on the type of facility, available budget and need to meet critical loads (i.e., hospital operations). The GET.invest Case Studies cover one example with a battery (hospital) and another without (office building). Similarly, not all facilities have diesel generators.

Customers

A description of potential customers based on their tariff category and type of business can be found in **Section 4.5** "Market Segmentation by Selected Sub-sector".

Financing options

This type of customer may have sufficient financial resources to cover (part of) the upfront costs for an on-site renewable plant. The owner can also opt to seek bank financing, which is often in the form of corporate or project finance.

— **Corporate finance:** Use of a corporate finance model to implement a captive power project by a facility owner depends on the strength of the balance sheet, potential security/collateral and existing relationships with banks. Under corporate finance, debt is repaid from any cash flows available to business. This is the most widely used financing model for businesses and corporates, including for recent energy efficiency and boiler fuel switch projects in Uganda.

— **Project finance:** Under project finance, a separate and dedicated legal entity (called a Special Purpose Vehicle or SPV) is established for a self-generator to house and ring-fence all project assets and revenues. Also known as non-recourse finance, this model is typically applied to infrastructure projects where there is a guaranteed revenue stream over a fixed period, and project performance is the basis of debt repayment. The additional transaction costs of project finance are usually only warranted for a large enough investment volume (e.g. at least 2 MW, EUR 4 million).

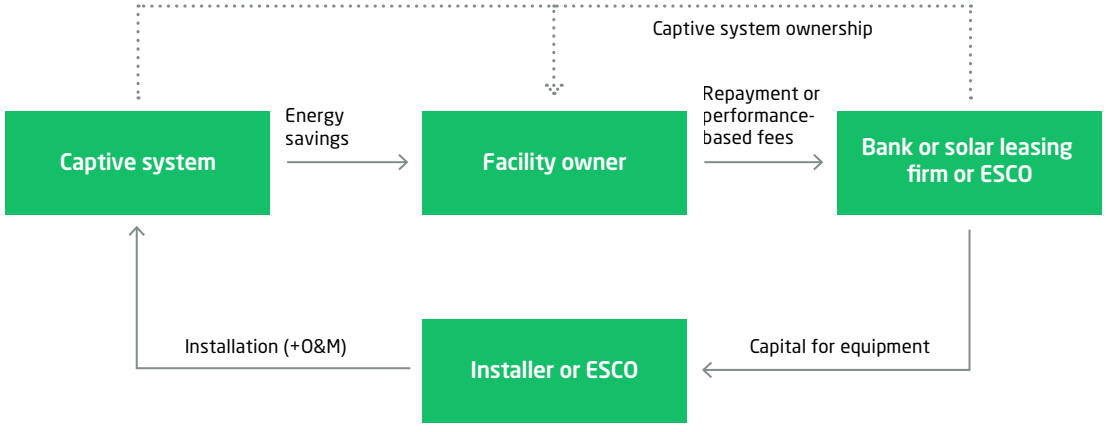
2) Third-party-owned without feeding into the grid

2a) Leasing and lease-to-own (for solar PV)

Overview

For facility owners who are not in a position to undertake or invest (entirely) upfront in a captive plant themselves, or who would rather pay for operating expenses than a capital expense, leasing a solar PV system can be attractive. Leasing allows the use of a captive plant without having to own it and with a contractual timeframe that is typically shorter than that of a PPA — e.g. 5–15-year terms being common under solar leasing contracts. A GET.invest Business Model Case, available at www.get-invest.eu, looks at the impact of leasing on project economics. A typical simplified leasing arrangement is presented in **Figure 20**. The dashed blue line indicates the transfer of ownership at the end of the term under lease-to-own.

FIGURE 20. Typical solar PV system leasing arrangement (no grid feed)[34]



34) Adapted from Wurtenberger, L; Bleyl, JW; Menkveld, M, Vethman, P and X van Tilburg (2012) Business models for renewable energy in the built environment, p. 28 and 75. IEA – Renewable Energy Technology Deployment, Link: http://iea-retd.org/wp-content/uploads/2012/04/RE-BIZZ-final-report.pdf – accessed March 2019

Customers

A description of potential customers based on their tariff category and type of business can be found in **Section 4.5** "Market Segmentation by Selected Sub-sector".

Financing options

Within this category, the facility owner might opt for a **a)** financing lease or **b)** an operating lease.

- **A financing lease (usually for lease-to-own):** a facility owner has the economic rights and risks to a solar PV plant (but not the legal ownership rights) and therefore usually must still capitalize the asset on its balance sheet. The solar assets are usually transferred to the customer for a nominal amount at the end of the contract. This can be accelerated with an option that the customer makes a larger lump-sum final payment.

- **An operating lease (no ownership):** the customer does not have any economic rights and therefore the PV system does not appear on the balance sheet. The equipment is removed at the end of the contract.

Where a solar leasing company is involved, in all cases installation will be their responsibility and in most cases also operations and maintenance. Apart from the lease type, there are variations to how the model is implemented. In some cases, no upfront payment is required and 100% of the costs are covered. In others, especially with lease-to-own or where a relatively short contract is preferred, the solar leasing company may require a 20–30% upfront payment or deposit by the customer. The remaining 70–80% of the capital costs are met by the leasing company and/or its financing partner. The costs are recovered – along with an allocation for O&M costs that usually are the responsibility of the leasing company and profit margin — in a periodic lease payment from the customer. Inflation is also often taken into account in the charges.

Payment is intended to come from the cost-savings on grid electricity and/or diesel power provided by the solar PV system. Where payment is instead directly tied to the amount of electricity generated, which is supplied at a discounted price, the contract is more likely to be structured as a PPA.

2b) Energy supply contract or PPA

Overview

Under this implementation model, a third-party energy services or supply company (ESCO) is engaged by the facility owner and – most often at the premises of the facility owner but sometimes on a neighbouring property – builds, owns and operates a captive generator selling power to the facility under a long-term agreement such as a PPA or energy supply contract (also used for non-electrical energy).

All the technical and economic risks associated with electricity supply are outsourced, including planning, development, financing, installation, operations and maintenance. The energy supply or PPA arrangement is usually only viable when the project size is at least 500 kW for solar and 1 MW or more in the case of bioenergy. Under the model, both the level of electricity supply and the off-take may need to be guaranteed and the price fixed or indexed to inflation for the duration of the agreement. The ESCO will recover its cost of energy from the tariff, which must be lower than the facility owner's current costs. PPA contracts are usually of a longer duration, from 15–25 years, reflecting the level of investment and amortization horizon of the captive plant.

Figure 21 gives a schematic of the concept.

Customers

A description of potential customers based on their tariff category and type of business can be found in **Section 4.5** "Market Segmentation by Selected Sub-sector".

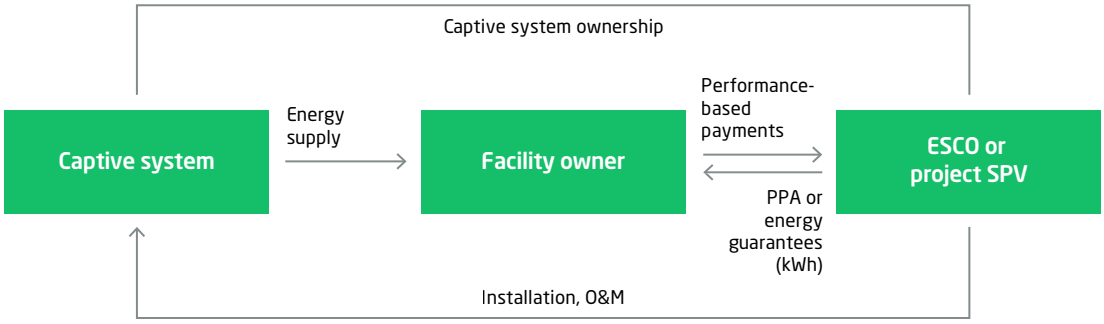
Financing options

The third-party ESCO will use its own funds or arrange its own financing for the captive project. For a larger project, especially a bioenergy plant, the ESCO might establish an SPV and seek project finance. There are some hybrid variants to the PPA or energy supply contract model where the facility owner also invests some of the capital.

Considerations for Uganda and the potential for other implementation models

Leasing and PPA arrangements can offer a number of advantages to a customer: **a)** low or no upfront costs, **b)** a balance sheet item can turn into an operating expense, **c)** medium to long-term certainty on electricity pricing, **d)** little or no responsibility for operations and maintenance and **e)** the facility owner can continue to focus on its core business. There may also be disadvantages, such as contractual commitments and transaction costs (e.g. due diligence).

FIGURE 21. Energy supply contracting or PPA concept (no grid feed)[35]



For solar PV, both leasing and PPA arrangements are considered to have good potential in Uganda especially with non-UGX denominated financing, since the models can overcome the upfront costs and other barriers faced by facility owners. There are a few solar leasing and financing companies active in East Africa who are already present or interested in Uganda. Solar leasing and financing providers should be aware that some potential project owners may anticipate a 20-year agreement/payment period to match the expected lifetime of quality PV equipment.

For bioenergy, the leasing model would be very difficult to implement for captive power due to the site-specific and tailored design nature of projects, the more complicated operations and maintenance and in particular the amount of fixed (i.e. non-removable or recoverable) equipment involved. The energy supply contracting or PPA model offers more but still limited potential for third-party generation and supply of electricity (and heat) from bioenergy due to the first factor as well as upfront costs and risks (e.g. single buyer, creditworthiness) and land and feedstock ownership issues among others.

Before establishing any performance-based payment for electricity delivered by a third-party owner (e.g. under a PPA) a developer should determine and if needed seek clarity from ERA regarding whether or not it could be deemed to be retail sale and therefore subject to regulatory requirements, including a sale licence under section 59 of the Electricity Act.

Due to the expertise and sometimes international exposure of the companies implementing leasing and PPA models it may be possible to access cheaper financing than the high interest rates offered by commercial banks in Uganda (see **Section 6.2**), where savings can be shared with the owner.

How liability, damage and other risks and costs such as for insurance are allocated under a leasing or energy supply arrangement in East Africa is not readily available information currently.

Sale of surplus captive power under the REFIT

Captive power plants may in principle sell surplus to the grid under the Renewable Energy Feed-in Tariff (REFIT). These projects would need to undergo a full-blown PPA and licensing process, with applicable fees and quarterly reporting requirements. In addition, most potential captive power users are supplied by the distribution companies and their networks would be used for FIT export but PPAs are with UETCL, adding another layer of complexity. Due to the requirements and associated transaction costs it will likely not make sense for project owners or developers to consider the REFIT option for captive power excess unless a firm export capacity of a certain minimum size is expected, e.g. 500–1,000 kW or even greater. Note that for solar PV there is no REFIT and that a REFIT review is currently underway.

35) Adapted from Wurtenberger, L; Bleyl, JW; Menkveld, M, Vethman, P and X van Tilburg (2012) Business models for renewable energy in the built environment. IEA – Renewable Energy Technology Deployment, Link: http://iea-retd.org/wp-content/uploads/2012/04/RE-BIZZ-final-report.pdf – accessed March 2019

Net metering

As of end-2018, there was no net metering framework in Uganda. **Section 4.7**, which covers the market outlook, reviews some recent developments in this area.

Power wheeling

The wheeling (or transferring) of power is allowed in Uganda but only for licensed generators. In 2016, a standard wheeling agreement was developed under GET-FiT for an IPP to sell to UETCL, wheeling through a distribution company network if it was connected at 11 or 33 kV. One standard agreement that is publicly available indicates the possibility of an electricity customer buying directly from UETCL rather than from a distribution company, via wheeling. Lack of involvement of the distribution companies in tariff setting for wheeling can, however, complicate matters.

Similarly to the REFIT option, it may not be worth it for captive plants with only a small export surplus to go through the regulatory requirements and negotiations for power wheeling.

The situation for direct sales and power wheeling may change in the future, as indicated in **Section 4.7**. For the time being, for most grid-connected customer it is recommended that a captive project be sized so as to avoid any spill over to the grid, unless there are compelling reasons otherwise (e.g. significant quantities of biomass available).

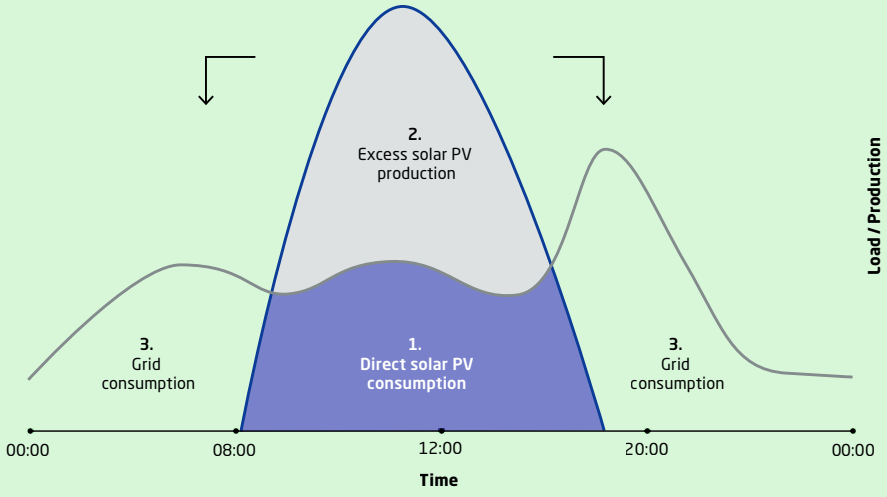
BOX 2. What is Net Metering?

Net metering (also known as net energy metering) is a policy that permits an electricity customer to generate electricity on site to offset its load, and to deliver any excess electricity to the utility at other times.

Net metering, in essence, allows decentralized producers of power primarily for own consumption to "bank" or "store" their electricity in times of over-production in the national grid, and to balance out their grid consumption with this banked or stored electricity during other times. Net metering is usually but not exclusively applied to small-scale generators using renewable energy sources.

The concept is presented for the example of solar PV in **Figure 22**. There are a number of variations to net metering, particularly with respect to whether the utility pays for net exports to the grid (electricity "credits"). One option is for credits to be "banked", such that any surplus is carried forward and used to offset consumption in future periods, but there is never any payment for net exports. Alternatively, net exports by customers can be paid for by the utility on a periodic basis, either based on the billing period or quarterly or annually.

FIGURE 22.
Net energy metering concept[36]



36) EUEI-PDF (2014) Assessment of a Net Metering Programme in Kenya – Volume I: Main Report, p. 7. Link: http://www.euei-pdf.org/en/GET.invest/renewable-energy-regulatory-capacity-development – accessed March 2019

4.5 MARKET SEGMENTATION BY SELECTED SUB-SECTOR

OVERVIEW OF MARKET SEGMENTS BY TARIFF CATEGORY

Section 3.4 provided information on the different tariff categories in Uganda. An overview of the potential for captive power and an indication of the types of businesses and other organisations likely to fall under each tariff category is provided in **Table 11**.

Off-grid facilities are a distinct case, regardless of their size, due to their remoteness and assumed high dependence on diesel generation. They do not fall under any tariff category.

INFORMATION ON SELECTED SUB-SECTORS

The Uganda Bureau of Statistics (UBOS) has data on the type, size, turnover, regional distribution and other characteristics of businesses from a census conducted in 2010–2011[37]. The resource is useful to help gain a more detailed an understanding of private sector activities in the country.

This section provides information on some sub-sectors with regards to their potential for captive power in Uganda. A high-level overview of the potential is provided in **Table 12**.

Other sectors with captive power potential not reviewed for this developer guide include the leather industry, fruit and vegetable processors, tobacco factories, cotton ginneries, soap producers, non-rice grain millers, animal feed factories, oil seed processing and beverage and bottling companies (among others), although a significant number are likely to fall under tariff code 30. On the commercial and services side, petrol stations and tourist lodges should also have good potential (there are about 30 lodges in the Albertine Rift alone).

