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Report

Captive Solar PV Market

Insights from Uganda

Preface

UNEP Copenhagen Climate Centre, with support from Denmark's development cooperation is implementing the 3-year Technology, Markets and Investment for Low Carbon and Climate Resilient Development (TEMARIN) project in Kenya and Uganda. The project aims to: 1) analyze successful case studies of market-led interventions and mechanisms in Kenya and identify key learnings; 2) support technology transfer partnerships in a select climate mitigation and adaptation technology in Uganda; and 3) understand how local PV companies can increase their share of the global value chain - and support them in doing so by co-creating outcomes and recommendations.

This report contributes to the first project aim, as its objective is to undertake a detailed analysis of the captive solar PV market in Uganda. This report on Uganda is a supplement to a similar one in Kenya published in 2020, as part of the TEMARIN project. This report provides an analysis of the market mechanisms of technology diffusion, the key drivers and determining factors, which lead to this uptake of captive solar PV in Uganda, and shares lessons and recommendations. This case illustrates how the captive solar segment has evolved, through which actors and supporting factors, and by what means in terms of support structures, enabling environment and policy incentives. The idea is to provide rich empirical insights into the mechanisms of technology diffusion, market creation, and investment opportunities for climate technologies, and to identify some of the current barriers for further market expansion.

In Uganda, UNEP Copenhagen Climate Centre is working with Finding XY and an independent consultant to support the implementation of the project.

Acknowledgements

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Executive summary

The captive solar market in Uganda is nascent but gaining traction with an estimated **89 captive PV systems installed and commissioned in commercial and industrial sectors between 2013 and 2021 generating 3.454 MW**. Nearly 69% of the captive solar systems identified are grid-tied, with or without battery storage. Battery storage in this case is used as a back-up for critical loads such as in emergency units in the health centres. The remaining 31% are off grid with battery storage and are used in areas with intermittent electricity access or without access to grid electricity. Out of the 89 projects in this study, 54 (61%) are financed via a rent-to-own model, 34 (38%) of the projects are financed via direct purchase, and one project (1%) uses a power purchase agreement.

Commercial captive PV systems account for 90% while industrial PV systems account for only 10% of the installations in Uganda. In terms of capacity, the average size of industrial solar segment is higher than the commercial solar segment. The average installed capacity for a captive PV project within the industrial segment is 66 kWp and within the commercial segment is 36 kWp. Key customers in the commercial segment include public institutions, agricultural facilities, fuel stations, flower farms, hotels, and office buildings. The industrial segment mainly includes agro-processing plants (coffee processing, dairy processing, and food processing).

There is a growing interest from commercial and industrial (C&I) businesses and investors alike in this market. **Consumers are interested in captive PV for three key reasons: i) the unreliable power supply, ii) high grid tariff/cost of electricity and iii) expensive diesel generator costs**. Captive solar PV offers a 20-30% lower price compared to the grid tariff (reported in our interviews). The average electricity tariffs for C&I between 2017-21 were ~$0.18 for commercial, ~$0.16 for medium industrial, and $0.10 for large industrial customers, respectively (ERA, 2021).

Comparing this against the levelized cost range of $0.12 – 0.14/kWh for captive solar power[1] shows that **commercial and medium industrial customers are the most likely prime beneficiaries for captive PV** based on the tariff alone. For other consumers, CO_2 emission reduction is a driver, when used to brand products as eco-friendly. In addition to the unreliable electricity and high tariffs, an easier and inexpensive licensing process for PV plants of capacity below 0.5 MW, and tax exemptions on solar products/components also make this an attractive investment.

There is a **need for scaling-up investments in the captive solar PV market segment**. Financing has been mainly provided by impact investors and crowd funding investors with limited involvement of local commercial banks. The financial institutions (FIs) interviewed expressed an overall interest in lending to this market segment but cited the lack of a clear government strategy for clean energy, competing financial resources and returns, as some of the main constraints to increased lending. Other challenges include inconsistent application of tax exemptions on solar products, and limited technical and management skills (impacting the quality and efficiency of installations) in Uganda.

Despite challenges, there is an increasing interest among stakeholders towards development of captive power projects in Uganda. The captive solar PV market segment has the potential to contribute to Uganda's overall energy system by providing critical ancillary services to the grid in the form of grid balancing and stability while providing C&I customers with power reliability and potential savings. However, for the market to grow, the policy and regulatory frameworks should be further tailored to the needs in the sector. The electricity market should be opened to prosumers, net metering guidelines (currently under development) should be implemented, and minimum standards for energy efficiency should be set for industries to make way for sustainable industrialization as well as improved productivity.

1 United Nations Environment Programme and Frankfurt School UNEP Collaborating Centre (2020). Clean captive installations for industrial clients in sub Sahara Africa – Kenya Country Study. UNEP, Nairobi, and FS UNEP, Frankfurt.

1. Introduction

Energy and electricity are key determinants of economic development, and a critical enabler of growth for sectors such as agriculture, industry, education, and healthcare. In Sub-Saharan Africa (SSA), with increasing urbanization and industrialization, there is a growing demand for energy. Limited electricity access and reliability continues to be a barrier to economic development in developing economies. This has direct negative implications for the productive sectors of the economy such as manufacturing, commercial, and hospitality. In Uganda, electricity is generated primarily via hydropower (80%), followed by thermal power, namely diesel generators (8%), bagasse/cogeneration (8%) and solar PV (4%)[2]. In addition to grid electrification, the decentralized sources of electricity include mini-grid solar and hydropower, and off-grid solar PV. Despite significant efforts, the electrification rate is still at only 50%, with grid connections at 24% and off-grid access at 26% in 2019[3].

Furthermore, 29% of industrial and commercial enterprises and 49% of manufacturing enterprises do not have access to electricity[4]. Although power is available in Uganda, many enterprises have electricity constraints due to limited transmission and distribution infrastructure, high tariffs and grid connection fees, unreliable supply, and uncoordinated intra- and inter-sectoral planning[5]. As a result, some business and commercial entities are opting for captive generation through solar PV to complement the grid, switch from diesel generation, or install a full off-grid solution with battery storage. This is particularly witnessed among facilities that are high energy consuming across Sub-Saharan Africa[6]. And as reported, this has led to increased electricity reliability, reduced electricity bills, and reduced carbon emissions.

Captive power typically refers to self-generation of electricity on site by larger commercial, industrial, or institutional facilities[7]. According to UNEP (2020), "*captive energy installations are electricity generation facilities that are used and managed by a commercial or industrialenergy user for their own energy consumption*".

Captive PV unit capacity sizes in the region range from 10 kW to a 2 MW. Captive power is also referred to in the following synonymous ways - as 'embedded generation', 'distributed generation', 'rooftop solar PV', 'on-site power', and 'grid-tied power'.[8]

The captive generation through solar PV is an emerging market segment in Uganda with at least 89 installations, with 3.454 MW installed, and an additional 2 MW in the pipeline.

In this report, we provide an overview of the captive solar PV market, the total installed capacity by type and facility and the size of potential projects to be installed (pipeline) in Uganda. The report further explorers the financing models and funders active or interested in the captive solar market, the policy and regulatory environment, key challenges, and makes recommendations to support the increased deployment of captive solar plants in Uganda. This follows similar research that has analyzed the growth and uptake of captive solar PV in Kenya9. There is an emerging body of work on the captive PV market in SSA, including reports by GET Invest10 2019 Bloomberg 201911, UNEP-DTU 2020, and UNEP 2020. As a dynamic and constantly evolving market, there is scope to further unravel the market developments and the potential of this segment in Uganda, and across countries in SSA. The target market for this report includes investors, financiers, client companies, project developers, engineering, procurement, and construction (EPC) companies, regulators, development partners.