Annex E provides details on the following selected sub-sectors:

- Dairy sector
- Cattle ranches
- Abattoirs
- Fish processing facilities
- Sugar sector
- Floriculture
- Tea factories
- Coffee factories
- Wood industry
- Rice millers
- Municipal waste
- Commercial buildings and institutions
- Telecommunication towers
- Healthcare

RENEWABLE ENERGY CAPTIVE POWER PLANTS IN UGANDA

A non-exhaustive list of renewable energy captive power generators of 15 kW and larger at different stages of implementation in Uganda is provided in **Table 13**, organized by energy source. All the projects are self-owned. Where a project size has two values (i.e. for most the sugar projects, one hydro and one biogas plant), the second indicates the capacity that is captive — the remainder is (or will be) exported to the grid under the REFIT.

Sugar factories have a number of characteristics — including substantial power and heat requirements, economies of scale, daily production, operations and maintenance capabilities, land availability, existing biomass delivery systems, waste management costs and tried and tested technologies — that make on-site co-generation very attractive, hence their large installed capacities and predominance on the list. The GET.invest Model Business Case on bioenergy has more information on such characteristics. Also notable is that there are at least 10 gasification units ranging from 10–250 kW using wood and agro-processing residue feedstock.

The limited number of solar PV systems in the table confirms the impression that Uganda is still a nascent market for medium to larger scale commercial, industrial and institutional users (>20 kWp)

37) Link: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2010%20COBE%20Report.pdf – accessed April 2019

TABLE 11. Likelihood of captive power viability and potential customers by tariff category

	COMMERCIAL USERS	MEDIUM INDUSTRIAL USERS	LARGE AND EXTRA LARGE INDUSTRIAL USERS
Tariff code	Code 10.2 415 V Max 100 A	Code 20 415 V Max 500 kVA	Code 30 and 40 11/33 kV >500 kVA
Likelihood of commercial viability	Solar PV: Likely for most cases. Can supply cheaper electricity during the shoulder tariff hours (06:00–18:00). Biomass/biogas: Only in very few cases is the conversion of biomass or waste residues to electricity likely to make commercial sense for customers in this category connected to the grid. This is due to economies of scale and availability of feedstock or substrate.	Solar PV: Less likely compared to Code 10.2 since the shoulder tariff is lower than for commercial users, and the case for PV is weakened, however, the size of systems at medium industrial facilities can result in lower capital costs per unit installed. In addition, in cases where peak demand is during daytime hours, a solar plant may also be able to meet the peak and thereby reduce demand charges. This may, however, not always be easy to achieve without oversizing the system. Biomass/biogas: While reasonable quantities of biomass feedstock or substrates are often available at medium industrial facilities, a captive plant using bioenergy might still not be sized large enough to achieve a levelised cost that is lower than the shoulder tariff. On the other hand, a bio-powered generator may be able to provide "baseload" electricity including to bridge black and brown-outs (saving on diesel generation) or supply during peak tariff hours (18:00–00:00), when the cost of grid electricity is higher.	Captive power is most likely to work in limited cases where plant economies of scale allow for very low levelised costs, the area grid is unreliable leading to significant diesel back-up generator use, there is a large surplus to sell under the FIT (for bioenergy only), co-generation needs can be met efficiently, there are high costs for disposal of waste residues or where the industrial facility is off-grid.
Potential owners or customers	Offices, smaller hotels and tourist lodges, apartment blocks, petrol stations, telecommunication towers, service centres, retail shops, banks, private hospitals and health centres, private schools, embassies and similar.	Medium-size power consumers (some timber, pharmaceuticals), smaller food and beverage processors (dairy, poultry, piggeries, fruit and juice), mid-sized agribusiness (smaller flower farms, horticulture, tea factories, coffee factories, some rice and maize millers, cotton ginneries, livestock farmers), smaller water utilities and medium-sized shopping malls, larger office blocks and hotels.	Plastics, textile, leather, paper, wood, paint, cosmetics and other manufacturers, larger food and beverage processors (breweries, dairy, poultry, bottlers, fruit and juice, edible oils), larger agribusiness (large flower farms, horticulture, tea factories, some rice and maize millers, tobacco producers) and larger shopping malls and office blocks. Steel, cement, some mines and sugar producers and other heavy manufacturing will fall under code 40.

TABLE 12. Captive power potential high-level overview in selected sub-sectors

SECTOR	NUMBER FACILITIES	POTENTIAL			USD OR EUR REVENUE
		PV	Bioenergy	CHP	
Dairy sector	At least 25 processors, 6–8 large scale, only one is integrated farm & milk processing. At least 60 small-scale milk collection centres in western Uganda, many farmers	M	L	L	Maybe
Commercial cattle farms	More than 150 large cattle ranchers, up to 7,000 head	M	L	L	N
Abattoirs	At least 4 large abattoirs, 3 in Kampala and 1 in Soroti	M	H	L	N
Fish processing facilities	At least 32 fish processors, some may not be very large	M	M	L	Maybe
Sugar factories	6 existing major producers, more under development	L	M	H	Maybe
Flower farms	12 flower exporters	H	L	L	Y
Tea factories	At least 22 tea companies	M	L	M	Y
Coffee factories	60 or more coffee factories, but only few large scale	M	M	L	Maybe
Forestry operations	Only 4 large-scale forestry and processing companies	L	M	M	Maybe
Rice millers	3 large scale, at least 4–5 medium scale	L	M	M	Maybe
Municipal waste	At least 5 major urban centres and 10–15 towns	L	M	L	N
Commercial buildings	Numerous, with 7 large shopping malls and many office blocks in Kampala and Entebbe alone	H	L	L	Maybe
Telecom towers	5 mobile operators, 4 main tower companies, at least 1,200 off-grid BTS and 3,400 in total	H	L	L	Maybe
Healthcare facilities	1,488 private and 874 NGO health care facilities in 2013 (varying sizes, small to large)	H	L	L	N

Note: L = low, M = medium, H = high, Y = yes, N = no

TABLE 13. Non-exhaustive list of renewable energy captive plants in Uganda[38]

ENERGY SOURCE	SECTOR	PROJECT	CAPTIVE TYPE	SIZE	STATUS**
Bagasse	Sugar	Kakira I	On-grid, co-gen	52 MW, 20 MW captive	Operational
Bagasse	Sugar	Kakira II	On-grid, co-gen	32 MW, 12 MW captive	Construction
Bagasse	Sugar	Kinyara	On-grid, co-gen	14.5 MW, 7 MW captive	Operational
Bagasse	Sugar	SAIL*	On-grid, co-gen	11.9 MW, 5 MW captive	Operational
Bagasse	Sugar	Lugazi	On-grid, co-gen	9.5 MW captive	Operational
Bagasse	Sugar	Mayuge I	On-grid, co-gen	1.6 MW captive	Operational
Bagasse	Sugar	Mayuge II	On-grid, co-gen	21–23 MW	Planning
Bagasse	Sugar	SCOUL*	On-grid, co-gen	26 MW, 12 MW captive	PPA negotiation
Hydro	Mining	Kasese Cobalt	On-grid	10.5 MW, 3 MW captive	Operational
Hydro	Health	Kisiizi hospital	Off-grid	294 kW	Operational
Hydro	Health	Kuvula hospital	Off-grid	120 kW	Operational
Wood	Forestry	Nyabyeya	Off-grid, gasifier	50 kW	Operational
Wood	Tea	Musizi	Off-grid, gasifier	250 kW	Not in use
Wood waste	Manufacturing	Undisclosed	On-grid	700 kW	Financing
Animal waste	Abattoir	Kampala abattoir	On-grid, biogas	18 kW	Operational
Palm oil residues	Agro-industry	Bidco	Mini-grid	1.5 MW	Operational
Agro-residues	Tea	Undisclosed	On-grid	700 kW, 300 kW captive	Feasibility
Agro-residues	Refugee camp	Adapt Plus	Off-grid, gasifier	32 kW	Operational
Agro-residues	Agro-industry	Mandulis I	Off-grid, gasifier	32 kW	Operational
Agro-residues	Agro-industry	Pamoja Cleantech	Mini-grid	32 kW	Operational
Agro + solar	Agro-industry	Pamoja Cleantech	Mini-grid, battery	50 kW	Construction
Solar	Manufacturing	Oscar Industries	On-grid	30 kW	Operational
Solar	Flowers	Aurum Roses	On-grid	30 kW	Operational
Solar	Education	Gulu college	On-grid	31 kW	Operational
Solar	Education	Luweero training	Off-grid, battery	72 kW	Operational
Solar	Health	Kampala hospital	On-grid, battery	52 kW	Operational
Solar	Health	Entebbe hospital	On-grid	289 kW	Construction
Solar	Social services	Orphanage	On-grid	15 kW	Operational
Solar	Water supply	GoU Panyamur	Off-grid	15 kW	Operational

* Note: SAIL = Sugar & Allied Industries Limited, SCOUL = Sugar Corporation of Uganda Limited
** Status is reported at the time of writing

38) Based on authors own research from various sources. Note that Pamoja Cleantech projects are considered captive plants as they provide processing power on site in addition to supplying a mini-grid

4.6 COMPETITIVE LANDSCAPE

Due to the current, nascent status of the market, there is not much of a competitive landscape per se for commercial and industrial captive power in Uganda. A brief note on existing companies in the captive solar space is provided in **Annex F**.

4.7 OUTLOOK ON MARKET DEVELOPMENT

The future of the captive power market in Uganda is dependent on various factors including **a)** the cost of renewable energy captive systems, **b)** retail electricity tariffs levels and **c)** the enabling environment.

The latter is a major factor dictating the evolution of this market. Two developments relate to this debate: On the one hand, Uganda may have a surplus of generation that increased demand from rural electrification and export markets may not be able to fully absorb in the medium-term. Therefore, increasing consumption in the commercial and industrial sectors would be important for demand-supply balancing. On the other hand, Uganda aspires to promote lower production costs and competitiveness in industry, which in some circumstances captive power can help to achieve. The government is also undertaking and supporting initiatives aimed at energy efficiency and load reduction.

Is net metering coming to Uganda?

Under Uganda's Scaling-Up Renewable Energy Program (SREP) Investment Plan (2015–2020), support for decentralized renewables development includes activities to assess and test the potential for a net metering programme and lay the foundation for private sector scale-up. The activities are:

- A pilot project for at least 10 solar PV systems on grid-connected public buildings in urban areas (each 25 kWp)
- Review and if needed draft regulations and standards for net metering

Grid considerations

The Ugandan power grid has stability issues that may place constraints on grid export from decentralized renewables under net metering. One factor is a high sensitivity and lack of automation in the electricity (distribution) network that may lead to an inability to deal with multidirectional flow of electricity. Furthermore, complications are expected because of the single buyer model with UETCL, whereas potential captive power customers would be connected to Umeme or other suppliers at the distribution level. This latter issue may be resolved once the 2015 Electricity Act (Amendment) Bill is enacted (see next).

Recommendations to accelerate private sector participation

As indicated in **Section 4.4**, excess power from a captive power system can only be sold to UETCL under the REFIT if **a)** the project goes through the PPA and licensing process and **b)** if the project is not solar PV. The situation is not likely to change. Only a very small number of self-generators will therefore pursue this option.

Better possibilities are indicated in a 2017 report on power sector reforms, where it is recommended that Uganda move away from a single buyer model. Such opening of the market could allow for direct sale of electricity from generators to eligible customers and/or from generators to distribution companies. The draft 2015 Electricity Act (amendment) Bill does include a proposed modification to section 56 to do away with the single buyer. At the same time, the Bill may introduce a more flexible approach to licensing requirements. It is, however, uncertain in what final form and by when the new Bill will be adopted. Furthermore, even once enacted, it could still take a while before relevant subsidiary regulations are also developed.

Captive system grid integration

In case of a future legislation (and subsidiary regulations) to allow a generator to sell power at the distribution level, network operators (e.g. Umeme) may also need to move more quickly to be able to manage reverse power flow. There is already a recommendation for the implementation of Automatic Meter Reading (AMR) measurement equipment to cover all feeders, prioritized for industrial and commercial customers, which would help utilities and customers to better control the use, production and consumption of electricity, among other benefits.

SECTION 5

How to Develop a Captive Power Plant in Uganda

This section provides information on the regulatory steps and considerations to developing a solar PV or bioenergy captive power system in Uganda, starting with some general insights.

Market entry and partnerships

For a foreign developer, equipment supplier or financier, establishing a partnership in Uganda is highly recommended to make use of local skills, knowledge and networks. One potential first step to access the market could be to work with energy auditing firms, electrical installation companies or water pump suppliers — for solar PV — and biomass transporters and wastewater treatment companies — for bioenergy — who will often have specific insights into company or sector energy costs, load profiles, feedstock or substrate availability and interest in energy savings. In teaming up with a partner, a captive power developer could also consider to provide a broader offer, e.g. advising on energy efficiency and load shifting and then sizing a generation system based on the change in demand. Providing after sales service and spare parts can also help gain customers.

Business associations — the Uganda Manufacturers Association (UMA), the Uganda Renewable Energy and Energy Efficiency Alliance (UNREEEA) and sector specific trade bodies — are a good first contact point.

Local supply and know-how

For a solar PV captive power project, even though there are suppliers and equipment available in country, a new developer of a single project may still need to import many components for reasons of a packaged EPC economies of scale, specifications and warranty. For example, for one recent solar PV system for a commercial customer in Uganda, about 90% of the material was imported. Installation and system integration can be done locally.

For biomass and biogas projects at captive power scale, almost everything apart from labour and cement may need to be brought into the country. Project owners and developers should plan to invest in training technically competent staff to be responsible for operations and maintenance.

Customer education

Potential customers will often want to first see at least one working example of a captive power system implemented by a developer, if not in Uganda then ideally in East Africa. An example system can help overcome one important reason for hesitation when industrial and commercial users consider an investment in captive.

Many owners of facilities with project potential are not familiar with technical and economic considerations of captive power and may have unrealistic expectations, e.g. that a grid-tied PV system will always supply power in the daytime without regard to how it is configured.

To ensure that a captive plant is properly sized and configured to meet customer loads and operations, a developer or investor should conduct their own assessment of demand and consumption. Some project owners do not keep sufficient records or have a detailed understanding of their power (and heat) use, and growth projections may be uncertain, which if relied upon could lead to system oversizing. The facility owner can ask Umeme for electricity meter records in 30-minute intervals.

Timeframe

For companies who do not already have a presence in Uganda, it should be recognized that it might take time before the first customer contract is signed to confirm real establishment in the market — 12–18 months for bioenergy and 4–8 months for solar PV.

For a facility owner, an implementation timeframe of 6–24 months should be expected, depending on project type and size, implementation model, access to finance, equipment importation and other factors.

5.1 INVESTOR PROTECTION AND PROCEDURES

In 2015, Uganda was ranked 9th in a 2015 global survey of the investment climate in 55 emerging economies. However, in global terms, Uganda ranked at 117 out of 140 countries in 2018 according to the Global Competitiveness Index 2018.

The Investment Code Act of 1991[39] provides procedures, incentives and protections for both local and foreign investors in Uganda. A foreign investor is defined as **a)** a person who is not a citizen of Uganda, **b)** a company in which more than 50% of the shares are held by non-Ugandans and **c)** a partnership in which the majority of partners are not citizens of Uganda.

The Investment Code distinguishes between two types of investors:

- A larger scale investor, who must apply for an investment license, contribute to the development of Uganda and invest at least USD 500,000 (EUR 430,000) (if a foreign investor) or USD 50,000 (EUR 43,000) (if a local investor) and who in doing so qualifies for investment incentives, such as concessional rates of import duty

- A smaller foreign investor who engages "only in trade", does not need to apply for an investment license and must deposit USD 100,000 (EUR 86,000) at the Bank of Uganda, which shall be used for the importation and purchase of goods by the business.

Foreign investors of both types receive protection in case of compulsory acquisition, with any compensation for such freely transferable out of Uganda. There are no foreign exchange controls affecting trade in Uganda. Businesses can bring in capital and repatriate profits without restriction.