The report is structured as follows: Section 2 describes the approach and methodology for carrying out the study. The captive solar PV market in Uganda is presented in Section 3, followed by an overview of financing models and financers in Section 4. Section 5 describes the relevant policy and regulatory frameworks, followed by a discussion of the market potential in Section 6, and the barriers for further uptake in section 7. Section 8 concludes the report and provides a set of policy recommendations.

2 For more details see Annex 2

3 Uganda Bureau of Statistics (UBOS), 2018. Energy for Rural Transformation (ERT III) Survey -Uganda Report. Kampala, Uganda; UBOS

4 ibid

5 Uganda National Development Plan III

6 Bhamidipati, P. L., & Gregersen, L. E. (2020). Clean captive power: Understanding the uptake and growth of commercial and industrial (C&I) solar PV in Kenya.

7 GET Invest Market Insights – Uganda: Captive Power Developer Guide, 2019

8 United Nations Environment Programme and Frankfurt School UNEP Collaborating Centre (2020). Clean captive installations for industrial clients in sub Sahara Africa – Kenya Country Study. UNEP, Nairobi, and FS UNEP, Frankfurt.

9 ibid

10 ibid

11 BNEF (2019), Solar for Businesses in Sub Saharan Africa, Bloomberg New Energy Finance, London.

2. Methodology

This report is based on primary and secondary data collected between April and October 2021 to identify the market opportunity, total capacity of installed captive solar, and the barriers and drivers for the development of the captive PV market in Uganda. We focus on Uganda as it has high densities of solar radiation and decentralized PV-based electrification. In addition, the national plans have accounted for several new economic zones and industrial parks, suggesting a growth of commercial and industrial consumers over the next decade. Other technologies used for self-generation such as biomass or cogeneration are not included in the report.

First, a background review was conducted to capture the publicly available information (e.g., reports, media articles) on this market segment. The resources made available by GET Invest9 played a key role in providing a baseline for captive PV power in Uganda. In 2019, GET Invest developed a captive PV developer's guidebook, provided funding for pilot projects, documented the business models for these projects, and provided insights into the market overall. This was an important source for the start-up of our work, which builds on this report, offers more up-to-date information on projects installed, on the EPC companies involved, on the emerging financial landscape, and provides additional clarifications on the specific regulations.

This led us to identifying the information on primary data required to get further insights. Primary data has been garnered through key informant interviews with representatives from solar PV companies installing captive solar systems, captive solar consumers, financing representatives (commercial and development banks) and policy makers. In total, 18 interviews were conducted over five months (see further details in Annex 1). All of these were accompanied by detailed notes, interview transcripts and identifying missing data. Follow-up emails and clarification questions were asked to the interviewees over the phone. This was followed by a data analysis and synthesis of all the information collected. Captive solar PV installations in the telecommunication sector with a total installed capacity of 5,400 kWp are excluded in this report because their capacity is less than 10 kWp and hence do not fall under the definition of captive solar systems. Furthermore, captive solar installations procured mainly through project contracts/tenders (from the government and development partners) have also been excluded in the report. This is because the research mainly focused on installations implemented under a market development approach where the customer also provides a financial contribution towards the purchase of the captive solar system.

In addition, we organized a webinar on captive PV on 8 September 2021 to share preliminary findings from this report and facilitated a discussion with panelists comprising of a solar company representative, a captive solar PV consumer, a commercial bank representative and the head of the Electricity Regulatory Authority. The webinar session was held to validate our findings, take different stakeholder perspectives on board, and clarify the regulations. Additionally, the webinar allowed us to consider inputs from a wider audience, which comprised of private sector actors, development partners and international organizations. The insights from this webinar have been incorporated into this report.

3. The Ugandan Captive Solar PV Market

This section provides an overview of the commercial and industrial user segments, and the electricity tariffs charged by the national utility. This is followed by an overview of the identified installed captive power systems including types, sizes, and facilities as well as an overview of the planned pipeline of projects.

Box 1. Types of Captive PV Systems - Grid-tied and Off-grid

Grid-tied (with or without a battery) – For consumers that have a high electricity consumption and are connected to the grid, the PV system supplements the daytime consumption. In some instances, the consumers also supplement the system with a battery to meet nighttime requirements as well.

Off-grid (with or without a battery) – For consumers that are not connected to the grid and are entirely reliant only on the captive solar PV system to meet their electricity needs. In some instances, consumers also supplement the system with a battery.

Who are the commercial and industrial consumers in Uganda?

Captive PV systems can be either grid-tied or off grid. In addition, they can be designed to include hybrid components such diesel generation and/or a battery for storage. The most common types of captive solar PV systems installed are grid-tied systems with or without a battery and off grid systems with a battery.

Electricity customers served by the national grid are divided into the following six categories: domestic, commercial, medium industrial, large industrial, extra-large industrial, and street lighting. Figure 1 shows the number of electricity customers within each of these categories. The user categories for whom it is relevant to install captive solar PV systems are the commercial, medium, and large industrial categories. Captive power is less relevant for the extra-large industries as their energy needs are too large and the tariffs, they are charged from the national grid are low.

TABLE 1. Number of electricity customer by categories in Uganda since 2015.

Customer Category	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020
Domestic	734,353	1,000,021	1,161,001	1,336,513	1,527,269
Commercial	63,963	86,081	100,193	114,064	89,464
Medium Industrial	2559	2512	2737	2834	2,925
Large Industrial	521	500	556	529	563
Extra Large Industrial	0	38	39	37	52
Street Lights	271	299	279	242	232
Total	**801,667**	**1,089,451**	**1,264,805**	**1,454,219**	**1,620,505**

Source: ERA (2021)[12]

12 https://www.era.go.ug/index.php/stats/distribution-statistics/customer-growth

▶ The commercial category comprises of retail shops, shopping centres, transportation and telecommunication providers, restaurants, bakeries, other service providers, and telecommunication towers. This category also includes Non-Governmental Organization (NGO) offices, education and healthcare facilities, and religious centres, among others[13].

▶ The medium industrial category comprises of small and medium sized enterprises focused on agro-processing, light manufacturing, beverages and tobacco, textiles and footwear, paper and printing, chemicals, cement, petroleum and chemical industries, textiles, dairy sector, and ranching.

▶ The large industrial category includes mining and quarrying, construction, and electricity and water utilities as well as floriculture, tea factories, coffee factories, wood-based industries, rice millers, municipal waste.[14]

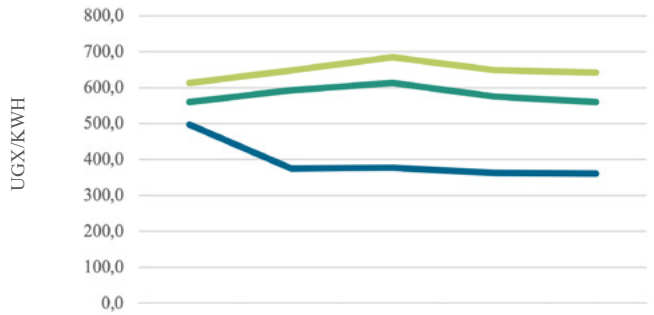
Recently, to support the recovery of small and medium-sized businesses from the adverse effects of the COVID-19 pandemic, the Electricity Regulatory Authority approved the new Electricity End-User Tariffs (to be charged by Umeme Limited in the Billing Period from July to September 2021)[15]. The new tariffs represented a weighted average reduction of 2% relative to the tariffs of the second quarter of 2021.