The Uganda Investment Authority (UIA) is semi-autonomous government body that acts as an investment promotion agency and provides access to information. UIA operates a useful One Stop Centre (OSC) for business registration, licensing, facilitation and aftercare. The centre has both physical premises where the main relevant government departments and entities can be accessed and an electronic portal for registration, licensing and other services that are available online. This includes for the following agencies:

- Uganda Registration Services Bureau (URSB) for company registration

- Uganda Revenue Authority (URA) for tax advice and registration, including the Tax Identification Number (TIN)

- The Directorate of Citizen and Immigration Control for work permits and other immigration documents

- The Lands Registry, which assists in the verification of land ownership

- The National Environmental Management Authority (NEMA) to facilitate environmental compliance

- Uganda National Bureau of Standards (UNBS) for standards advice

The UIA One-Stop-Centre website is: https://www.ebiz.go.ug.

5.2 BUSINESS LICENCING AND REGISTRATION

BUSINESS REGISTRATION

All potential companies in Uganda are required to be registered with the Uganda Registration Services Bureau (URSB)[40], which administers and attends to matters incidental to the Companies Act of 2012. The Companies Act provides for the incorporation, regulation and administration of companies and other related matters, including the registration of foreign companies doing business in Uganda. There are no local ownership requirements for registering foreign businesses in Uganda.

The process of starting a business as a foreigner is as follows:

39) Link: https://www.ugandainvest.go.ug/wp-content/uploads/2016/02/Investment-Code.pdf – accessed April 2019

40) Link: https://ursb.go.ug/ – accessed April 2019

FIGURE 23. Process of starting a business in Uganda

Reserve Company Name
Agency: Uganda Registration Services Bureau
Period: 2 Working Days
Cost: 23,000 UGX (EUR 5.5)

↓

Obtain Certificate of Incorporation
Agency: Uganda Registration Services Bureau
Period: 1–3 Days
Cost: USD 470 (EUR 403) and UGX 65,000 (EUR 15) filing fees, plus stamp duty & legal fees

↓

Obtain an Investment License
Agency: Uganda Investment Authority
Period: 2–5 Days
Cost: Free of charge

↓

Obtain a Taxpayer Identification Number
Agency: Uganda Revenue Authority
Period: 1–10 Days
Cost: Free of charge

↓

Obtain a Trading License
Agency: Local Area Authority
Period: 1 Day
Cost: UGX 78,750-498,750 (EUR 18–116) (for Kampala)

↓

Register with National Social Security Fund
Agency: NSSF Authority
Period: 1–7 Days
Cost: Free of charge

Full information on registering a business, associated application forms, the associated fees and complying with annual filing requirements with URSB can be found on the URSB website.

BUSINESS TAXES

In addition to being registered with URSB, all companies must register with the Uganda Revenue Authority (URA)[41] for Pay as You Earn (PAYE), income tax and possibly Value Added Tax — depending on the scope and scale of the business. In Uganda the following tax laws are relevant:

- Income Tax Act
- Value Added Tax Act
- Stamp Duty Act
- East African Customs Management Act
- East African Excise Management Act
- Customs Tariff Act
- Excise Tariff Act
- Traffic and Road Safety Act

Income Tax

Income tax is charged under the Income Tax Act of 1997, as amended. Residents (including companies) in Uganda are taxed on worldwide income while non-resident persons are taxed on income derived from sources within Uganda. Income tax is imposed on business income, employment income and property income.

Tax rate for individuals in employment is based on income and employers are required by law to deduct payroll tax (PAYE) from an employee's salary.

Corporate income tax is 30% for resident and non-resident companies alike. In addition, repatriation of profits by branches of non-resident companies is taxed at 15%.

Withholding Tax (WHT) is tax withheld on income at source. WHT obligations vary depending on the nature of the payment and residency status. **Table 14** shows the rates that may be relevant for captive power projects.

41) Link: https://www.ura.go.ug/index.jsp – accessed April 2019

TABLE 14. Uganda withholding tax rates relevant for captive power projects[42]

NATURE OF PAYMENT	RESIDENT RATE	NON-RESIDENT RATE*
Dividend — unlisted companies	15%	15%
Interest	15%	15%
Management/ professional fee	0–6%	15%
Purchase of asset from non-resident	10%	—
Leasing equipment	—	15%
Rents	—	15%
Ugandan source service contract	—	15%

*Note: non-resident tax rate in all cases is a final tax. Rates may vary under tax treaties. Uganda has a double-taxation treaty with United Kingdom, Denmark, Norway, South Africa, Netherlands, Mauritius, Italy, Zambia and India. Treaties with Egypt, China, UAE, Sudan, Belgium and Seychelles have been negotiated but not yet signed.

The Income Tax Act also has typical provisions for thin capitalization, transfer pricing and others.

Value Added Tax (VAT)

Under the Value Added Tax Act of 1996[43], as amended, VAT is a consumption tax charged at a rate of 18% of all supplies of eligible goods and services made by persons registered or required to register for VAT purposes. Some supplies are zero-rated or exempt from VAT — see next.

The threshold for VAT registration was increased in 2015 to annual turnover of UGX 150 million (EUR 35,000).

Stamp Duty

Stamp duty is payable under the Stamp Duty Act of 2014 on any document which upon being created, transferred, limited, extended, extinguished or recorded confers upon any person, a right or liability. Instruments or documents attracting stamp duty of relevance to captive power projects include: agreements, articles of association, company share capital (0.5%), insurance policies, powers of attorney, customs bonds (0.05%), mortgage deeds (0.5%), leases (1%), hire purchase agreements (1%) and transfer of immovable property (1%).

Customs Duty

This is a tax levied on goods imported (import duty) or exported (export duty) from Uganda at specific or ad valorem rates. The East African Community Customs Management Act of 2004 (EACCMA)[44] is the legal framework for customs operations in Uganda and the East Africa region. Goods imported into Uganda from outside of the East African Community (EAC) are valued for tax purposes. Typical rates that apply to an import of goods from outside the EAC are:

- Import duty — 25% (rate for finished goods)
- VAT — 18%
- Withholding Tax — 6% (0% for plant and machinery)
- Excise Duty — varies, but usually not applicable to captive power

More information can be found on the URA website.[45]

42) Deloitte (2015) Uganda Budget Highlights and Quick Tax Guide 2015 – Diving deep, June 2015, p. 16, Link: https://www2.deloitte.com/content/dam/Deloitte/ug/Documents/tax/Tax_Budget%20highlights%202015_UG.PDF – accessed March 2019

43) Link: https://ulii.org/ug/legislation/consolidated-act/349 – accessed April 2019

44) Link: http://kenyalaw.org/kl/fileadmin/pdfdownloads/EALA_Legislation/East_African_Community_Customs_Management_Act_2004.pdf – accessed April 2019

45) Link: https://www.ura.go.ug/index.jsp – accessed April 2019

5.3 BUSINESS INCENTIVE AND TAX EXEMPTIONS

ALLOWANCES UNDER THE INCOME TAX ACT

In 2017, the initial allowance for certain capital investments was re-instated. An investor who places an eligible item of property into service for the first time outside a radius of 50 km from Kampala during a year of income is allowed a deduction for that year for an amount equal to 50% of the cost basis of the property at the time it was placed into service. An eligible item means plant and machinery wholly used in the production of income.

Plant, equipment and machinery used in certain industries can also benefit from an accelerated depreciation rate of 20-40%.

VAT AND CUSTOMS DUTY EXEMPTIONS

VAT exemptions can change annually so developers should make sure they have the latest information. The following supplies relevant for captive power are VAT exempt in Uganda as of late 2017.

- Financial services
- Sale, lease or letting of property (except for commercial premises)
- The supply of deep cycle batteries and photosensitive semiconductor devices including solar PV whether or not assembled in modules or made into panels
- The supply of any goods and services to the contractors and sub-contractors of hydroelectric power, solar power, geothermal power or biogas and wind energy projects

As of 2016, the supply of power generated by solar is no longer VAT exempt. VAT at 18% is also charged on items such as cables that could be used in non-renewable energy projects.

Furthermore, under the 5th Schedule of EACCMA 2004 the supply of the following is exempt from Customs Duty and VAT at importation:

- Specialised equipment for the development and generation of solar and wind energy, including accessories and deep cycle batteries which use and/or store solar power

However, if and when these are sold locally (rather than being used by the importer) they attract VAT at 18% (except where they are locally VAT exempt as per above).

Uganda does not refund VAT incurred by a foreign business, unless the foreign business has a permanent establishment in Uganda and is registered for VAT in Uganda.

5.4 IMPORTATION PROCESS

Much of the required equipment and materials for a captive power plant is not usually readily available in Uganda. Importation will therefore be needed, including cost-control during importation. Buying equipment in bulk can lead to more competitive pricing, but this could be negatively offset by local storage costs if not all components can be deployed at once. Developers could also consider joint bulk procurement to help maximize use of space in shipping containers

Equipment imported in shipping containers and other surface freight usually enters Uganda via Kenya (Mombasa). For small components, air freight to Entebbe is also an option. Customs clearance processes of up to 3–4 months and shipping times of about 3 months can impact cash flow and where storage is involved can also increase costs. Divergent processes within the East African Community (EAC) make it difficult for companies to import duty-free and double taxation sometimes occurs. Importation delays might not necessarily only occur in Uganda but also in Kenya or Tanzania when goods are shipped by sea.

In all cases for Uganda, a pre-export verification of conformity (PVOC) is needed in the country of origin for products regulated by the Uganda National Bureau of Standards (UNBS)[46]. A Certificate of Conformity (CoC) is issued by a PVOC agent and is required for customs clearance to avoid denial of entry.

46) Link: https://unbs.go.ug/ – accessed April 2019

If an investor/developer does not already have a presence or local partner in Uganda to liaise with the authorities, a professional clearing agent can help with the equipment importation process. Regardless, it is recommended to write to seek official guidance or approval from relevant parties well in advance of equipment import for captive power. For example:

- A written opinion from a Ugandan tax advisor on duties and taxes payable
- Guidance from a clearing agent or similar on what (if any) import licences may be needed. For example, for PV panel mounting structures, aluminium requires an import licence
- A letter from the Uganda Revenue Authority (URA) confirming which equipment (if any) is tax-exempt and which is not. A visit to URA headquarters may be necessary to ensure clarity.
- Written confirmation from UNBS if there will be any requirements for local testing of equipment.
- Where the importer is a member of UMA, USSIA or another trade body, the association could also potentially provide support (if needed)

For solar PV, and bioenergy to the extent possible, it may be helpful to package the import as a complete system as a way to address the lack of clarity around ancillary components. In other cases, and especially where the end-user has charity or similar tax-exempt status in Uganda, it may be appropriate for the customer to be the importer instead of the developer, investor or equipment supplier.

5.5 ENERGY SECTOR LICENCING AND REGULATIONS

Captive power licencing options

As noted in **Section 3.1**, the electricity sector is anchored upon the Electricity Act of 1999. The relevant subsidiary regulations are:

- The Electricity (Installation Permits) Regulations, 2003
- The Electricity (Primary Grid Code) Regulations, 2003
- The Electricity (Quality of Service Code) Regulations, 2003
- The Electricity (Safety Code) Regulations, 2003
- The Electricity (Tariff Code) Regulations, 2003
- The Electricity (Licence Exemption) (Isolated Grid Systems) Order, 2007
- The Electricity (Application for Permit, Licence and Tariff Review) Regulations, 2007
- The Electricity (Licence Fees) (Amendment) (No. 3) Regulations, 2014

Energy licensing and related (e.g., tariff) approvals are to be obtained from ERA while any interconnection approval (for any captive power surplus export capacity), if allowed, will need the agreement of the distribution utility, or potentially UETCL.

While there is currently no explicit regulatory framework for captive power, a self-generator must still adhere to the Act, the regulations and other standards where applicable. For licencing, a distinction is made for different sizes and types of captive plants as follows:

- For captive power generation for internal use only (no grid feed in, i.e. “behind the meter”) — whether the project is grid-connected or off-grid — if the project is less than 500 kW, there is no requirement for a licence. However, the project should still obtain a licence exemption. This entails writing to ERA with information including the technology, size, location, expected generation and project timeframe. ERA will normally respond with a letter stipulating any conditions for the approval/exemption.
- If the project is larger than 500 kW, even if there is no spill over to the grid (which is not allowed at the time of writing), or even if the facility is off-grid (except in the case described next), a generation license will be issued for own consumption, without any tariff review. In this case, the generation license application process, fees and reporting requirements will be applicable.

— However, if the captive project is less than 2 MW and plans for local distribution of electricity, it may be possible to obtain a license exemption under the Electricity (Licence Exemption) (Isolated Grid Systems) Order, which would save on licensing fees. The reason for the uncertainty is because this Order is intended for off-grid systems for rural electrification (i.e., mini-grids), which should usually be at least 1 km from the main grid, and because a license is needed if it is interconnected to the main grid, it may not be possible to obtain this exemption. Developers should also be aware that new supporting documentation under this Order (e.g. an application for licence exemption form) was released in 2017. Moreover, ERA is reviewing the Electricity (Licence Exemption) (Isolated Grid Systems) Order in an effort to attract private investment. The review is expected to be complete by end of 2019.

— If a captive plant (bioenergy only) wishes to sell excess energy to the national grid (regardless of its size), there would be a full licensing process under the REFIT and a PPA with UETCL would be needed, along with the licencing fees and quarterly reporting.

— Selling surplus captive power to third party grid or directly to consumers would require not only a generation licence but also sales licence, possibly a distribution licence and a tariff review. Direct sale to third-party single buyers is currently not allowed.

Where a developer is unsure, it is recommended to write to either ERA and/or the commissioner of energy in the Ministry of Energy and Mineral Development (MEMD) to request administrative guidance.

Even where a licensing exemption is obtainable, in some rare cases a developer may still want to apply for a generation license (e.g. to provide certainty for investors).

Where there is no grid feed-in, the distribution company (e.g. Umeme) and system operator (UETCL) do not need to be informed of the project by the developer. Nevertheless, it is advisable to have an early discussion with the distribution company to make them aware of the planned system, especially where commissioning may have some impact on the feeder line. This could also be an opportunity to find out from the distribution company if they might derive any benefits in terms of grid stability from a distributed generator in the location.

Installation and commissioning of a plant (including synchronization of the system with the grid) must be undertaken by an ERA licensed technician.

Electricity licencing procedure

To start the licencing process for an unsolicited project pursuant to section 29 of the Electricity Act, a captive power developer must submit a Notice of Intended Application (NIA) to ERA, which contains information on the developer and the project. ERA will then publicize the NIA and seek comments from affected parties within a fixed period of not less than 30 days. The developer must respond to any comments received.

On the basis of the NIA process, ERA issues a permit for a specific period (usually 18 months renewable up to 24 months), which is used to conduct feasibility studies, obtain an Environmental Impact Assessment (EIA) certificate and develop the project to the point that it is ready to apply for a licence. The licence application follows a similar procedure to that for the NIA, with a 30-day public comment period. Where relevant (e.g. for captive power surplus export), the licence will include the tariff approved by ERA, as computed under the Electricity (Tariff Code) Regulations of 2003. At any time during the application process, ERA may call for a public hearing on the project.

As a condition of approval, a licence will usually stipulate that the project must adhere to relevant regulations such as the Electricity (Installation Permits) Regulations, the Electricity (Primary Grid Code) Regulations and the Electricity (Safety Code) Regulations. The consideration by ERA in granting a licence are included in Section 37 of the Electricity Act.

A generation licence has total processing timeframe of approximately 6 months, although in some cases longer is required. Applicants should provide all financial information in preferably USD and not EUR. The details and timing of and application forms for the licencing process are found in the Electricity (Application for Permit, Licence and Tariff Review) Regulations of 2007. An outline of the process is also found on the ERA website[47] and is summarised in **Annex D**.

The application permitting and licencing fees applicable to captive power projects up to 10 MW are provided in **Table 16**.

47) Link: https://www.era.or.ug/ – accessed April 2019

TABLE 15. Uganda electricity licencing fees for projects up to 10 MW[48]

NATIONAL GRID CONNECTED SYSTEMS			ANNUAL FEES (USD)
Generation CAT.IV	Small generators	0.5 MW and above but less than 10 MW	12,000
Generation CAT.V	Very small generators	0.5 MW and above but less than 2.0 MW	6,000
		Below 0.5 MW	2,500
Distribution CAT.IV	Small distributors	2 MW (16 GWh) and above but less than 10 MW (80 GWh)	12,000
Distribution CAT.V	Very small distributors	0.5 MW (4 GWh) but less than 2 MW (16 GWh)	3,500
		Less than 0.5 MW (4 GWh)	1,500

ISOLATED GRID SYSTEMS – COMBINED GENERATION, DISTRIBUTION AND SALES LICENCE			ANNUAL FEES (USD)
Isolated Grid CAT.II	Small generators	2 MW and above but less than 10 MW	12,000
Isolated Grid CAT.III	Very small generators	0.5 MW (4 GWh) and above but less than 2 MW (16 GWh)	3,500
		Less than 0.5 MW (4 GWh)	Exempt

APPLICATION AND APPROVAL FEES	ONE-OFF FEES (USD)
Permit for feasibility studies	3,000
Licence application, transfer, amendment or modification or renewal	3,500
Permit extension application	1,000
Application for licence exemption	3,000

48) GoU (2014) The Electricity (Licence Fees) (Amendment) (No. 3) Regulations, 2014. Link: http://www.era.or.ug/index.php/2013-12-14-14-58-04/regulations-codes/doc_download/211-the-electricity-licence-fees-amendment-no-3-regulations-2014 – accessed March 2019

5.6 ENVIRONMENTAL LICENCING

The National Environment Act of 1995[49] is the framework law on the environment in Uganda, providing for its sustainable management and establishing the National Environment Management Authority (NEMA) as the principal government agency.

There are a number of subsidiary regulations to the Act. The ones most relevant for captive power projects are:

— The Environmental Impact Assessment Regulation, 1998

— The National Environment (Waste Management) Regulations, 1999

— The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, 1999

— The National Environment (Audit) Regulations, 2006

— The National Environment (Noise Standards and Control) Regulations, 2003

In addition, NEMA issued the National Environmental Impact Assessment Guidelines for the Energy Sector in 2004 that differentiates renewable and non-renewable energy projects.

According to the Environmental Impact Assessment Regulation of 1998 (the EIA Regulation), the steps that a developer of a project may have to undertake are: **a)** submission to NEMA of a project brief, **b)** development of an Environmental Scoping Study **c)** preparation of an Environmental Impact Assessment (EIA) Terms of Reference, **d)** identification and NEMA approval of the external EIA experts, **e)** public notification of the intended project, **f)** preparation of an EIA report and Environmental Impact Statement, including local consultation, **g)** submission of the Statement, **h)** invitation of general public comments, **i)** NEMA decision on whether a public hearing should be held or not, **j)** NEMA decision to award a certificate of approval (with conditions) or not and **k)** publication of the EIA documentation.

Once the project is implemented, the owner will need to conduct an initial self-audit (conducted by external NEMA approved experts) within a specific time frame. Depending on the results of the audit, further self-auditing may be required. NEMA may also conduct its own audit at any time.

It should be noted that the EIA Regulation as currently published does not have a provision for the step of "Environmental Scoping Study", which is meant to help define the ToR for a full EIA. Nevertheless, it is a NEMA requirement and will soon be formalized in law. Developers should also note the EIA process includes social components and should rather be considered as an Environmental and Social Impact Assessment (ESIA).

Whether or not a captive power project needs to go through the full EIA process will depend on its characteristics. At minimum, all projects — even those that are likely to be exempt — must submit a Project Brief to NEMA. Information on what is to be included in the Project Brief is in section 5 of the Environmental Impact Assessment Regulation of 1998. NEMA uses the Project Brief to take a decision whether or not a full EIA is needed. If it is not required, the NEMA certificate of approval is issued on the basis of the Project Brief.

Any greenfield project (e.g. new industrial facility) with a captive power component will need to undergo the full EIA process. Furthermore, any large project situated externally to an existing premises (e.g. a ground-mounted PV array) or one with noise or effluent impacts (e.g. a biomass combustion plant) is highly likely to be subject to an EIA. On the other hand, a captive plant that is fully contained within an existing facility may not be required to perform an EIA. When preparing this developer guide, it was noticed that:

— Existing roof-mounted solar PV systems for self-consumption in Uganda were not reported to have undergone an EIA

— At least one developer of a small captive bioenergy plant at an existing facility did not have to conduct an EIA, although NEMA visited the site

49) Link: https://nema.go.ug/sites/all/themes/nema/docs/national_environment_act.pdf – accessed April 2019

Officially, the full EIA review process can be completed in three months. However, even though NEMA does its best to adhere to the timelines, it has faced capacity constraints in the past.

Other relevant information for developers to be aware of for the EIA process in Uganda:

- Everything is approved centrally in Kampala. At the local level, a district environmental officer is involved but documentation is all processed through headquarters
- NEMA approval is for both construction & operations under one licence
- The transportation component of a biomass project might, however, need a separate waste transport licence if the biomass is classified as "waste." Currently, companies who transport coffee husks and saw dust do not require a waste transport license.

At the time of writing, the National Environmental Act and subsidiary regulations were under review. It is not expected that this will affect the EIA process significantly. For example, the missing provision on the environmental scoping study will be included and there will be more emphasis on the social aspects.

The current EIA fees, payable even if the process stops at the Project Brief stage, are dependent on the value of the project. For a project with a value of more than UGX 5 billion (EUR 1.17 m), the fee is 0.1% of the total value with no cap. Below that value, the fee is UGX 2,000,000 or less (EUR 470). The fees are found in Schedule 3 of the Environmental Impact Assessment Regulation.

Apart from the permitting requirements under the National Environment Act, others that may be relevant for a captive power project include:

- Depending on the size and location of the captive plant, the Public Health (Building) Rules[50] may apply. These require that the developer gives notice and plans are approved by the local authority before construction of or alteration to a building begins.
- The Directorate of Water Resource Management (DWRM) of the Ministry of Water and Environment may need to be involved under the Water Act of 1997[51] and Water Resources Regulations of 1998[52] in the case of impacts on surface water or water abstraction.

5.7 WORK PERMITS AND SOCIAL SECURITY CONTRIBUTIONS

All foreigners intending to work in Uganda must hold an appropriate work permit. Applications must be made directly to the Directorate of Citizenship and Immigration[53]. A list of the documentation needed to apply for a permit is found on the Uganda Investment Authority One-Stop-Centre website.

For a new foreign investor in Uganda, there are two prior steps to complete: **a)** register and incorporate a company and **b)** deposit USD 100,000 (EUR 86,000) or equivalent with the Bank of Uganda. Work permit fees are found in **Table 16**. The fees vary by duration of the permit. A non-refundable pre-payment fee of USD 1,500 (EUR 1,285) is included in the fees.

50) Link: https://www.kcca.go.ug/uploads/acts/Building%20Regulations.pdf – accessed April 2019
51) Link: https://www.mwe.go.ug/sites/default/files/library/Uganda%20Water%20Act.pdf – accessed April 20190
52) Link: http://extwprlegs1.fao.org/docs/pdf/uga14414.pdf – accessed April 2019
53) Link: https://www.immigration.go.ug – accessed April 2019

TABLE 16. Work permit fees in Uganda[54]

CLASS	FEES IN USD ($) BY MONTHS			
	6	12	24	36
a) Class B (Agriculture)	800	2500	4000	5000
b) Class C (Mining)	800	2500	4000	5000
c) Class E (Manufacturing)	800	2500	4000	5000
d) Class F (Professional)	800	2500	4000	5000
e) Class G (Expatriate employment)	800	2500	4000	5000

Under the National Social Security Fund Act of 1985 (the NSSF Act)[55], a company with more than five employees must add 10% to the gross monthly wage of each employee as a social security contribution on top of the five per cent that is to be deducted from the employee's own wages.

54) Okuja, Joseph (2018) Domestic Tax Laws of Uganda. Link: https://www.ura.go.ug/Resources/webuploads/GNRART/DT_Laws_2018_Edition.pdf – accessed March 2019

55) Link: https://www.nssfug.org/uploads/NSSF%20Act.pdf – accessed April 2019

SECTION 6

Financing Captive Power in Uganda

6.1 TYPICAL FINANCING MODALITIES

For typical financing modalities, please see implementation models in **Section 4.4**.

6.2 DOMESTIC FINANCING OPPORTUNITIES

In general and although this is changing, commercial banks in Uganda are still building their capacities in energy sector financing. Interest rates for loans in local currency are high (20% plus margin), and 100–120% collateral can be required. Bank loans have a 5–7 year tenure but financing for some captive projects will typically demands a 10-year credit line.

GOVERNMENT INSTITUTIONS

Uganda Development Corporation

The Uganda Development Corporation (UDC) is a government vehicle for investment in strategic sectors of the economy in partnership with the private sector. Investment from UDC may not be suitable for most captive power project owners and developers because of the public-private partnership angle. However, in some cases potential project owners may already be able to qualify. UDC for example has previously provided equipment under lease financing to two tea factories.

Uganda Energy Credit Capitalisation Company

The Uganda Energy Credit Capitalisation Company (UECCC) provides financing options and support instruments with the aim of facilitating investment in renewable energy projects. However, as of end-2017 support was only available for activities relating to rural electrification and energy access. This could, however, change in the future.

Uganda Development Bank

The Uganda Development Bank (UDB) is a limited liability company 100% owned by the government. UDB can finance private sector projects with different products: project finance, trade finance, equity and quasi-equity, both for greenfield projects and existing businesses. UDB has been approached by project owners who are interested in captive power (sugar and rice sectors).

UDB can provide longer loan tenors (up to 15 years in USD, but usually only where project revenues are also in USD). The maximum loan size is USD 10 million. As of mid-2017, the USD interest rates were 6-month London Interbank Offered Rate (LIBOR) +6% and 12–16% on UGX. The maximum tenor for UGX is 10 years. A grace period of up to three years may be available. For captive power projects, UDB would probably require guarantees.

COMMERCIAL BANKS AND OTHERS

Commercial Bank of Africa

The Commercial Bank of Africa (CBA) focuses on its existing portfolio of clients, which include private hospitals and schools. CBA will not finance greenfield projects unless it is part of the activities of a group customer. CBA has some experience with leasing arrangements and is in principle interested in captive power for its clients. Corporate finance is an option for a project, unless it has a CAPEX of more than USD 1 million or a repayment period of more than three years, in which case project finance is preferred. USD 2 million is the maximum loan amount from CBA Uganda, but support from the CBA wider group (internal syndication) means up to USD 15 million can be made available.

CBA's loan tenor can be up to 10 years for UGX and five years for USD or EUR, with a grace period up to 24 months. The base interest rate for USD and EUR as of mid-2017 was 11%, but lower might be possible. At the time, the base interest rate for UGX was 22.5%, with lower pricing depending on the risk. CBA often requires guarantees, including sometimes shareholder personal guarantees.

Diamond Trust Bank

As of end-2018, Diamond Trust Bank (DTB) was the only bank in Uganda that was participating in a regional green credit line called SUNREF (Sustainable Use of Natural Resources and Energy Finance — see more next). The credit line is made available to commercial banks for on lending for smaller renewable energy and energy efficiency projects. In 2017, a fuel switch biomass boiler replacement project was announced as the first beneficiary of the credit line in Uganda. Other projects in the pipeline include the hotel, sugar and tea sectors. Captive power is eligible for financing.

Under the SUNREF credit line, the maximum project size is USD 10 million. There is no minimum size. Lending is only in USD but UGX loans may be available in the future. The interest rate offered by DTB is typically in the range of 6–7% on USD. Most loans are on a corporate finance basis — there had not been any project finance deals by mid-2017. One of the eligibility criteria on the energy side is that a project achieves a minimum of 15% energy savings or energy benefit.

Other commercial banks

It has been reported that both Kenya Commercial Bank and Standard Bank in Uganda are interested in solar PV captive power and that there has been willingness to finance at least one project. However, both institutions cannot offer loan terms of longer than five years for such projects. In addition, a project owner, developer or investor equity share of at least 20% is required.

The East Africa Development Bank (EADB) and the Eastern and Southern African Trade and Development Bank (TDB, previously PTA Bank), both regionally active and with a presence in Uganda (EADB's headquarters), might also be potential sources of debt for captive power. EADB is known to be interested in the sector and has previously evaluated potential opportunities.

Other financiers

For solar PV leasing and PPA arrangements for larger captive projects, there are a number of specialised solar financiers active in the East African market as noted in **Annex F**.

6.3 INTERNATIONAL FINANCING OPPORTUNITIES

In addition to international private finance, which in East Africa already included financing from solar leasing companies and crowd-funded or peer-to-peer lending for commercial solar systems, there are several public funding opportunities listed next. In addition, developers are encouraged to review the GET.invest Funding Database (to be found at www.get-invest.eu) for an overview of financing opportunities that may be applicable to captive power.

Feasibility study funding opportunities

Feasibility study co-funding is a special category of support available for projects that meet different conditions. For example, the Belgian Investment Organisation (BIO), the Nordic Project Fund (NOPEF), the Norwegian Development Agency (NORAD), Deutsche Investitions- und Entwicklungsgesellschaft (DEG) and Oesterreichische Entwicklungsbank (OeEB — the Austrian Development Bank), among others, all have feasibility study funding mechanisms. Closer to Uganda, the Africa Co-Gen project in the past has funded feasibility studies for CHP in Uganda.

Sustainable Use of Natural Resources and Energy Finance

The Sustainable Use of Natural Resources and Energy Finance (SUNREF) is a green credit line financed by the by l'Agence Française de Développement (AFD) for commercial bank on lending to smaller renewable energy and energy efficiency projects, including captive power. The credit line is available to participating banks in East, West and southern Africa, including Diamond Trust Bank in Uganda, where more banks are expected to join.

The SUNREF credit lines in East Africa are supported with technical assistance from a secretariat hosted at the Kenya Association of Manufactures in Nairobi. For more information please see the SUNREF website[56].

Powering Agriculture

Powering Agriculture is an energy grand challenge fund for clean energy innovations in the agriculture sector of developing countries. Powering Agriculture is funded by the United States Agency for International Development (USAID), the Swedish International Development Cooperation Agency (Sida), the German Federal Ministry for Economic Cooperation and Development (BMZ), Duke Energy and the Overseas Private Investment Corporation (OPIC).

Grantees of Powering Agriculture include an off-grid biomass and solar PV developer in Tanzania, a biomass captive power plant in Ethiopia, a micro-steam turbine firm, a solar agro-processing company and a renewable energy leasing company targeting the horticultural sector including in Uganda. More information can be found on Powering Agriculture's website[57].

The Africa Enterprise Challenge Fund

The Africa Enterprise Challenge Fund (AECF) is an Africa-based challenge fund that supports businesses in agriculture, agribusiness, rural financial services and communications systems, renewable energy and climate resilience. AECF provides catalytic funding in the form of repayable and non-repayable grants to businesses that would otherwise not be able to secure early stage and growth financing, in addition to business growth support. AECF is part of the Alliance for Green Revolution in Africa (AGRA) family and has been supported by governments (Australia, Canada, Denmark, The Netherlands, Sweden and

56) Link: https://www.sunref.org/en/ – accessed April 2019
57) Link: https://poweringag.org/ – accessed April 2019

United Kingdom) as well as international financial institutions (Consultative Group to Assist the Poor and IFAD).

AECF has previously had funding windows for which Ugandan companies were eligible, including Renewable Energy and Adaptation to Climate Change Technologies (REACT).

Energy and Environment Partnership Southern and East Africa

The Energy and Environment Partnership for Southern and East Africa (EEP-S&EA) is a programme that promotes renewable energy, energy efficiency, and clean technology investments. EEP began in 2010 and had has been funded by the Ministry of Foreign Affairs of Finland, the Austrian Development Agency, and the UK's Department for International Development (DFID). Approximately EUR 60 million in support was available through challenge funds to support projects at pilot and scale-up phases between 2010–2017.