According to ERA, under the new tariffs, commercial consumers pay an average tariff of UGX 616.6 ($0.167), medium industrial consumers UGX 526.9 ($0.142), large industrial consumers UGX 355.0 ($0.096) and extra-large consumers UGX 300.2 ($0.081).

Within the region, the competitive tariff range for captive solar targeting the commercial and industrial sector is between $0.10 - $0.14/kWh[16]. Therefore, even with the newly introduced subsidized tariffs for grid-electricity for the commercial and medium industrial segments (approximately $0.17/kWh and $0.14/kWh respectively) captive power still seems to be competitive for these segments. For large industrial consumers the grid-tariff of $0.096/kWh is low compared to the cost of captive power and therefore, additional factors than cost such as power reliability and stability will play a role for this segment in determining their need for a captive system.

As shown in Figure 2, the average electricity tariffs charged by commercial and medium industrial categories have increased from 2017 to 2019 and thereafter reduced while the tariff for large industrial customers has been decreasing over the years with a slight increase 2019 compared to the tariff for the previous year. According to ERA, the increase in tariffs in 2018 was attributed to the depreciation of the Uganda Shilling against the United States Dollar during the Second Quarter of 2018 and the incremental increase in the international price of fuel, among other factors. As mentioned, the reduction in tariff in 2020- 2021 was aimed at supporting the Electricity Consumers (SMEs) to recover from the effects of the COVID-19 pandemic and to contribute to the recovery of the economy.

FIGURE 1. Average electricity Tariffs for commercial and industrial consumers (2017- 2021)



Commercial
Medium industrial
Large Industrial

2017	2018	2019	2020	2021
613,0	648,3	684,8	649,4	642,4
559,7	592,5	613,2	575,2	560,2
497,1	375,5	377	362,4	361

13 GET Invest Market Insight: Uganda – Captive Power Developer Guide, 2019

14 National Planning Authority, Third National Development Plan, 2020.

15 https://www.era.go.ug/index.php/media-centre/what-s-new/362-era-reduces-electricity-tariffs-for-the-third-quarter-of-2021#:~:text=Commercial%20Consumers%20will%20pay%20UGX,been%20maintained%20at%20UGX%20370.0

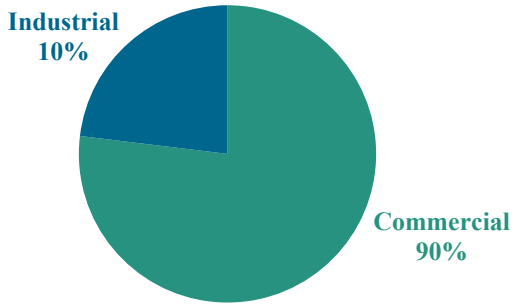
16 United Nations Environment Programme and Frankfurt School UNEP Collaborating Centre (2020). Clean captive installations for industrial clients in sub Sahara Africa – Kenya Country Study. UNEP, Nairobi, and FS UNEP, Frankfurt.

Roof mounted captive solar power on a rose farm

Installed Captive PV systems (by type, facility, and capacity)

This research has identified 89 captive PV systems installed and commissioned in commercial and industrial sectors between January 2013 and October 2021. A database of this has been compiled and presented in Annex 2. Most of the captive solar PV systems are commercial systems accounting for 90% (80 C&I systems) while industrial systems account for 10% (9 C&I systems) as highlighted in Figure 3. The data collected from these 89 systems were further disaggregated to share findings on the types of systems, the installed capacities and facility-level category of users (see full list of installed systems in Annex 3).

FIGURE 2. Number of captive solar PV installations by customer segment



Source: Authors' elaboration

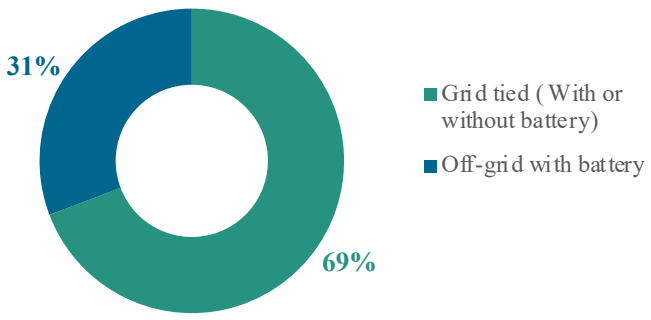
Sixty-nine percent of the captive solar systems are grid-tied with or without battery storage, while 31% are off grid with battery storage used in areas with intermittent electricity access or without access to grid electricity. Battery storage for grid-tied systems is used as a power back up or for critical loads, such as in emergency units in the health centres (see Figure 4).

Several solar PV companies service the captive PV market segment in Uganda. Their roles include (either partly or fully): i) designing the rooftop PV system; ii) procurement and installation of the system; iii) operations and maintenance; and iv) providing consultancy/ advisory services. The report has captured profiles of 13 PV companies engaged in multiple services and are active in the rooftop PV market. The details of the 13 companies have been provided in Annex 2.

The total installed capacity from the 89 identified captive solar plants is 3.454 MW. Table 2 below provides a breakdown of the installed capacity based on the size and number of the captive solar PV systems. The captive PV systems in the size range between 10 kWp to 50 kWp constitute the highest installed capacity of 1,460 kWp (42%), followed by those in the size range between 100 kWp to 500 kWp (8) which contribute an installed capacity of 861 kWp (25%). The least number of captive solar PV systems fall in the category of sizes ranging from 50 kWp to 100 kWp with a contribution of 617 kWp (18%) and lastly the larger captive solar systems of a capacity more than 500 kWp contribute an installed capacity of 516 kWp (15%).

Of the total installed capacity of 3454 MW, captive solar PV systems with sizes ranging from 10 kWp to 500 kWp account for 86% (2,973 kWp) while those of more than 500 kWp account for 14% (516 kWp). There is a higher concentration of captive PV systems in the capacity ranges between 10-50kWp (43%), followed by installations between 100-500kWp (25%). The least concentration is the higher capacity ranges i.e., above 500kWp. (See Table 2).

FIGURE 3. Captive Solar PV Systems by Type



Source: Authors' elaboration

TABLE 2. Total installed capacity by size of captive solar system.

Size	No	Total capacity (kWp)	Percentage
10-50 kWp	75	1495	43%
50- 100 kWp	8	617	18%
100-500 kWp	5	861	25%
>500 kWp	1	516	14%
Total	**89**	**3454**	**100%**

Source: Authors' analysis and GET Invest market insights- Captive Power Guide

Based on the type of facility, Table 3 shows that 80 out of 89 captive solar systems have been installed in the commercial segment. This segment includes an automotive company (dealing in the marketing and sales of motor vehicles and motorcycles in Kampala), schools (lower and upper secondary schools, vocational and technical training institutes), agricultural facilities, fuel stations, health centers, a horticulture facility (flower farm) a hotel, office buildings and a market (mall). In terms of solar PV capacity, commercial solar installations account for 2,858 kWp of the total installed capacity. The average size of the commercial captive solar PV systems is 36 kWp with sizes ranging from 10 kWp to 516 kWp.

The nine identified industrial captive solar PV systems are installed in agro-processing plants (coffee processing, dairy processing, and food processing) and in a stationary factory. The industrial captive solar systems account for 596 kWp of the total installed capacity of 3.454 MW. The average size of the industrial systems is 66 kWp with sizes ranging from 10 kWp to 200 kWp.