EEP S&EA funded nine projects in Uganda in the past. Developers are encouraged to follow the facility's progress[58].

ElectriFI

ElectriFI is a specialist debt and equity financing partner for small-scale private companies focusing on new or improved electricity connections as well as on generation capacity from sustainable energy sources in emerging countries. ElectriFI is a 215-million-euro impact investment facility for renewable energy companies active on- and off-grid in emerging markets. Partnering with the European Development Finance institutions, the European Commission launched ElectriFI in December 2015 during the COP21 in Paris. ElectriFI is also funded by contributions from the US Power Africa and Sweden.[59]

58) Link: https://eepafrica.org/ – accessed April 2019
59) Link: http://electrifi.eu/ – accessxed April 2019

ANNEX A

Key Electricity Sector Actors

Ministry of Energy and Mineral Development (MEMD)[60]

The Ministry of Energy and Mineral Development (MEMD)'s mandate is "to establish, promote, strategically manage and safeguard the rational and sustainable exploitation and utilisation of energy and mineral resources for social and economic development." Its role is to provide policy guidance, to create an enabling environment in order to attract investment, to establish the energy and mineral resource potential of the country and to monitor the activities of private companies in the sector.

Electricity Regulatory Authority (ERA)[61]

The Electricity Regulatory Authority (ERA) is a statutory body established in 2000 to regulate the generation, transmission, distribution, sale, export and import of electricity in Uganda. It also guides the liberalization of the electricity industry, and manages licensing, rates, safety and other matters. It is responsible for ensuring compliance with electricity license conditions, and for protecting the interests of consumers in respect of prices and terms of supply as well as the quality, efficiency, continuity and reliability of supply services. ERA also helps promote frameworks that stimulate investment and competition, facilitates the least-cost development path and helps to work towards power grid financial sustainability for reinforcements and extensions.

Rural Electrification Agency (REA)[62]

The Rural Electrification Agency (REA) was established as a semi-autonomous agency by MEMD in 2001, with an operational mission to implement the rural electrification agenda under a public-private partnership. REA functions as the secretariat of the Rural Electrification Board, which carries out MEMD's rural electrification responsibilities as defined in the Electricity Act.

Uganda Electricity Generation Company Limited (UEGCL)[63]

The Uganda Electricity Generation Company Limited (UEGCL) was incorporated in 2001 and is wholly owned by the government of Uganda. UEGCL is responsible for the construction, operation and maintenance of power plants and the generation and sale of electric power, among other roles. It owns the 180 MW Nalubaale and the 200 MW Kiira hydropower plants. These facilities have been operated and maintained by Eskom Uganda Limited since 2003 pursuant to a 20-year concession agreement.

Uganda Electricity Transmission Company Limited (UETCL)[64]

The Uganda Electricity Transmission Company Limited (UETCL) is owned by the Ministry of Finance, Planning and Economic Development and remains the sole operator of the transmission system (above the 33 kV network). UETCL is the counterparty to PPAs and sells on power to distribution network companies. It responsible for bulk power purchases and sales, imports and exports of energy, and also has the role of national system operator.

Uganda Electricity Distribution Company Limited (UEDCL)[65]

The Uganda Electricity Distribution Company Limited (UEDCL) is the owner of the electricity distribution network. Management for most of the UEDCL network was transferred to private operator Umeme Limited under a concession arrangement in 2004. As a result, UEDCL's responsibilities changed to include **a)** administration of the arrangement, **b)** supervision of pre-existing rural electrification plans and **c)** ensuring that it is in a position to take over operations of distribution businesses if needed. UEDCL also operates a small number of mini-grids.

60) Link: http://www.energyandminerals.go.ug/ – accessed April 2019
61) Link: http://www.era.or.ug/ – accessed April 2019
62) Link: http://www.rea.or.ug/ – accessed April 2019
63) Link: http://uegcl.com/ – accessed April 2019
64) Link: http://www.uetcl.com/ – accessed April 2019
65) Link: http://www.uedcl.co.ug/ – accessed April 2019

Umeme Limited[66]

Under a 20-year concession agreement Umeme Limited operates, maintains, upgrades and expands the distribution system. It buys in bulk from UETCL, sells electricity to its customers and improves efficiency within the network. Industrial and government customers account for about 70% of the utility's annual revenue. Umeme is listed on the Uganda Securities Exchange (USE) and on the Nairobi Securities Exchange (NSE).

Other private distribution companies

At the time of writing, nine distribution companies and cooperatives sell electricity to end-users. In addition to UEDCL and the largest distributor, Umeme, these are the West Nile Rural Electrification Company, Kilembe Investments, Kalangala Infrastructure Services, Kyegegwa Rural Electricity Cooperative Society, Bundibugyo Electricity Cooperative Society, Pader Abim Community Multipurpose Electricity Cooperative Society and Kisiizi. The operations of the second largest distributor — Ferdsult Engineering Services — were taken over by UEDCL in 2016 — as business could not be sustained.

Independent Power Producers

Several IPPs and private distribution companies have entered the power sector following liberalization. There are at least 15 operational IPPs and more than 25 others have received preliminary approvals or generation licenses, with a range of plant sizes, locations and renewable energy technologies (small hydro, bagasse, biomass, solar PV and wind).

66) Link: http://www.umeme.co.ug/index.php – accessed April 2019

ANNEX B

Contact Information for Government Institutions

TABLE 17. Contact Information for Government Institutions

INSTITUTION	CONTACT DETAILS
Ministry of Energy and Mineral Development	Amber House, Kampala Road P.O. Box 7270, Kampala Phone: +256 414 323355 / 234733 Email: psmemd@energy.go.ug Web: www.energyandminerals.go.ug
Electricity Regulatory Authority	Plot 15, ERA House, Shimoni Road, Nakasero P.O. Box 10332, Kampala Phone: +256 414 341852 / 0757341646 Email: info@era.or.ug Web: www.era.or.ug
Electricity Disputes Tribunal	4th Floor Amber House Kampala
Uganda Electricity Transmission Company Limited	Plot No.10, Hannington Rd P.O. Box 7625, Kampala Phone: +256 417 802000 / 414 233433/4 Email: Transco@uetcl.com Web: www.uetcl.com
Uganda Electricity Distribution Company Limited	UEDCL Tower, 6th Floor, Plot 37, Nakasero Road P.O. Box 7390 Kampala Phone: +256 312 330300 Email: contact@uedcl.co.ug Web: www.uedcl.co.ug
Rural Electrification Agency	Plot 10 Windsor Loop, Kololo, 2nd Floor- House of Hope P.O. Box 7317, Kampala Phone: +256 312 318100 Email: rea@rea.or.ug Web: www.rea.or.ug

National Environment Management Authority	NEMA House, Plot 17/19/21 Jinja Road, Kampala Phone: +256 414 251064 / 251065 / 251068 Email: info@nemaug.org Web: www.nema.go.ug
Directorate of Water Resources Management	Ministry of Water & Environment P.O. Box 20026, Kampala Phone: +256 414 505942 Email: mwe@mwe.go.ug Web: www.mwe.go.ug
Uganda Investment Authority	The Investment Centre, Plot 22B Lumumba Avenue TWED Plaza P.O. Box 7418 Kampala Phone: +256 414 01000 Email: info@ugandainvest.go.ug Web: www.ugandainvest.go.ug
Uganda Revenue Authority	Plot M193/M194, Nakawa Industrial Area P.O. Box 7279, Kampala Phone: +256 417 440000 / 444602 / 444620 Email: info@ura.go.ug Web: www.ura.go.ug
Uganda National Bureau of Standards	Plot M217 Nakawa Industrial Area P.O. Box 6329 Kampala Phone: +256 414 505995, +256 222369, 0800 133133 (toll free) Email: info@unbs.go.ug Web: www.unbs.go.ug
Directorate of Citizenship and Immigration Control	Plot 75 Jinja Road P. O. Box 7165 / 7191, Kampala Phone: + 256 414 595945 Email: www.immigration.go.ug Web: www.immigration.go.ug

ANNEX C

Relevant Stakeholders

This Annex compiles a non-exhaustive list of stakeholders selected according to their relevance to the subject of this guide.

Agence Française de Développement[67]

The French Development Agency (AFD) is engaged in green financing as well as small hydropower projects in Uganda.

Delegation of the European Union to Uganda[68]

The EU Delegation is actively supporting several programmes to promote the private sector and advance access to sustainable energy.

Deutsche Gesellschaft für Internationale Zusammenarbeit[69]

GIZ under the Promotion of Renewable Energy and Energy Efficiency Programme (PREEEP) works with the government of Uganda to increase access to renewable energy.

Private Sector Foundation Uganda[70]

PSFU is the apex body for the private sector with membership for over 200 business associations, corporate bodies and major publicsector agencies.

Uganda Manufacturers Association[71]

UMA represents the interests of the industrial and commercial sectors with over 700 members drawn from small, medium and large private commercial and public sector entities.

Uganda National Renewable Energy and Energy Efficiency Alliance[72]

UNREEEA is the umbrella organisation of renewable energy and energy efficiency associations in Uganda, including the Uganda Biomass Energy Efficient Technologies Association (BEETA) and the Uganda Solar Energy Association (USEA).

Uganda Small Scale Industries Association[73]

USSIA is an association for micro, small and medium-scale value addition and related service support enterprises with approximately 4,500 members categorized into 12 industrial sectors.

US Agency for International Development[74]

USAID supports the power sector in Uganda under Power Africa and private sector development including rural electrification through renewable energy in off-grid areas.

World Bank and African Development Bank

The World Bank and the African Development Bank are, among other activities, working with the government of Uganda to investigate the possibilities for net metering in the country.

67) Link: https://www.afd.fr/en/page-region-pays/uganda – accessed April 2019
68) Link: https://eeas.europa.eu/delegations/uganda_en – accessed April 2019
69) Link: https://www.giz.de/en/worldwide/19268.html – accessed April 2019
70) Link: http://www.psfuganda.org – accessed April 2019
71) Link: http://www.uma.or.ug/ – accessed April 2019
72) Link: http://unreeea.org – accessed April 2019
73) Link: http://www.ussia.or.ug/ – accessed April 2019
74) Link: https://www.usaid.gov/uganda – accessed April 2019

ANNEX D

ERA Licencing Procedure

TABLE 18. ERA licencing procedural steps

STEPS		REQUIREMENTS	FEEDBACK
Notice of Intended Application (NIA)	A person intending to establish a project for which a license is required under the Electricity Act shall submit to ERA a Notice of Intended Application (NIA).	— Submit form A NIA Application Form, which is inclusive of relevant annexes — Other important requirements include: Pre-feasibility study, Gantt chart, Experts CVs, Project references, Declaration of intent from partners (to carry out feasibility studies) and Project Financial Model — Payment of application fees (3,000 USD)	— Developer will receive completeness notification within 30 days of submission — If application deemed incomplete, developer will also be informed within 30 days and renewed 30 window of review begins after re-submission
Publication of notice of intended application	ERA publishes the application for public comments 30 days after complete notice of intended application	— Developer to respond to comments within 15 days	— Window for comments open for 30 days
Grant of permit	ERA issues permit to carry out feasibility study subsequent to public comment period	— Developer must have addressed public comments within 15 days of end of public comment period — Posting a performance bond and submission of implementation time plan within 14 days of license award	— 30 days subsequent to end of public comment period
Feasibility study and related activities	Subsequent to the award of feasibility permit, the developer has to carry out feasibility study and acquire all relevant permit/licenses	— Submission of quarterly progress reports to ERA — Utilization of ERA templates for reporting — PPA signature — EIA license or exemption (>0.5 MW full EIA) — Other licenses (which ones) trading, abstraction? — Signing implementation agreement with ERA — Biomass and Bagasse have different feasibility reporting templates. There is no template for solar PV.	— 18 months

STEPS		REQUIREMENTS	FEEDBACK
License application	—	— Submit Form B License Application Form — Feasibility study — Licenses/permit — Assessment of public comments — Payment of application fees (USD 3,500) — Performance bond and insurance	— Document review and notification process – 30 days — If application incomplete, review of 30 days re-starts — Processing and award of license takes 180 days from date of receipt of the application
Publication of application	Once the application has been deemed complete, ERA will publish the application for comments	—	— To be published within 45 days of receipt of the application. The public notice is run for a period of 30 days — A public hearing is held within 30 days from the end of the public notice period
Award of license	Within 180 days max starting from the day of complete application, ERA shall make decision if a generation license shall be granted	— Posting two performance bonds and submission of revised implementation plan	— Max 180 days after complete application
Construction	Once the license has been granted, the developer has to adhere to licensing requirements	— Achieve financial close within 180 days of licensing — Commence construction as per implementation plan — Report quarterly on project progress using ERA formats — Compliance with license conditions	—
Operation of power plant	Once the project is operational project has to adhere to licensing conditions	— Compliance with licensing requirements — Quarterly reporting using ERA formats	—

ANNEX E

Additional Sub-Sector Information

Dairy sector

There are 6–8 large-scale dairy processors in Uganda. Only one of these is an integrated operation with cows on site, 260 of which are zero-grazed and up to 400 more that range, with some small potential for biogas. Where cow dung is not available, biogas potential from milk processing is only from the wastewater, and is therefore lower. A typical COD in the inflow water from one factory to its lagoons was in the range of 150 mg/l, which is not high enough for commercial biogas production.

There is nevertheless solar PV potential (electricity for processing/homogenization and cooling) both at the small to medium-sized milk processors (who will be in code 10.2 or code 20) and at milk collection centres. For example, a 10,000 litre cooling tank might have a load of 40 kW. In 2009, there were over 60 milk collection centres in western Uganda although the potential power requirement of each was estimated to be much lower — 750 W representing a local market of 4.5 MW.

Dairy processors are best accessed through the Uganda Dairy Processors Association and dairy farmers through industry cooperatives.

Cattle ranches

About 165 large ranches account for about 2 percent of cattle in Uganda. These are large-scale commercial systems practicing modern animal husbandry methods. The largest ranches are up to 25,000 ha and have up to 7,000 cattle, with a capacity to increase the number of cattle substantially. The ranches are owned both by private firms and larger corporations. The Uganda Beef Producers Association is a good entry point.

Abattoirs

A large number of abattoirs are found in Uganda, but many are small-scale. There are at least three large abattoirs in Kampala and one in Soroti. Many slaughterhouse are run in a disorderedly state (e.g. insufficient animal holding areas, capacity constraints, poor hygiene) and can have very low profit margins, which may pose barriers to commercial captive power without first an investment in the business itself. For estimated waste quantities from three abattoirs, please see **Table 8** above.

Fish processing facilities

There are at least 32 fish processing factories although only a small number may be of a sufficient size for small captive power potential, with daily processing capacities of up to 50 tonnes. The factories have cooling, pumping and lighting loads. Given the significant amount and high estimated COD (12,400 mg/l) of the wastewater as per **Table 8** above, there is reasonable potential although some of the large factories may have integrated effluent treatment measures. The Uganda Fish Processors and Exporters Association is the industry body.

Sugar sector

The sugar sector in Uganda is already implemented co-generation from bagasse. However, vinasse (where available) and mud press cake/waste water are generally not yet exploited for energy production via biogas. However, from an economic perspective both biogas and PV potential are considered to be lower as the established factories are in the larger code 20 and code 30 industrial consumer tariffs.

Floriculture

Floriculture bioenergy potential depends on the organic residue type and quantities (and seasonality). For example, a producer of flower cuttings (propagating seedlings by cutting parts from adult plants) will not have as much biomass residue as a producer of cut flowers (e.g. rose exporter) because the unused portion is not uprooted and replanted. Flower farms with higher residues may also have higher disposals costs, if they are not composting on site. In addition, with biogas systems, the heat and/or CO_2 from a plant could be pumped into greenhouses, albeit with CO_2 concentration as a limiting factor. Furthermore, the digestate effluent from a biogas reactor could be used for fertilizer. However, some floriculture producers have strict requirements for inputs and digestate properties may not

be suitable. Overall, based on the flower farms assessed the bioenergy potential is considered to be low.

On the other hand, PV potential is fairly high due to cold room, lighting, water pumping, fans, misting equipment and other loads, which run during shoulder hours. Of course this depends on the tariff code. Of the 12 flower exporters, 5–6 are estimated to be code 20. They others code 30.

A good starting point to access the market is the Uganda Flower Exporters Association. There also is a GET.invest Case Study for solar PV in the floriculture sector available.

Tea factories

Tea covers an area of 21,000 ha in Uganda, with an estimated 180,000 ha of potential tea land unexploited. There are at least 22 tea companies active in Uganda and some own more than one tea factory. Annual tea production in Uganda since 2010 has been in the range of 54,000–63,000 tonnes. Between 87–95% of the tea is exported, providing foreign currency revenue. Production of tea is usually year-round, with two longer high seasons and two shorter low seasons, the latter occurring in February and one-two months in July–September.

The electrical demand at most team factories ranges between 250 kW to 1 MW. If a tea factory is in tariff code 20, solar PV potential is considered to be moderate due to continuous daily and annual loads. One of the main electrical loads is for tea withering. In Uganda, withering often takes place from the late afternoon (once the tea is picked during the day) until the early morning. Because of this, at some factories peak demand occurs in the evening. One tea factory is experimenting with drip irrigation, which could increase production by up to 20%. If irrigation were adopted more widely, electricity consumption would increase. Most of the larger tea estates are in code 30. Some in the southwest of the country are connected to a UETCL distribution network with a flat daily rate, unlike the Umeme time-of-use tariff. Where a tea factory is at the fringes of the grid, electricity is less reliable and more of the demand is met by diesel generators.

Tea bioenergy potential is low because of little biomass residues, except where **a)** there is instant tea production (which is not currently the case in Uganda) or **b)** other crops — e.g. flower, fruit or vegetables — are also farmed on site or nearby. Plantation wood is often available but already used directly for heating. Some factories have washing wastewater with organic content that is collected in ponds, but the quantities are usually quite small and COD quite low, in the range of 210 mg/l.

The Uganda Tea Association can provide access to the tea companies.

Coffee factories

Coffee factories often have both biomass and biogas potential, from the coffee fruit husks and the wet pulp after washing and processing. Up to 50% of weight of fresh coffee bean is pulp, while 45% of coffee bean dry weight is husks. Most coffee factories where the pulp is found are small-scale. Coffee pulp can also be used as an organic fertilizer, which use could conflict with energy production. Coffee is also quite seasonal, with pulping machines only in operation for 6–7 months of the year. This could limit the potential for solar PV. Where there is irrigation in the off-season, the demand might be more consistent. On the bioenergy side, there is already demand for coffee husk for direct combustion in the clay/brick making (e.g. Uganda Clays, Kajjansi Bricks) and cement (e.g. Hima Cement) sectors. In 2004, this usage was approximately 12,000 tonnes/year or an estimated 7% of available husks at the time. This has since increased dramatically.

One of Uganda's largest coffee farms produces up to 3,000 tonnes of green coffee per annum. This gives an indication of biogas potential up to 150 kW, but the owner is not currently interested.

Wood industry

The forestry and wood product industry in Uganda is characterized by many small and informal actors. There are only four larger timber companies operating in the country, two of which have integrated harvesting and milling of sawn wood and other products. There are at least 84 other companies involved in plantation growing and 45 small licensed sawmills operating inside forestry plantations, with low recovery rates. Numerous small and medium sized companies, undertaking secondary processing, trading, carpentry, furniture making, etc., are also active in the industry.

Logging residues are generated during logging operations, which usually take place in geographically sparse locations, except for at the four larger companies. The same applies to residues generated during wood processing. Only the larger operators are likely to have sufficient wood waste, electrical and thermal loads and technical and financial capacity to implement a bioenergy power plant at an economical scale. In fact, one of the four

larger wood processors is already planning to invest in bioenergy for captive power. For at least one of the others, the bioenergy potential may not be financially viable to exploit for power due to insufficient load hours. Direct heating with biomass, and possibly gasification at smaller operations (performance issues notwithstanding), may be more appropriate. At some facilities, wood residue is already used for charcoal production and briquetting, and neighbouring communities may be allowed to collect firewood from off-cuts, thereby reducing the amount of biomass available for captive power. Wood waste at the processing level was estimated at almost 190,000 tonnes in 2014 as shown in **Table 6** above.

The Uganda Timber Growers' Association is the main wood industry body.

Rice millers

In 2015 rice was planned on an area of 95,000 hectares and production reached 238,000 tonnes in Uganda. The main growing areas were in the eastern and northern regions of the country in the districts of Busia, Iganga, Pallisa, Soroti, Tororo and Amuru, with some in Hoima in the western region. There are at least three larger and 4–5 medium size millers in the country producing between 10,000–40,000 tonnes per annum. The quantity of rice husk is about 30% of the weight of the rice from the paddy according to one miller, which is higher that the estimated in **Table 7**.

Much of the rice in Uganda is de-husked and milled at the larger facilities. The potential of bioenergy from rice husks depends in part on the type of rice and there are at least 10 varieties planted in Uganda. Some of the rice husk also has other uses, which impacts on the final quantities that might be available. On the other hand, some rice millers also plan to mill other grains such as maize, which would increase waste quantities available. The main millers in Uganda operate 24/7/365 due to year-round availability of paddy rice.

At least three of the rice millers have interest or intentions to develop captive power plants, including one that might target surplus export capacity to supply the grid under the REFIT. Plant capacities could reach or exceed 1 MW, making steam turbines potentially viable. At the smaller millers, another technology or direct heating may be more suitable — there is likely to be co-generation potential for drying and other requirements.

One consideration is that all of the larger and some of the medium rice millers fall under tariff code 30. This means that a bioenergy captive plant needs to be able to deliver at a very low LCOE to be feasible, or there needs to be a significant heating component that allows for economical CHP.

The rice industry may be best reached through the Uganda Manufacturers Association. There also is a Case Study for bio-energy in the rice sector available.

Municipal waste

Municipal waste can be a difficult market segment for commercial captive power due to issues around private sector market access. Nevertheless, some solid and liquid municipal waste streams have potential for biogas, co-processing/refuse derived fuel (RDF) or landfill gas. A recent study gives an indication for biogas in Uganda at the prefeasibility level of assessment:

— Cities such as Kampala, Jinja, Mbarara and Mbale have enough market organic waste for between 400 kW and 2 MW of biogas power to be installed in each municipality. Kampala may also have enough wastewater for 1 MW.

— At Gulu market, a biogas plant of between 44–100 kWel may be feasible. There are approximately 10–15 other towns in Uganda of a similar size.

Commercial buildings and institutions

Commercial buildings such as shopping malls, office blocks, hotels and institutions such as universities have good potential for solar PV when they are code 10.2 or code 20 customers. Many are, but some also fall under large industrial code 30. Daytime power consumption in commercial and public buildings frequently has a similar profile to the solar radiation curve although for some such as hotels the peak may be more in the evening. At the same time, at many commercial properties, energy is one of the largest expense items.

Some buildings have separate tenants with individual electricity meters but others will have a single or a few shared meters for the entire premises. In both cases there are always some communal loads, e.g. for corridor and public space lighting, water pumping, etc. With multiple tenants or owners, there are different considerations to keep in mind, such as:

— Whether or not the owner of the PV system will need to apply for an electricity distribution or sale license

— If and how captive generation costs and costs savings can be shared

— If the PV plant should be sized only for communal loads or for all loads

In the main urban areas, property management companies are often responsible for a portfolio of properties and can help to identify potential projects and manage solar PV systems. There also is a GET.invest Project Case Study for solar PV on an office building in Kampala available.

Telecommunication towers

There are five mobile network operators in Uganda and a number of other telecommunication firms such as virtual network operators and tower companies. Telecommunication base transceiver stations and repeater sites (VHF, UHF and cellular) for data, video and voice communication typically require between 5–15 kW per site, as well as potentially battery storage. In 2009, there were more than 800 off-grid telecommunication masts in Uganda, of which 95% were powered by diesel gensets.

It can be assumed that while a number of masts have since been grid connected or hybridized with solar PV and wind systems, new ones have also been erected in off-grid areas. In 2012, for example, about 41% of the telecom towers in Uganda, or 1,249, were still off-grid, although many had batteries — but not renewables — integrated in with the gensets. As of early 2015, Uganda had a total of 3,400 masts, more than half of which were owned by the tower companies.

Even where the masts are supplied by grid electricity, there may still be potential for solar PV integration (with batteries), either to reduce grid costs or improve power reliability. In 2009 the market sub-segment size was estimated to be as high as 35 MW. A re-calculation with figures from 2012 comes to about the same about — 33 MW.

It should, however, be noted that the tower companies themselves are often already installing PV systems, and that the number of masts may reduce in the future due to co-tenancy. One major operator active in Uganda has recently set up a new investment company to finance telecom infrastructure including for renewable energy. Another barrier to the deployment of PV at telecom towers is the lack of secure space available at some locations.

Healthcare facilities

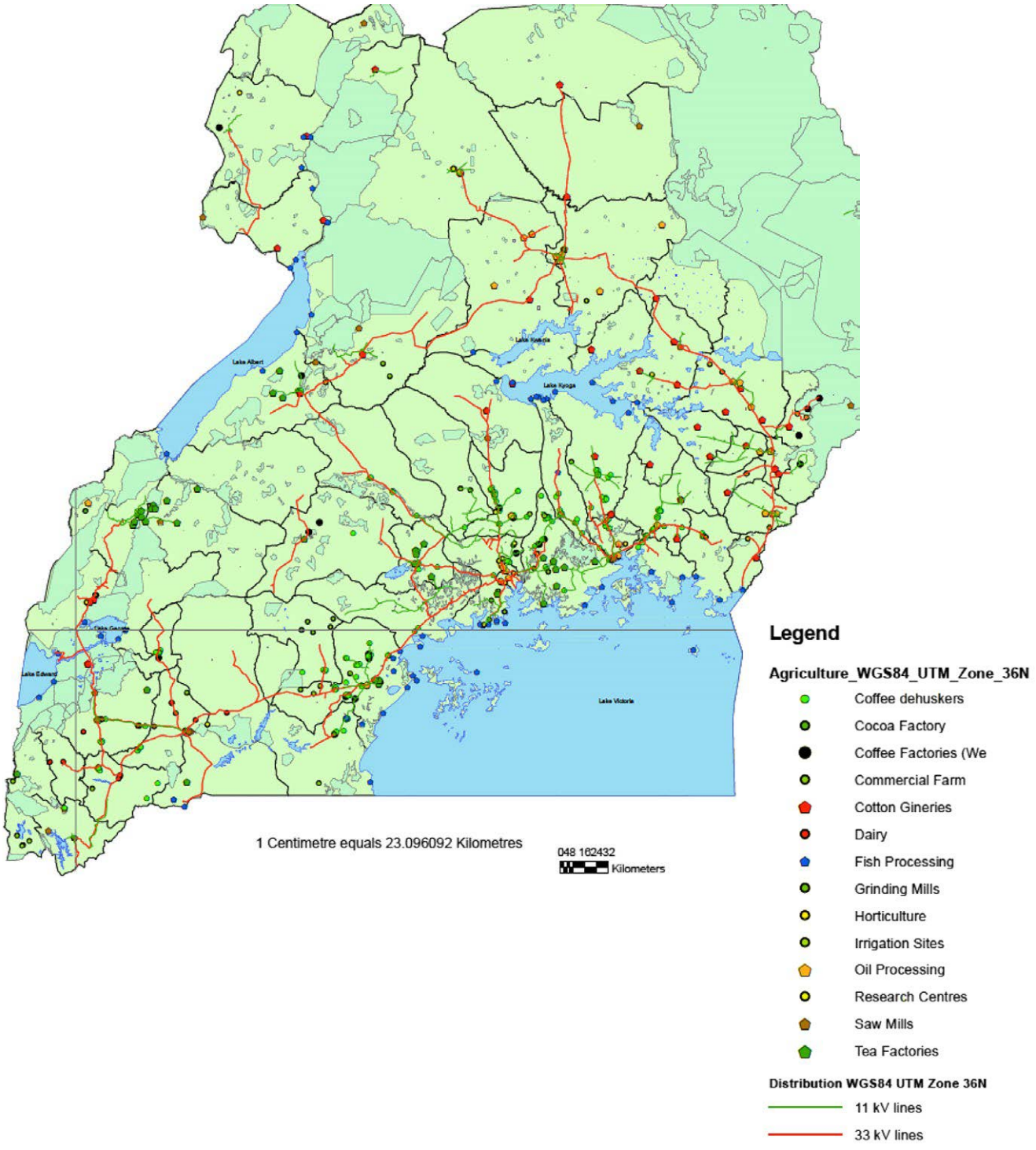
In 2013, there were 1,488 private and 874 NGO health care facilities — hospitals and health centres — in Uganda. Most are located in Kampala, but also a significant number in Wakiso, Jinja, Kabale, Kasese and Rukungiri. Health care facilities have good potential for solar PV as most — except for the very largest — are in the code 10.2 and code 20 tariff categories and also have consistent demand for power during the day and over a year. For hospitals, however, peak load often falls in the evening (17:00–22:00). With the higher demand in the peak time-of-use tariff band and since many hospitals have critical or non-interruptible equipment, the deployment of battery storage with a PV system may be economical — and essential.

For further information, there is a GET.invest Project Case Study for solar PV on a private (non-profit) hospital, to be found at www.get-invest.eu.

Location of some agro-industrial facilities in Uganda

The location of selected agro-industrial facilities as of 2008 in Uganda is given in **Figure 24**. Even though the map is not recent, it still provides a good indication of the distribution of major agri-businesses across the country.

FIGURE 24. Location of selected agro-industries in Uganda (2008)[75]



75) REA (2008) IREMP Master Plan Report, Annexure 2: Nature of Demand GIS Maps, p. 6.
Link: http://www.rea.or.ug/resources/Annex%201%20Electricity%20Infrastructure.pdf – accessed March 2019

ANNEX F

Some Captive Solar Market Players

ESCO/leasing providers

A number of solar leasing or solar ESCO-with-financing firms in the East Africa market are known or assumed to be interested in Uganda. These include SolarAfrica, Crossboundary, responsAbility, Ariya Capital, Ecoligo, Interfinance, Solarise Africa and Centennial Generation. As at the end of 2017, none of the firms had announced involvement in a project in Uganda.

Stand-alone solar system suppliers and installers

There are about 30 suppliers and installers of solar PV, solar water heating and related equipment (e.g. batteries, charger controllers) active in Uganda. These include G-Teck Energy Solutions, Davis & Shirtlff, Energy Monitoring, UltraTec (U) Ltd, Equator Solar, PowerGen EPC, Solar Point, Kirchner Solar Uganda Ltd, New Sun Limited, MAK General Services, Melville Engineering Services and Solar Energy for Africa, among others. Some focus on certain market segments — e.g. public, health and educational institutions — and others might be specialists in tender opportunities. Such companies, in particular the larger ones, have already implemented smaller (15–30 kW) captive power scale systems and may be both competitors and potential partners for new entrants in the market.