TABLE 3. Captive solar systems by type of facility

Type of Facility	Category	No of systems	PV Capacity (kWp)	Average System Size (kWp)
Automotive	Commercial	2	150	75
Coffee processing	Industrial	2	272	136
Dairy Processing	Industrial	5	268.5	53.7
Education	Commercial	20	343	27.8
Farm	Commercial	10	600	60
Fuel stations	Commercial	25	250	10
Health	Commercial	9	645	71.6
Horticulture	Commercial	1	30	30
Hotel	Commercial	1	30	30
Stationary factory	Industrial	1	30	30
Food Processing	Industrial	1	25	25
Office building	Commercial	11	775	78.1
Market	Commercial	1	35	35
Total		**89**	**3,454**	**50.9**

Source: Authors' elaboration

Box 2. provides the case of the captive power system installed by National Union of Coffee Agribusinesses and Farm Enterprises (NUCAFE).

Box 2. Customer case study: NUCAFE

The National Union of Coffee Agribusinesses and Farm Enterprises (NUCAFE), a national umbrella organization of coffee farmers installed a **172 kWp captive solar PV system** to power the coffee grading, processing plant, and warehouse. The captive solar PV system is also being used to operate an energy management system, which supports the platform to support tracking of carbon emissions avoided by switching from use of a diesel generator to solar PV. The solar plant was funded with grant investment capital from the ABI Development Fund and a loan for the construction of the warehouse where the solar PV system is installed. The farmer organization also received technical support from NIRAS to assess demand and map out energy needs with support from European Union.

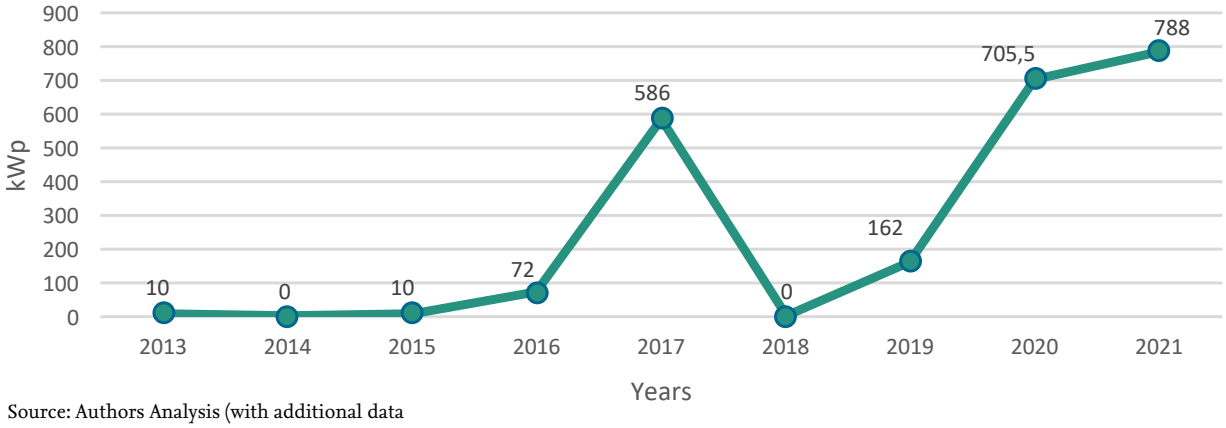
Before installation of the captive solar PV system, NUCAFE incurred high electricity bills from the use of back up diesel and had power outages for at least 2-3 hours every two weeks, which disrupted their operations.

Since the deployment of the captive PV system in 2020, NUCAFE has reportedly saved about 60% on the electricity bills and diesel generator costs, which is an equivalent of UGX 6 million per month. The savings are high due to the use of PV at full capacity and limited loan repayments. NUCAFE has expanded its customer base to serve eco-friendly coffee buyers across the coffee value chain as it increases returns for its membership of 213 farmer groups. The use of captive solar PV will also save 241.3 tons of CO2 emissions per annum.

(Authors elaboration, drawing on https://nucafe.org/nucafes-first-industrial-solar-power-plant/)

Source: Interview data

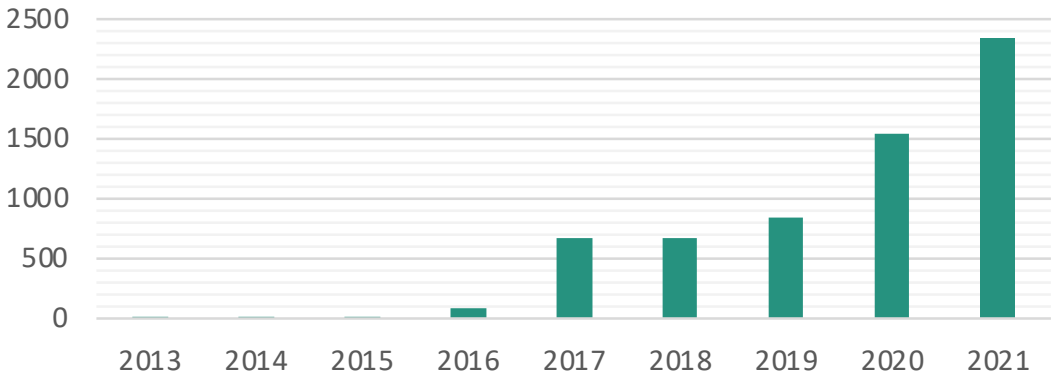
FIGURE 4. Captive Solar PV installed capacity in the period 2013 to October 2021.



Source: Authors Analysis (with additional data from GET Invest Captive Power).

During the period 2013 to 2017, a total of 678 kWp of captive solar PV systems was installed. The total installed capacity in this period includes 534 kWp for captive solar systems derived from the information collected from the GET Invest report in addition to 144 kWp identified in this study. The installed capacity has increased by 978 kWp in the period 2018 to October 2021 with no registered installations in 2018. Figure 6 shows the cumulative installed capacity in the same period.

FIGURE 5. Cumulative installed capacity in the period 2013 to October 2021 (kWp)



Source: Authors' analysis

Based on interviews, it is estimated that between October 2021 and 2023, an additional 2 MW will be added. The planned captive solar PV projects are at various stages of development. Most of the planned projects have not reached a financial close as they are in the initial stages of feasibility and contract negotiation. The industrial market segment is expected to contribute the highest installed capacity with 1,868 kWp with one packaging facility accounting for 1,500 kWp. The commercial market will account for 159 kWp of the installed capacity in the pipeline. Excluding the largest facility, the average size of projects in the pipeline is 88 kWp. See Table 4 for the pipeline of projects.