DOCUMENT REFERENCES

TABLE 19. Reference Table for **Table 1** Key Electricity Figures

Installed generation capacity (MW, 2017)	http://www.era.or.ug/index.php/usoa/10-data-statistics/12-electricity-generation-statistics — accessed May 2019
Installed fossil fuel capacity (2017), % of total installed capacity	http://www.era.or.ug/index.php/usoa/10-data-statistics/12-electricity-generation-statistics — accessed May 2019
Hydro capacity (2017), % of total installed capacity	http://www.era.or.ug/index.php/usoa/10-data-statistics/12-electricity-generation-statistics — accessed May 2019
Other renewable energy capacity (2017), % of total installed capacity	http://www.era.or.ug/index.php/usoa/10-data-statistics/12-electricity-generation-statistics — accessed May 2019
Renewable electricity output as % of total electricity output excl. hydro, 2017	http://www.era.or.ug/index.php/usoa/10-data-statistics/12-electricity-generation-statistics — accessed May 2019
Avg. distribution and transmission losses as % of output (2013)	http://www.era.or.ug/files/ANNUAL_TARIFF_REVIEW_REPORT_2016_3.pdf — last accessed August 2017, link no longer available
Net electricity imports (2014), kWh	http://www.era.or.ug/files/ANNUAL_TARIFF_REVIEW_REPORT_2016_3.pdf — last accessed August 2017, link no longer available
Electrification rate, total (2016) %	http://www.worldenergyoutlook.org/media/weowebsite/2015/WEO2016Electricity.xlsx — link accessed May 2019
Electrification rate, urban (2016) %	http://www.worldenergyoutlook.org/media/weowebsite/2015/WEO2016Electricity.xlsx — link accessed May 2019
Electrification rate, rural (2016) %	http://www.worldenergyoutlook.org/media/weowebsite/2015/WEO2016Electricity.xlsx — link accessed May 2019
Peak demand (2017), MW	http://www.era.or.ug/files/Q4_2017_Tariff_Order_Paper_for_Publication.pdf — last accessed August 2017, link no longer available
Per capita electricity consumption (kWh, year)	https://assets.kpmg.com/content/dam/kpmg/pdf/2016/05/kpmg-sub-saharan-africa-power-outlook.pdf — link accessed May 2019

TABLE 20. Customer breakdown by distribution company and tariff category (Q4 2016)[76]

DISTRIBUTOR	NUMBER OF CUSTOMERS*				
	Domestic	**Commercial**	**Medium industrial**	**Large industrial**	**Total**
		415 V 100 A	**415 V 500 kVA**	**11/33 kV >500 kVA**	
Umeme	867,671	79,746	2,564	527	950,508
Ferdsault	23,756	402	108	0	24,266
WENRECO	6,037	5,043	21	0	11,101
UEDCL	10,537	244	5	0	10,786
Kilembe Investment	10,051	155	24	0	10,230
Bundibugyo Co-op	7,057	52	0	0	7,109
Kyegegewa Co-op	2,942	60	0	0	3,002
Pader Amib Co-op	2,512	56	0	0	2,568
Kalangala Infrastructure	2,428	19	0	0	2,447
Total	**932,991**	**85,777**	**2,722**	**527**	**1,022,017**

*Notes: a) public sector customers are included in the numbers but street lighting customer numbers are not shown,
b) only Umeme distinguishes between medium and large industrial customers and c) Ferdsault and UEDCL figures are for Q2 2016

Agriterra (2012) Identification of livestock investment opportunities in Uganda, final report. Link: https://www.agriterra.org/assets/uploads/15820/Livestock%20market%20study.pdf — accessed April 2019

Alternative Energy Africa (2017) Uganda to Compensate UEGCL for Unused Karuma Production, 15 May 2017. Link: http://www.ae-africa.com/read_article.php?NID=8212 — accessed April 2019

Bjergegaard, Rasmus (2015) Rural Electrification of Uganda — A Technological and Least-cost Feasibility Study. Master Thesis, Sustainable Energy Planning and Management, Aalborg University. Link: http://projekter.aau.dk/projekter/files/217025764/Report.pdf – accessed April 2019

Bingh, Lars Petter (2004) Opportunities for Utilizing Waste Biomass for Energy in Uganda, Master Thesis, Norwegian University of Science and Technology. Link: https://brage.bibsys.no/xmlui/handle/11250/242609 — accessed April 2019

Bloomberg New Energy Finance (2017) Findings Overview, New Energy Outlook 2017. Link: https://about.bnef.com/new-energy-outlook/#toc-download — accessed April 2019

CAMUSAT (2017) CAMUSAT website. Link: http://camusat.com/aktivco/aktivco-1/ — accessed April 2019

Center for Climate and Energy Solutions (2016) Co-Generation/Combined Heat and Power, Climate Techbook. Link: https://unisonenergy.com/app/uploads/2014/09/C2ES-Cogeneration-CHP.pdf — accessed April 2019

76) Author derived from Electricity Regulatory Authority (2017), ERA Distribution Statistics Q4 2016. Link: http://www.era.or.ug/index.php/statistics-tariffs/2013-11-27-16-54-30/distribution-statistics – last accessed March 2019, link no longer available

Central Intelligence Agency (2017) Uganda, Africa, The World Fact Book. Link: https://www.cia.gov/library/publications/the-world-factbook/geos/ug.html — accessed April 2019

Christensen, Stephen (2012) Comparing the Sustainability of Biomass Fuel Supply Options for a Small Scale Gasification Project in Rural Uganda, Master of Science Thesis in the Innovative and Sustainable Energy Engineering (ISEE) Nordic Master Degree Programme, 2010-2012, Chalmers University of Technology. Link: http://publications.lib.chalmers.se/records/fulltext/175513/175513.pdf — accessed April 2019

City Population (2017) Major Cities, Republic of Uganda. Link: http://citypopulation.de/Uganda-Cities.html?cityid=1760 — accessed April 2019

ClimaTemps (2014) Sunshine and Daylight Hours in Entebbe, Uganda. Link: http://www.uganda.climatemps.com/sunlight.php — accessed April 2019

Climatescope (2016) Uganda. Link: http://global-climatescope.org/results/ug — accessed April 2019

Commonwealth Development Corporation (2016) What is the Link Between Power and Jobs in Uganda? Final Report by Steward Redqueen. Link: https://assets.cdcgroup.com/wp-content/uploads/2016/11/25150848/Link-between-power-and-jobs-in-Uganda.pdf — accessed April 2019

Daily Monitor (2017) "The Electricity Regulatory Authority — Steering the Unbundled Electricity Supply Industry to Efficiency" in Power Sector – Impact of Unbundling Special Report, Daily Monitor, 5 May 2017

Davis & Shirtliff (2017) May/June 2014 D&S Uganda Solar Pump Installation, Davis & Shirtliff website. Link: https://www.davisandshirtliff.com/solar-installations/105-may-june-2014-d-s-uganda-solar-pump-installation — accessed April 2019

de la Rue du Can, Stephane; Pudleiner, David; Jones, David and Aleisha Khan (2017) Energy Efficiency Road Map for Uganda: Making Energy Efficiency Count. Lawrence Berkeley National Laboratory, MEMD, SE4All, Power Africa. Link: https://ies.lbl.gov/publications/energy-efficiency-roadmap-uganda — accessed April 2019

Deloitte (2015) Uganda Budget Highlights and Quick Tax Guide 2015 – Diving deep. Link: https://www2.deloitte.com/content/dam/Deloitte/ug/Documents/tax/Tax_Budget%20highlights%202015_UG.PDF — accessed April 2019

Deutsche Gesellschaft für Technische Zusammenarbeit (2009) Uganda's Bioenergy Market: Target Market Analysis. Link: https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-bioenergy-uganda.pdf — accessed April 2019

Deutsche Gesellschaft für Technische Zusammenarbeit (2009) Uganda's Small-Hydro Energy Market: Target Market Analysis. Link: https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-hydro-uganda.pdf — accessed April 2019

Deutsche Gesellschaft für Technische Zusammenarbeit (2009) Uganda's Solar Energy Market — Target Market Analysis. Link: https://www.giz.de/fachexpertise/downloads/gtz2009-en-targetmarketanalysis-solar-uganda.pdf — accessed April 2019

Deutsche Gesellschaft für Technische Zusammenarbeit (2010) Agro-industrial Biogas in Kenya: Potentials, Estimates for Tariffs, Policy and Business Recommendations. Link: http://kerea.org/wp-content/uploads/2012/12/Agro-Industrial-Biogas-in-Kenya.pdf — accessed April 2019

Eberhard, Anton, Katharine Gratwick, Elvira Morella and Pedro Antmann (2016) Independent Power Projects in Sub-Saharan Africa: Lessons from Five Key Countries. Directions in Development. Washington, DC, World Bank. Link: https://openknowledge.worldbank.org/handle/10986/23970 — accessed April 2019

Electricity Regulatory Authority (2006) A Study on the Impact of the Electricity Sector on the Industrial Sector, Final Report

Electricity Regulatory Authority (2015) Statement on the Electricity End-User Tariffs for the Year 2015. Link: http://www.era.or.ug/index.php/2013-12-14-14-58-04/guidelines/doc_download/202-statement-on-the-electricity-end-user-tariffs-for-the-year-2015 — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2016) ERA Annual Report 2015-2016. Link: http://www.era.or.ug/index.php/newsletters/doc_download/450-era-annual-report-2015-16 — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2016) ERA Tariff Review Report for 2016. Link: http://www.era.or.ug/files/ANNUAL_TARIFF_REVIEW_REPORT_2016_3.pdf — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2016) The Least Cost Generation Plan 2016–2025. Link: http://www.era.or.ug/index.php/newsletters/doc_download/437-the-least-cost-generation-plan-2016-2025 — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2016) Uganda Renewable Energy Feed-in Tariff (REFIT) Phase 3 Guidelines. Link: http://www.era.or.ug/index.php/2013-12-14-14-58-04/guidelines/doc_download/383-uganda-renewable-energy-feed-in-tariff-phase-3-guidelines-2016

Electricity Regulatory Authority (2017) Directive No ERA/002/2017 Interconnection Code and Standard Wheeling Agreements. Link: https://www.getfit-uganda.org/app/download/29325656/Uganda-REFIT-Guidelines-Phase+3-2016.pdf — accessed April 2019

Electricity Regulatory Authority (2017) ERA Determination of Tariff Adjustment Factors for the Third Quarter of 2017. Link: http://www.era.or.ug/files/Tariff_Order_Paper_for_the_Third_Quarter_of_2017.pdf — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2017) ERA Determination of Tariff Adjustment Factors for the Fourth Quarter of 2017. Link: https://www.era.or.ug/index.php/tariffs/tariff-reviews — accessed April 2019

Electricity Regulatory Authority (2017) ERA Distribution Statistics Q4 2016. Link: https://www.era.or.ug/index.php/stats# — accessed April 2019

Electricity Regulatory Authority (2017) ERA Generation Statistics website. Link: https://www.era.or.ug/index.php/stats# — accessed April 2019

Electricity Regulatory Authority (2017) Government to Enact Law on Energy Efficiency and Conservation, ERA website, 12 September 2017. Link: http://www.era.or.ug/index.php/2013-10-23-18-03-21/2013-10-23-18-12-48/latest-news/696-government-to-enact-a-law-on-energy-efficiency-and-energy-conservation — last accessed August 2017, link no longer available

Electricity Regulatory Authority (2017) Second Grid-Connected Solar Plant in Uganda Commissioned, ERA website. Link: http://www.era.or.ug/index.php/2013-10-23-18-03-21/2013-10-23-18-12-48/latest-news/709-second-grid-connected-solar-plant-in-uganda-commissioned — last accessed August 2017, link no longer available

Energy and Environment Partnership (2017) Renewable Energy Market Landscape Study Covering 15 Countries in Southern and East Africa, Volume II: Country Profiles Stakeholder Maps. Link: http://eepafrica.org/renewable-energy-market-landscape-study-highlights-the-unique-value-and-need-of-eeps-flexible-early-stage-funding-in-southern-and-east-africa/ — last accessed August 2017, link no longer available

Energy Sector GIS Working Group Uganda (2017) Uganda Energy Utilities 2016. Link: http://www.energy-gis.ug/gis-maps/ — last accessed September 2017, link no longer available

Ernst & Young (2017) EY Global Tax Alert — Uganda Issues Tax Amendment Bills 2017. Link: http://www.ey.com/gl/en/services/tax/international-tax/alert--uganda-issues-tax-amendment-bills-2017 — accessed April 2019

Foster, Vivian and Jevgenijs Steinbuks (2009) Paying the Price for Unreliable Power Supplies: In-house Generation of Electricity by Private Firms in Africa, World Bank. Link: https://openknowledge.worldbank.org/handle/10986/4116 — accessed April 2019

Frost & Sullivan (2015) Electricity Supply Shortfall Drives Diesel Genset Market in Kenya, Uganda and Tanzania, 25 March 2015 press release. Link: https://ww2.frost.com/news/press-releases/electricity-supply-shortfall-drives-diesel-genset-market-kenya-uganda-and-tanzania-finds-frost-sullivan/ — accessed April 2019

Fusion Media Limited (2017) Historic Exchange Rate Data for UGX/EUR and UGX/USD. Link: https://www.investing.com — accessed April 2019

Greacen, Chris (2014) Mini-grid systems on the Rise in Tanzania: Status of Implementation and Regulatory Framework Conditions, GIZ Mini-grid Workshop Oresentation, 19 March 2014, Berlin. Link: https://www.giz.de/fachexpertise/downloads/2014-en-greacen-pep-fachworkshop-mini-grids.pdf — accessed April 2019

Groupe Speciale Mobile Association (2010) MTN Uganda — Feasibility Study. Green Power for Mobile. Link: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/07/MTN-Uganda-Feasibility-Study.pdf — accessed April 2019

Groupe Speciale Mobile Association (2012) Powering Telecoms: East Africa Market Analysis — Sizing the Potential for Green Telecoms in Kenya, Tanzania and Uganda, GSMA. Link: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2012/10/GPM-Market-Analysis-East-Africa-v3.pdf — accessed April 2019

G-Teck (2017) Solar Hybrid Projects, G-Teck website. Link: http://www.g-teck.com/source/projects.php — accessed April 2019

International Finance Corporation (2014) Harnessing Energy from the Sun: Empowering Rooftop Owners. White Paper on Grid-Connected Rooftop Solar Photovoltaic Development Models. Link: http://www.ifc.org/wps/wcm/connect/8bb2a280479cb-7248b0fff299ede9589/Harnessing+Energy+From+The+Sun_Final.pdf?MOD=AJPERES — accessed April 2019

International Renewable Energy Agency (2015) Battery Storage for Renewables: Market Status and Technology Outlook. Link: https://www.irena.org/documentdownloads/publications/irena_battery_storage_report_2015.pdf — accessed April 2019

International Renewable Energy Agency (2016) Solar PV in Africa: Costs and Markets. Link: https://www.irena.org/DocumentDownloads/Publications/IRENA_Solar_PV_Costs_Africa_2016.pdf — accessed April 2019

International Renewable Energy Agency (2016) The Power to Change: Solar and Wind Cost Potential to 2025. Link: http://www.irena.org/DocumentDownloads/Publications/IRENA_Power_to_Change_2016.pdf — accessed April 2019

Kaboggoza, John (2011) Forest Plantations and Woodlots in Uganda. Link: http://www.sifi.se/wp-content/uploads/2012/02/Forest-plantations-and-woodlots-in-Uganda.pdf — accessed April 2019

Kalema, Solomon (2016) Latest Fuel Prices, The New Vision, 28 June 2016. Link: https://www.newvision.co.ug/new_vision/news/1428020/fuel-prices — last accessed August 2017, link no longer available

Kamau, George (2017) "Uganda: Now Bujagali Seeking U.S.$500 Million in Fresh Debt," The East African, 5 October 2017. Link: http://allafrica.com/stories/201710050463.html — accessed April 2019

Keatley, Patrick (2003) Obituary: Idi Amin, The Guardian, 18 August 2003. Link: https://www.theguardian.com/news/2003/aug/18/guardianobituaries — accessed April 2019

Komakech, Daniel (2017) Bosco Uganda Launched a 30 kW Solar Power in Gulu, Uganda, 23 March 2017, Bosco Uganda website. Link: http://boscouganda.com/bosco-uganda-launched-a-30-kilowatts-solar-power-in-gulu-uganda/ — accessed April 2019

KPMG (2016) Sub-Saharan Africa Power Outlook 2016. https://assets.kpmg.com/content/dam/kpmg/pdf/2016/05/kpmg-sub-saharan-africa-power-outlook.pdf — accessed April 2019