TABLE 4. Pipeline of Captive Solar PV projects (October 2021)

Facility	Category	Number	Size (kWp)
Fish processing	Industrial	1	30
Hotel	Commercial	1	100
Packaging	Industrial	1	1500
Industry	Industrial	1	200
Mall	Commercial	1	20
Agro processing	Industrial	2	138
Health Centres	Commercial	2	39
Total		**9**	**2027**

Source: Authors' elaboration

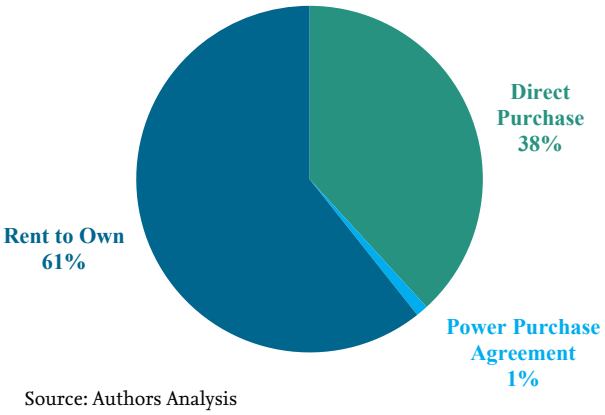
Solar panels installed on the rooftop of car parking, in other words, solar carport system

4. Financing Captive Solar PV in Uganda

Financing models

There are several ways in which a consumer can finance the deployment of captive C&I PV systems. These include direct purchase, rent-to-own / finance lease, operating lease, and power purchase agreements (PPA)[17]. These four financing models are described below. As shown in figure 8, Out of the 89 projects identified in this study, the majority (54) of projects are financed via rent-to-own, whereas 34 projects are financed via direct purchase and one project uses a PPA model. The full list of the 89 projects and its financing models are shown in Annex 3.

FIGURE 6. Financing models used for Captive Solar PV systems in Uganda



Source: Authors Analysis

Direct purchase

Under this model, the owner purchases the solar PV system upfront, financed with either their own capital or loans. Once purchased, the user can either take on the responsibility of operations and maintenance (O&M) or enter into an O&M contract with the EPC or system supplier. In most cases, the EPC contractor will include 1- 2 years of O&M and training for the company's staff in its price offer. This model is in some cases facilitated with grants or subsidies to specific projects, and commercial bank financing has come predominant through the SUNREF green credit line participating bank Diamond Trust Bank[18]. An estimated 38% of commercial and industrial captive solar PV systems in Uganda have been purchased using the direct purchase model. Direct purchase or Outright purchase is the dominant model used in the captive market in Kenya (UNEP DTU, 2020).

Rent-to-own (financing lease)

With rent-to-own, a third party finances the captive plant either fully or partially. The client makes a small upfront capital investment (usually up to 30 percent in Uganda) and thereafter a monthly lease payment for the duration of the contract. The client effectively pays off the value of the solar plant through the monthly payments, and ownership is transferred to the client at the end of the contract. The duration of the contracts under this model is between 1 – 2 years. Under this model, system O&M is usually the responsibility of the developer for the duration of the lease. The Rent-to-own model is the most used model by customers to purchase captive solar PV systems in Uganda and accounts for an estimated 61% of captive solar PV installations. Companies such as Solar PiPo and Solar Now offer instalment payments using the rent-to-own model.

17 Bhamidipati, P. L., & Gregersen, L. E. (2020). Clean captive power: Understanding the uptake and growth of commercial and industrial (C&I) solar PV in Kenya.

18 https://observer.ug/business/38-business/45314-afd-dtb-to-support-renewable-energies

Operating lease

With this model, an end user makes little or no upfront payment, and the lease period spans several years, the term of which is dependent on the financing institution. The developer is responsible for O&M during the lease period. In some contracts, the developer/financier provides performance guarantees to the end user in terms of energy production. At the end of the lease period, the end user may be given the option to purchase the system at residual value or to extend the lease, or the developer removes the plant from its premises. There is no known company currently in Uganda that is using the operating lease model.

Power purchase agreement (PPA)

This model differs from the rent-to-own and operating lease arrangements as monthly payments are not fixed but based on the energy consumed (X amount / kWh consumed) over a long-term contract (for example, 15 years or more) by an end user from a third-party-owned captive plant on either the end user's premises or a nearby premises. The plant owner is responsible for developing, financing, building, and operating the plant. Electricity produced is metered using a prepaid meter and fed into the customers mains. Customers sign a long-term PPA and pay for electricity used through mobile money, the bank online or by cheque. After paying for 20 years, the customer has the option to transfer the asset to the customer or replace it. GRS and its partner- en.Power Life – use this model. This is the only project that uses the PPA in the Ugandan commercial and industrial solar market.

Current and Potential Financiers

Investments in the energy sector in Uganda have focused more on large-scale electricity utilities compared to the off-grid solar PV and captive power market segments. In the captive solar PV market, debt financing has been mainly provided by impact and crowd funding investors such as Go parity, en.Power. Life and Sun Funder. There is limited involvement of local commercial banks with only Diamond Trust Bank who have provided credit under the SUNREF programme. Financial institutions interviewed expressed interest in lending to the captive solar PV market but cited the lack of strategy for clean energy investments, limited energy sectoral experience and investment resources as some of the main constraints to increased lending to the captive solar PV market[19] .

In Table 6, we provide an overview of the current key financial players and their involvement in the captive solar PV market in Uganda.

19 Interviews with Financial institutions, June 2021.

TABLE 5. Funders of Captive Solar PV projects in Uganda

Funder	Description	Contribution to Captive PV
aBi Development Ltd Agribusiness is our Business	ABI channels development funding to agribusinesses and agriculture in Uganda. It focuses on increasing agricultural production & value addition[20].	Funded the captive solar PV system of 172 kWp for a coffee association
GOPARITY	Go Parity is an impact investment platform that connects companies looking for finance for their sustainable projects with individuals and entities who want to invest sustainably.	Funded 79 kWp of captive solar for the industrial sector including the 30-kWp captive solar power plant for a dairy cooperative in Buyende[21].
enPower.life	Enpower Life is an independent power producer that produces and sells electricity to commercial and industrial customers using Power Purchase Agreements for 20 years[22].	Funded 30kWp in the commercial sector for an eco-tourist hotel in Kampala
Sunref DTB DIAMOND TRUST BANK	Through a partnership with SUNREF, Diamond Trust Bank provided finance to small and mid-sized renewable power plants in high energy consuming industries and supported energy companies to provide affordable energy solutions to manufacturing and processing businesses[23].	Diamond Trust Bank provided a loan for the deployment of a 30 KW grid tied captive solar system with batteries for a commercial building in Uganda.
SunFunder	SunFunder provides finance for solar energy in parts of the world where people and businesses lack reliable access to electricity[24].	SunFunder has provided debt financing to solar companies offering commercial and industrial solar PV in schools, health centres amongst other off-grid solar products.

Source: Authors' compilation

The captive PV market is growing and a greater number of commercial and development banks, alternative finance platforms and energy financing programmes are entering into this market. Some stakeholders have had success in other markets such as Kenya and are currently exploring opportunities to expand into the Uganda market. Actors exploring the C&I market in Uganda include:

- **Development and Commercial banks**: Uganda Development Bank, East African Development Bank, Post Bank and Equity Bank. For example, East Africa Development Bank is considering a detailed climate change mitigation strategy to support industries such as Kayonza Tea Growers to adopt a more climate sensitive approach to its operations by switching from diesel generators to solar[25].

- **Alternative financing mechanisms**: Investment firms such as Cross Boundary and crowd funding platforms- Sun Exchange are exploring investment opportunities for Captive Solar projects in Uganda.

- **Energy Financing programmes** such as Camco Clean Energy's REPP, UNCDF's Energy programme, European Union's ElectriFI, European Union's Uganda Green Enterprise Finance Accelerator, and the World Bank's Energy Access Scale up programme are considering or in the design stage of initiatives to expand and scale expand their portfolio into captive solar PV markets.