Kreditanstalt für Wiederaufbau (2016) Analysis of Lessons Learned in Biogas Projects in Uganda and Selected Other Developing Countries: Overview Study. Prepared by GOPA International Energy Consultants for KfW

Kyongera, Denis (2015) Mapping Private Sector Investments and Their Impacts on Great Apes Habitats in Uganda's Albertine Rift Region. Link: http://pubs.iied.org/pdfs/G03910.pdf — accessed April 2019

Masera, D and A Faaij (2014) Renewable Energy for Inclusive and Sustainable Development: the Case of Biomass Gasification. UNIDO. Link: https://www.unido.org/fileadmin/user_media_upgrade/What_we_do/Topics/Energy_access/Gasification_FINAL.pdf — accessed April 2019

Miito, Gilbert John and Noble Banadda (2017) A short review on the potential of coffee husk gasification for sustainable energy in Uganda. F1000Research, 6:1809. Link: https://f1000research.com/articles/6-1809/v1 — accessed April 2019

Ministry of Energy and Mineral Development (2014) 2014 Statistical Abstract. Link: http://www.energyandminerals.go.ug/downloads/2014StatisticalAbstract.pdf — last accessed August 2017, link no longer available

Ministry of Energy and Mineral Development (2015) Biomass Energy Strategy (BEST) Uganda. Link: http://www.undp.org/content/dam/uganda/docs/UNDPUg2014%20-%20Biomass%20BEST%20Strategy(compressed).pdf — accessed April 2019

Ministry of Energy and Mineral Development (2015) Uganda's Sustainable Energy for All (SE4All) Initiative Action Agenda. Link: https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/Uganda_AA_EN_Released.pdf — accessed April 2019

Ministry of Energy and Mineral Development (2016) SE4ALL Investment Prospectus for Uganda: Final Report for Distribution — private and confidential, EU Technical Assistance Facility for the "Sustainable Energy for All" Initiative (SE4ALL) — Eastern and Southern Africa

Ministry of Energy and Mineral Development (2017) Consultancy Services for Review of the Power Sector Reforms in Uganda

Ministry of Water & Environment (2013) Proposal for Nationally Appropriate Mitigation Action (NAMA) Seeking Support for Implementation: Integrated Bio-Wastewater Treatment for Agro-Process Wastewater. Link: http://www.lowemissiondevelopment.org/lecbp/docs/countries/Uganda/Uganda_NAMA_Integrated_Wastewater_Treatment.pdf — accessed April 2019

Ministry of Water and Environment (2016) State of Uganda's Forestry 2016. Link: http://www.mwe.go.ug/sites/default/files/State%20of%20Uganda%27s%20Forestry-2015.pdf — accessed April 2019

Ministry of Water, Lands and Environment (2002) National Biomass Study, Technical Report

Murphy, Mark Patrick, Twaha, Ssennoga and Ines S. Murphy (2014) Analysis of the Cost of Reliable Electricity: A new Method for Analyzing Grid Connected Solar, Diesel and Hybrid Distributed Electricity Systems Considering an Unreliable Electric Grid, with Examples in Uganda. Energy 66: 523-534. Link: http://dx.doi.org/10.1016/j.energy.2014.01.020 — accessed April 2019

Nabanyuma, Robert (2017) Forest Plantations Industry in Uganda and the Role of Small Growers. Link: http://newforests-forafrica.org/wp-content/uploads/2017/06/Short-Paper-Robert-Nabanyumya-AFIC-Ghana-June-2017.pdf — accessed April 2019

National Aeronautics and Space Administration (2008) Surface Meteorology and Solar Energy (SSE) Release 6.0 Data Set, January 2008. Link: https://eosweb.larc.nasa.gov/sse/ — last accessed August 2017, link no longer available

National Forest Authority (2016) National Forestry Authority Business Plan 2016/2017 — 2020/2021. Link: http://www.nfa.org.ug/images/NFA_Business_Plan_%202016.pdf — accessed April 2019

National Renewable Energy Laboratory (2017), SWERA Beta, GHI NREL Moderate Resolution. Link: https://openei.org/wiki/Solar_and_Wind_Energy_Resource_Assessment_(SWERA)#/?aL=0bbQfG%255Bv%255D%3Dt&bL=groad&cE=0&lR=0&mC=0.7745125438579877%2C33.134765625&zL=7 — accessed April 2019

Nations Encyclopedia (2017) Uganda. Link: http://www.nationsencyclopedia.com/Africa/Uganda.html — accessed April 2019

Nations Online Project (2017) Political Map of Uganda. Link: http://www.nationsonline.org/oneworld/map/uganda-map.htm — accessed April 2019

Okello, Collins (2014) Assessing Sustainability of Bioenergy Systems in Developing Countries: Methodological Development and Application. DPhil Thesis, University of Naples Federico II. Link: http://www.fedoa.unina.it/10041/1/C_Okello_2014.pdf

Okoboi G, & Mawejje J (2016) Electricity Peak Demand in Uganda: Insights and Foresight. J. Energ Sustain Soc (2016) 6. Link: https://doi.org/10.1186/s13705-016-0094-8 — accessed April 2019

Okoboi G, Mawejje J (2016) The Impact of Adoption of Power Factor Correction Technology on Electricity Peak Demand in Uganda. J Econ Struct 5(1). Link: https://link.springer.com/article/10.1186/s40008-015-0034-3 — accessed April 2019

Okuja, Joseph (2017) Domestic Tax Laws of Uganda, 23/06/2017. Link: https://www.ura.go.ug/Resources/webuploads/GNRART/DTLaws_2017_Edition.pdf — accessed April 2019

Olupot, PW, Candia A, Menya E and R Walozi (2016) Characterization of Rice Husk Varieties in Uganda for Biofuels and Their Techno-economic Feasibility in Gasification. Chemical Engineering Research and Design Volume 107: 63-72. Link: https://doi.org/10.1016/j.cherd.2015.11.010 — accessed April 2019

Owiny, Tobbias Jolly (2017) "Government to Reduce Power Tariffs After Karuma Starts Working," The Monitor, 2 November 2017. Link: http://allafrica.com/stories/201711020122.html — accessed April 2019

Powering Agriculture (2016) Powering Agriculture — Sustainable Energy for Food, Massive Open Online Course, Course Reader. Link: https://poweringag.org/sites/default/files/170202_PA_MOOC_Reader.pdf — accessed April 2019

Renewable Energy and Energy Efficiency Partnership (2016) REEEP Switch Africa Green Sustainable Energy Consumption and Production (SECP) in Agriculture and Integrated Waste Management: Research and Training. UNEP, UNDP and UNOPS. Link: https://www.reeep.org/sites/default/files/4470%20SWITCH%20AFRICA%20%20SANEDI%20REEEP%20RESEARCH%20REPORT%20FINAL%202016.pdf — accessed April 2019

Powering Agriculture (2017) Ecoligo Launches New Solar Project on Crowdinvesting Platform. Link: https://poweringag.org/news-events/news/ecoligo-launches-new-solar-project-crowdinvesting-platform — accessed April 2019

Renewable Energy Cooperation Programme (2014) Assessment of a Net Metering Programme in Kenya — Volume I: Main Report. Link: https://renewableenergy.go.ke/asset_upld/files/Net%20Metering%20Assessment%20Report%20Volume%201.pdf — accessed April 2019

Renewable Energy Cooperation Programme (2016) Scoping Mission Report Uganda, 14–18 March 2016 (draft)

Renewable Energy Cooperation Programme (2017) Variable Renewable Energy Integration in Uganda: Understanding the Technical and Economic Impacts, Kampala workshop presentation, 9–10 August 2017

Rural Electrification Agency (2008) IREMP Master Plan Report, Annexure 2: Nature of Demand GIS Maps. Link: http://www.rea.or.ug/resources/Annex%201%20Electricity%20Infrastructure.pdf — last accessed August 2017, link no longer available

Rural Electrification Agency (2013) Rural Electrification Strategy and Plan 2013–2022. Link: http://www.rea.or.ug/resources/strategy%20and%20plan%202013-2022.pdf — accessed April 2019

Salman, Zafar (2015) BioEnergy Consult website, Biomass Resources from Rice Industry, 25 November 2015, https://www.bioenergyconsult.com/tag/rice-husk/ — accessed April 2019

SMA Sunny Portal (2017) Publicly Available PV System list, Uganda country page, SMA website. Link: https://www.sunny-portal.com/Templates/PublicPagesPlantList.aspx — accessed April 2019

SolarGIS (2013) Global Horizontal Irradiation Uganda. Link: http://solargis.com/products/maps-and-gis-data/free/download/uganda — last accessed August 2017, link no longer available

Subhes C. Bhattacharyya (2014) Viability of Off-grid Electricity Supply Using Rice Husk: A case Study From South Asia. Biomass and Bioenergy 68: 44-54. Link: https://www.sciencedirect.com/science/article/pii/S0961953414003043 — accessed April 2019

Sustainable Use of Natural Resources and Energy Finance (2017) 1st Beneficiary of SUNREF in Uganda: Financing Biomass Boilers, SUNREF website, 15 August 2017. Link: https://www.sunref.org/en/une-chaudiere-a-biomasse-pour-le-premier-financement-de-sunref-en-ouganda/ — accessed April 2019

Synergy Enviro Engineers (2017) Solar Photovoltaic Systems. Link: http://www.synergyenviron.com/resources/solar-photovoltaic-systems — accessed April 2019

The Republic of Uganda (2007), The Renewable Energy Policy for Uganda. Link: https://eaenet.org/wp-content/uploads/2017/02/The-Renewable-Energy-Policy-for-Uganda-2007-2017.pdf — accessed April 2019

The Republic of Uganda (2015) Scaling-Up Renewable Energy Program Investment Plan. Link: https://www.climateinvestmentfunds.org/country/uganda — accessed April 2019

The Republic of Uganda (2016) Electricity Wheeling Agreement Between Uganda Electricity Transmission Company Limited and DISCO and the Company. Link: http://www.uetcl.com/images/electricity%20wheeling%20agreement.pdf — accessed April 2019

Trading Economics (2017) Uganda Inflation Rate, 1 January 2013–29 September 2017. Link: https://tradingeconomics.com/uganda/inflation-cpi — accessed April 2019

Twaha S, Ramli MA, Murphy PM, Mukhtiar MU, Nsamba HK (2016) Renewable Based Distributed Generation in Uganda: Resource Potential and Status of Exploitation. Renewable and Sustainable Energy Reviews 57. Link: http://www.sciencedirect.com/science/article/pii/S1364032115015348 — accessed April 2019

Uganda Bureau of Statistics (2011) Report on the Census of Business Establishments, 2010/2011. Link: http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/2010%20COBE%20Report.pdf — accessed April 2019

Uganda Bureau of Statistics (2016) 2016 Statistical Abstract. Link: http://www.ubos.org/onlinefiles/uploads/ubos/statistical_abstracts/2016%20Statistical%20Abstract.pdf — accessed April 2019

Uganda Bureau of Statistics (2017) Table 1: Summary Statistics, Annual GDP Financial Year 2016–2017 (Revised), UBOS Indicators, Macro-Economic Statistics webpage. Link: http://www.ubos.org/onlinefiles/uploads/ubos/GDP/2017/updated/AGDP2016_17.xls — accessed April 2019

Uganda Bureau of Statistics (2017) UBOS Business & Industry Statistics, Agriculture webpage. Link: https://www.ubos.org/ — accessed April 2019

Uganda Communications Comission (2015) Cell Site Passive Infrastructure Market Assessment. Link: http://www.ucc.co.ug/files/downloads/SMP_Report_Cell_Site_Passive_Infrastructure_April%202015.pdf — accessed April 2019

Uganda Development Corporation (2017) Equipment for Two New Tea Processing Factories in Kisoro and Kabale, 6 March 2017, UDC website. Link: http://www.udc.go.ug/index.php/projects-under-udc/equipment-for-two-new-tea-factories — last accessed October 2017, link no longer available

Uganda Electricity Transmission Company Limited (2015) Grid Development Plan 2015–2030. Link: http://www.uetcl.com/images/uetcl%20grid%20plan%202015-%202030.pdf — accessed April 2019

Uganda Investment Authority (2017) Start a Business. Link: https://www.ebiz.go.ug/starting-a-business-in-uganda-as-a-foreign-investor/?f=foreign — accessed April 2019

Uganda Manufacturers Association (2017) UMA website (undated), UMA Engages Bujagali Energy Ltd, IPS On Electricity Tariffs. Link: https://uma.or.ug/index.php?option=com_k2&view=item&id=52:tax-amendment-acts-2014-15 — accessed April 2019

Uganda Registration Services Bureau (2017) Business Registration. Link: http://ursb.go.ug/services/business-registration/ — accessed April 2019

Uganda Tea Association (2017) UTA website. Link: http://www.ugatea.com/ — accessed April 2019

United Nations Economic Commission for Africa (2015) Uganda Country Profile 2015. Link: https://www.uneca.org/sites/default/files/images/ORIA/CP/uganda.pdf — accessed April 2019

United Nations (2017) Total Population Dataset, World Population Prospects 2017, UN Department of Economic and Social Affairs, Population Division. Link: https://esa.un.org/unpd/wpp/DataQuery/ — accessed April 2019

Wambi, Michael (2016) Biomass Could Help Power Africa's Energy Transition, Inter Press Service News Agency, 11 May 2016. Link: http://www.ipsnews.net/2016/05/biomass-could-help-power-africas-energy-transition/ — accessed April 2019

Wesonga, Nelson (2017) "Government Takes Over Power Distribution in 7 Districts," The Monitor, 7 March 2017. Link: https://allafrica.com/stories/201703070052.html — accessed April 2019

Wilson, Christopher (2009) Biogas, general presentation, 14 July 2009, Nairobi

Womakuyu, Frederick (2012) Uganda's Environmental Impact Assessment Process Under Fire, 13 September 2012, Oil in Uganda website. Link: http://www.oilinuganda.org/features/environment/ugandas-environmental-impact-assessment-process-under-fire.html — accessed April 2019

World Bank (2014) Enterprise Surveys Uganda 2013–2014. Link: http://www.enterprisesurveys.org/data/exploreeconomies/2013/uganda#infrastructure — accessed April 2019

World Bank (2016) Uganda Poverty Assessment 2016: Fact Sheet. Link: http://www.worldbank.org/en/country/uganda/brief/uganda-poverty-assessment-2016-fact-sheet — accessed April 2019

World Bank (2017) Commodity Markets Outlook October 2017. Link: http://pubdocs.worldbank.org/en/743431507927822505/CMO-October-2017-Full-Report.pdf — accessed April 2019

World Bank (2017) Monthly Prices, Commodity Markets Data. Link: http://www.worldbank.org/en/research/commodity-markets — accessed April 2019

World Bank (2017) Uganda Climate Historical Records, Climate Change Knowledge Portal. Link: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=UGA — accessed April 2019

World Bank (2017) Uganda Country Overview. Link: http://www.worldbank.org/en/country/uganda/overview — accessed April 2019

World Bank (2017) World Bank Open Data. Link: https://data.worldbank.org — accessed April 2019

World Economic Forum (2017) Uganda Country Profile, Global Competitiveness Index 2017–2018, Key Indicators 2016. Link: http://reports.weforum.org/global-competitiveness-index-2017-2018/countryeconomy-profiles/#economy=UGA — accessed April 2019

World Wide Fund for Nature (2015) Energy Report for Uganda: A 100% Renewable Energy Future by 2050, WWF Uganda Country Office. Link: http://www.ivl.se/download/18.4b1c947d15125e72dda353e/1452527987219/C144.pdf — accessed April 2019

Wurtenberger, L; Bleyl, JW; Menkveld, M, Vethman, P and X van Tilburg (2012) Business models for renewable energy in the built environment. IEA — Renewable Energy Technology Deployment, Link: http://iea-retd.org/wp-content/uploads/2012/04/RE-BIZZ-final-report.pdf — accessed April 2019

CONTACT

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