20 https://www.abi.co.ug/abi-development-ltd-welcome/abi-development-what-we-do/
21 https://goparity.com/project/solar-buyende-cooperative-158
22 https://enpower.life/about/company/
23 https://www.eeas.europa.eu/delegations/ghana/eu-under-sunref-putting-energy-efficiency-and-renewable-energy-within-reach_en?s=101
24 https://www.sunfunder.com/
25 https://www.eadb.org/news-events/kayonza-tea-growers

5. Market Potential for Captive Solar PV in Uganda

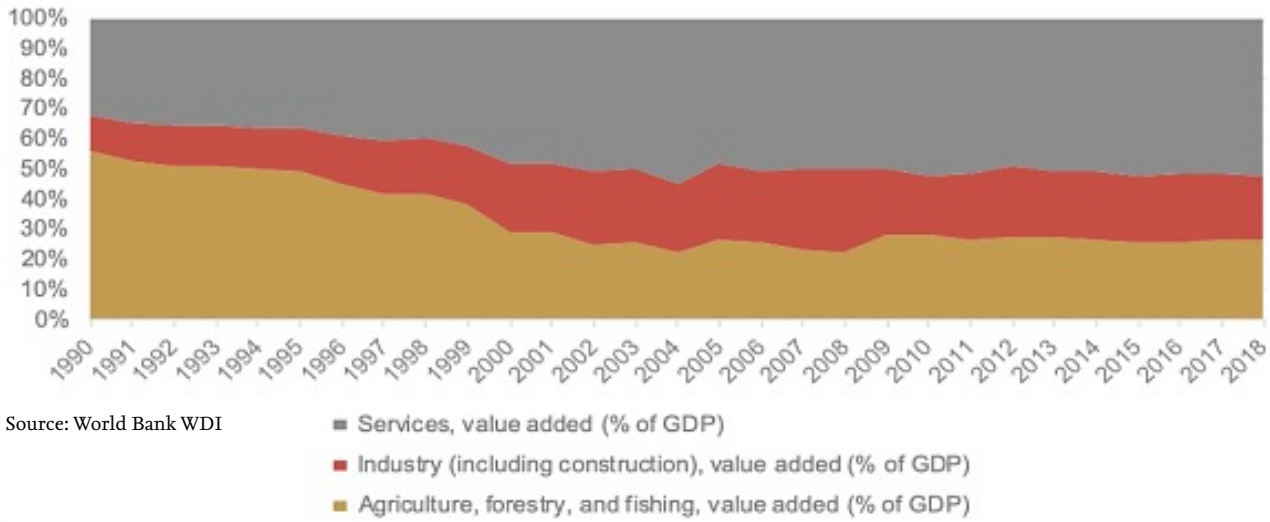
Uganda Manufacturers Association (UMA) reports that Uganda had approximately 900 industries in 2019 with an annual turnover of at least $1 million and seven large shopping malls[26] in 2019 in Kampala. There are also 21,435[27] private and public primary, secondary and tertiary education institutions and 6,929[28] private and public health centres which are potential market segments for deployment of captive solar PV.

According to the 3rd National Development Plan[29] (NDPIII), the industrial sector and commercial sector consume 66% and 13%, respectively, of the total electricity generated. This comprises 80% of the total electricity consumption in Uganda.

The share of agriculture value added in GDP has declined from 53% in 1990 to 24% in 2018. At the same time, the contribution of industry (including manufacturing, construction, and mining) to GDP grew from 10% to 20%, and the contribution of the services sector from 30% to 48% (WDI) over this same period. Uganda is beginning to industrialize and there is a high potential for growth.

During the FY2019/20, Umeme's energy sales were primarily to the large and extra-large industrial customers, both customer categories constituting 38.3% of

FIGURE 7. Composition of services, industry, and agriculture in Uganda's GDP



Source: World Bank WDI

26 GET Invest Market Insights – Uganda: Captive Power Developer Guide, 2019

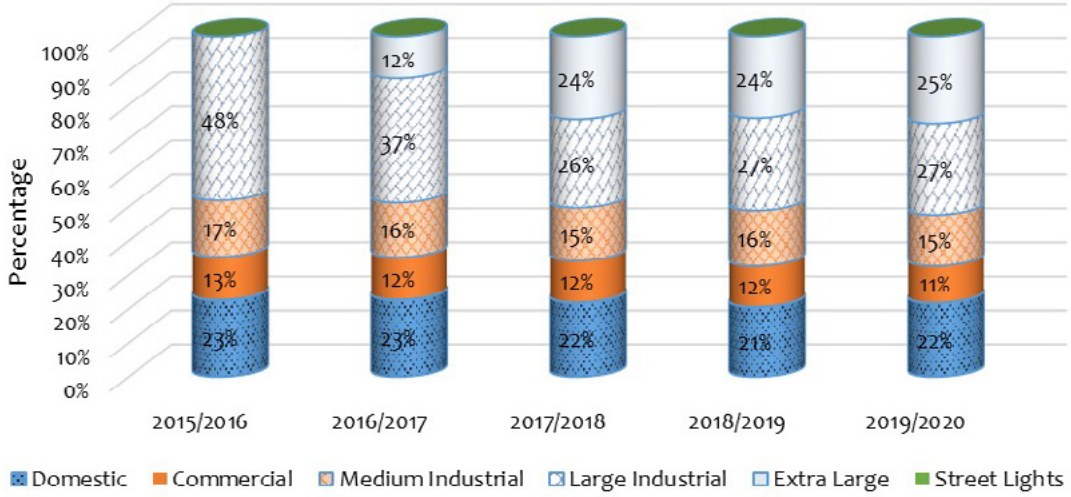
27 https://www.ndcs.undp.org/content/ndc-support-programme/en/home/impact-and-learning/library/uganda--green-school-nama.html#:~:text=The%20Green%20School%20NAMA%2C%20which,solutions%20for%20schools%20in%20Uganda.

28 https://www.health.go.ug/cause/nkwanzi-rakai-lwengo-kalangala-mukono-buikwe-mpigi-butambala-butam-butamba-wakiso-mubende-lyantonde-n-n-n-sembabule-buvuma-kampala-m-m-a-complete-list-of-all-health-facilities-in-uganda/

29 Ibid

the total energy sales while the sales to medium industrial, commercial, and domestic customers constituted 18.3%, 13.6%, and 29.7%, respectively[30]. Power demand has been growing at an average of 9.1% annually[31]. The C&I customers remain the commercial, medium industrial, and to some extent, large industrial electricity consumer categories for Uganda. Despite a drop in the percentage share of electricity consumed in the commercial and medium industrial customers in the FY2019/20 due to the COVID-19 lock down, these segments contributed to 78% of electricity consumed in FY 2019/2020.

FIGURE 8. Snapshot of electricity consumption across defined electricity segments



Source: ERA

Over the years, some industries have integrated captive power to address high-energy costs and power reliability incidences[32] . Sugar manufacturing factories have been early adopters in the installation of bagasse power generation, complementing main grid. The substantial power and heat requirements, economies of scale, daily production, operations and maintenance capabilities, land availability, existing biomass delivery systems, waste management costs, and other tried and tested technologies make on-site co-generation very attractive for sugar factories[33].

Captive solar projects with a levelized energy cost between $0.12 - $0.14/kWh have a strong potential when compared with the average historical electricity tariffs for commercial and medium industrial sector of $0.18/kWh and $0.16/kWh respectively.

30 UMEME Annual Report 2020, P.11
31 https://www.umeme.co.ug/press-media/939
32 Cases-in-point: Kakira Sugar Works, Sugar Corporation of Uganda Lugazi (SCOUL), Kinyara Sugar – all cogeneration plants between 2014 – 2017.
33 ibid

TABLE 6. Captive Power Potential High-level Overview in selected sub-sectors

Sector	No. Facilities	Potential (PV*)	USD / EUR Revenue
Flower Farms	12 flower exporters	H	Y
Commercial buildings	Numerous, with over 7 large shopping malls and several office blocks in Kampala and Entebbe alone	H	Maybe [Y]
Health care facilities	1488 private and 874 NGO health care facilities in 2013, of varying sizes (small to large) [close to 1800 private health care facilities in 2019]	H	N
Telecommunications Towers	5 mobile operators, 4 main tower companies, at least 1200 off-grid BTS and 3400 in total [1 main tower company, 2 mergers, 2 exits and 1 new entrant]	H	Maybe [Y]
Commercial cattle farms / ranches	More than 150 large cattle ranchers, up to 7000 heads of cattle [closer to 200 large cattle ranchers]	M	N
Abattoirs	At least 4 large abattoirs; 3 in Kampala & 1 in Soroti	M	N
Fish Processing facilities	At least 32 fish processors of varying sizes	M	Maybe [Y]
Dairy	At least 25 processors, 6 – 8 large scale, 1 integrated farm & milk processing. At least 60 small-scale milk collection centres in western Uganda. Numerous farmers.	M	Maybe
Tea factories	At least 22 tea companies	M	Y
Coffee factories	60 or more coffee factories, a few large-scale	M	Maybe [Y]
Rice Millers	3 large-scale, 4 – 5 medium scale	L	Maybe
Forestry Operations	Only 4 large-scale forestry and processing companies	L	Maybe
Sugar factories	6 major producers, [10 medium players], more under development	L	Maybe [Y]
Municipal Waste	At least 5 major urban centres and 10 – 15 towns [20 towns now]	L	N

Source: GET Invest Market Insight – Uganda.
Note: H – High, M- Medium, L – Low, Y – Yes, N – No. [includes updated information garnered from recent market developments and interviews conducted.] *Potential focus is only solar PV, excluding biomass and CHP.

From the table above, there is likely to be high potential for captive power installations in flower farms, commercial buildings and institutions, healthcare facilities. Commercial cattle ranches, dairy farms, tea and coffee factories, abattoirs, and fish processing facilities have medium potential. The table also shows that the potential market for captive solar power installations in Uganda will be the high (H) and medium (M) potential sub-sectors.

Aerial photo of a rooftop captive PV on a commercial building

6. Drivers and Barriers of the Captive Solar PV Market

Drivers and Enabling factors

The market for commercial and industrial solar PV projects is driven by five main factors: i) unreliable power supply, ii) electricity cost savings, iii) environmental gains, and iv) a conducive regulatory environment. These are elaborated in the following.

i. **Unreliable power supply**: Power consumers in Uganda still face the challenge of power outages which affects hours of work and service delivery to customers. For example, a survey by UBOS indicated that, on average, schools reported at least 2 unscheduled electricity interruptions per week, with the interruption lasting for an average of 3 hours. For the schools in the Eastern and Northern region, the power disruptions lasted for an average of 6 hours. Captive power presents an opportunity to improve power reliability and quality, not just for public institutions but also industrial units.

ii. **Electricity costs savings**: Consumers want to lower their operational costs for electricity to be competitive. Captive solar PV offers a relatively lower price, in some instances between 20-30% compared to the grid tariff, as reported by interviewees. The average electricity tariffs for C&I sub-sectors between 2017 – 2021 shows the tariffs of ~$0.18 for commercial, ~$0.16 for medium industrial and $0.10 for large industrial customers respectively (ERA statistics). Comparing this against the levelized cost range of $0.12 – 0.14/kWh[34] for captive solar power, it shows that commercial and medium industrial customers are the prime beneficiaries for captive power on basis of tariff alone.

iii. **Environmental gains**: C&I enterprises using diesel generators (DG) as a main source of electricity or as a backup are switching to captive solar PV to reduce costs as well as their CO_2 emissions. NUCAFE installed a rooftop PV in 2020 and is now able to track its reduced CO_2 emissions, with replacement of the use of DGs. With this, NUCAFE has expanded its customer base to include eco-friendly coffee buyers.

iv. **Conducive regulatory environment**

   a. **Easier and inexpensive licensing process for solar plants of capacity less than 0.5 MW**: The 1999 Electricity Act requires that captive solar power plants with a generation capacity of less than 0.5 MW only need to be registered, but do not have to apply for a generation license. This makes it quick to execute a captive solar PV project as a solution for their energy and environmental needs. Furthermore, license exemptions are also provided for plants of less than 2 MW.

   b. **Tax exemptions on selected solar components**: With respect to taxes, solar generators comprising of a solar panel and battery are exempted from taxes. Solar panels are exempted from infrastructure levy and VAT while deep cycled batteries are exempted from VAT[35].

United Nations Environment Programme and Frankfurt School UNEP Collaborating Centre (2020). Clean captive installations for industrial clients in sub Sahara Africa – Kenya Country Study. UNEP, Nairobi, and FS UNEP, Frankfurt.

35 USEA Solar taxation handbook.

Barriers to uptake of captive solar PV systems

i. Unclear licensing process for captive solar plants: The current licensing process is not fully tailored to the process and requirements of captive solar plants in the country. From the interviews conducted, it is unclear who should apply for a license, what are the fees, how does the application process for plants below 500kW differ from those above 500 kW, what exemptions apply and under what conditions and why are PPAs not allowed between the project developer and the customer. Some of these questions have been answered by ERA during the interviews and workshop, but information is not updated on their website.

ii. Limited access to financing; C&I projects require high upfront capital investment, preferably from a patient financier or funder. Most of the local commercial banks in Uganda lack experience in energy project financing, sticking to the traditional requirement for collateral as opposed to cash flow-based financing, which would be more appropriate for energy projects. Moreover, the interest rates are high: between 18- 25% per annum. There is also a high perception of risk attached to captive power projects, which are, in many cases, unfamiliar territory to the local banks. Where financing is accessible through international funders, there is a foreign exchange risk from lending in foreign currency, i.e., use of funds in local currency and repayments in foreign currency.

iii. Taxation Inconsistency: There are inconsistencies in the application and interpretation of the taxation regime especially on solar components at customs. It was reported that inverters used in the DC system are not tax exempted, yet some other DC solar components are exempted. It is also not clear if there are any tax breaks for captive solar projects. According to USEA, tax breaks are applied on a case-by-case basis. These inconsistencies in information have the potential to destabilize the investment commitments for intended project developers. The personnel at Uganda Revenue Authority are not always technically able to distinguish between solar-specific components and appliances, and those which are for multiple use, prolonging the clearance process and time. The tax application inconsistencies make it challenging to plan for prices and leads to increased prices where taxes are charged instead of being exempt.

iv. Limited project management and technical skills: Captive PV project development requires a requires a blend of management and technical skills: overseeing and working closely with EPC contractors while ensuring timely completion of the project, right specifications, and within the allocated budget. There are skill gaps in terms of system design, installation, and maintenance. There is a need to build the requisite competences and skillsets in-country.

v. Limited awareness among potential customers of the benefits of captive solar. The process of customer acquisition requires detailed site assessment which includes access to electricity bills and taking electricity meter readings, which some potential customers find intrusive. Other potential customers are not convinced that solar can be used for high energy consuming organizations and are unaware of the electricity cost savings that come with use of solar for commercial and industrial use.

Box 3. Clarifications from ERA on Captive solar PV regulations

- Projects below 500 kW need to register with the regulator. The registration process for projects below 500 kW is supported by ERA in liaison with the Solicitor General's office. ERA provides a form that is filled, required documentation attached and the applicant pack is then returned to ERA who will follow the process and register with the Solicitor General after the prescribed fee is paid by the applicant. This process can take from one to three weeks. This provision is provided for in section 51 (2) of the Electricity Act of 1999 and the procedure above provided for under Regulation 4 of the Electricity (Isolated Grid) Regulations of 2020.
- Projects equivalent to or exceeding 500 kW (500 kW – 2 MW), a project developer / client must apply for a license for own use or a license exemption. The application procedure for a certificate of exemption is as follows:
    - Undertake a feasibility study;
    - Apply to the Authority for an exemption from the requirement to hold a license in the prescribed form (Schedule 3);
    - The application is gazetted by the Authority;
    - The Authority considers the application and any representations received from the public;
    - A decision is taken whereupon a Statutory Order is issued alongside a Certificate of Exemption and adherent terms and conditions.
- When licensing for one's own use, there are certain procedures aimed to safeguard and protect the lives of the users.

While the prescribed duration for the full license application process is 18 - 24 months (about 2 years), ERA has been working to improve its internal capacity and efficiency, bringing this duration down to 12 months.

Roof mounted captive solar on an industrial/factory site

7. Conclusions and Recommendations

The market for captive PV in Uganda is in early stage, and C&I consumers are benefiting from a reduction in electricity costs, improved power reliability and quality, and a reduced carbon footprint from switching to the use of solar PV instead of diesel generators. Since 2013, the captive solar PV market has grown from 10 kWp to 788 kWp by October 2021, with 90% of all installations for commercial customers. The total installed capacity is 3.454 MW with the most common size of installations ranging from 10 kWp to 500 kWp, accounting for 85% (2,838 kWp), while those of more than 500 kWp account for 25% (516 kWp) of the total installed capacity. Most captive solar PV installation are less than 500 kWp because of the easier and less expensive regulatory process that only requires only registration, rather than a generation license which is required for plants generating more than 500 kWp.

Further growth is expected from the industrial sector especially within manufacturing and agro-processing industries. Information gathered on the projects in the pipeline show that out of the estimated 2 MW to be added between 2022 and 2023, 92% of the installed capacity will be generated from the industrial customer segment and 8% from the commercial segment.

One of the main factors driving Uganda's captive PV market is the cost savings resulting from a lower tariff compared to the grid tariff. Between 2017 and Q2 2021, the average electricity tariffs for C&I sub-sectors were ~$0.18 for commercial, ~$0.16 for medium industrial and $0.10 for large industrial customers respectively, according to ERA. Comparing this against the levelized cost range of $0.12 – 0.14/kWh[36] for captive solar power, it shows that commercial and medium industrial customers are the prime beneficiaries for captive power on basis of tariff alone. Captive PV is less attractive for the extra-large industries as their energy needs are too large, and the tariffs they are charged from the national grid is low due to incentives.

Other market drivers include improved productivity from reduction of power outages, and mark-up on eco-certified produce/exports etc. (with the reduction of CO_2)

Financing for captive solar PV installations has been mainly provided by impact and crowd funding investors who provide debt financing to the project developers. There is limited involvement of local commercial banks who are interested in the market but cited a lack of strategy for clean energy investments, limited experience in the energy sector, and limited investment resources.

For customers, the consumer financing models for captive PV include either rent-to-own (where the customer pays an upfront cost and the balance is paid over the contract period), direct purchase, (using their own capital or debt), or a PPA model (where customers pay for electricity consumed over an agreed timeframe). Out findings highlight that the rent-to-own model is the most dominant form of financing captive PV in Uganda, followed by the direct purchase model. The PPA model is the least commonly used.

The key barriers holding back the captive PV market growth are limited access to patient working capital, and limited skillsets, especially in project management, system design, and installation. The unclear policy and regulatory framework, especially concerning the licensing process, poses an additional risk to investments in captive solar projects, because it is not tailored to the captive solar market.

To address the barriers, all relevant stakeholders, including the Ministry of Energy and Mineral Development, Electricity Regulatory Authority, Industry associations (such as UMA, USSIA, USEA, UNREEA), private sector actors (including electricity distribution companies) need to be engaged to come up with optimal solutions to spur the growth of the captive solar market in Uganda. In the following, we put forward a set of recommendations.

36 United Nations Environment Programme and Frankfurt School UNEP Collaborating Centre (2020). Clean captive installations for industrial clients in sub Sahara Africa – Kenya Country Study. UNEP, Nairobi, and FS UNEP, Frankfurt.

Recommendations

The policy and regulatory framework is vital to improving the enabling environment for increased stakeholder engagement. Stakeholders include project developers, EPCs and financiers. Though the country's policy and regulatory framework is established, gaps exist which could be filled to support development of the captive solar market in Uganda. The study makes two recommendations to the government.

Update and streamline the licensing process for captive solar generation plants: The current licensing processes should provide clarifications with specific information relevant for the players in the captive solar market. Information relating to who should apply for the license, procedures, and application fees for a license for self-consumption or own use and exemptions will help address the ambiguities in the current licensing process.

Develop and enforcing minimum standards for energy efficiency for high energy consuming entities: Energy efficiency standards will help reduce electricity consumption from machines, equipment and appliances and optimize power supply and reliability at an affordable cost to the customer. it is important to set minimum standards for energy efficiency for industries and to set up measures for monitoring implementation and enforcement across the board.

Other ongoing policy improvements, such as amendments to the electricity act to removal the monopoly of UETCL and UEDCL as single buyers and suppliers for electricity and the development of a net metering code are also welcome developments that will in future provide incentives for development of captive solar.

To facilitate increased capital flows to the captive solar market, financial institutions should **tailor loan products to the market environment**. For example, flexible and long-term credit terms fitting the customer electricity savings should be offered and where applicable, the solar PV system should be accepted as collateral. Furthermore, they should also be supported in building skills and competencies to assessing investments for C&I including risk analysis and mitigations for the utilization of C&I projects to improve access to finance.

Finally, there is a need to **increase awareness about captive solar** to company and institutional CEOs, managers, engineers, financial institutions, and other decision makers. Targeted awareness campaigns through industry associations such as UMA and USIA by presenting business cases and site visits to demonstrate the economic and environmental benefits will help build market and consumer confidence and shorten the sales process.

8. Annexes

Annex 1: Stakeholders Interviewed

Company/Organization	Representative
All in Trade	Managing Director
Aptech Africa	Chief Business Development officer
American Tower (ATC Uganda)	Head of Power / Snr Manager Technical Support
E-Power Solutions	Co-founder and Technical Director
Equator Solar Group	CEO
GRS	Director and Team Leader
Green power international	Technical Director
ITAL Trade	Managing Director
Orb Energy	Vice President Africa
OFGEN	Business Development Manager and Technical Director
Starsight Premier Energy Group	Chairman and CEO
Solar PiPo	Director Operations Management & Co-founder
Village Energy	Managing Director
Ministry of Energy and Mineral Development	Ag, Commissioner Renewable Energy
Electricity Regulatory Authority	Principal Economist, Projects Engineer and Projects Coordinator
Uganda Development Bank	Climate Finance specialist
Post Bank	Head of strategy and Planning, Executive Assistant, manager Research and product development
Uganda Manufacturers Association	Training and projects Coordinator
Uganda Small Scale Industries Association	Senior Development Officer

Annex 2: Key Solar PV captive power developers, ESCOs and EPCs in Uganda

Company	Location	Overview
All in Trade	Uganda	All in Trade Limited is an ISO 9001:2015 certified private Uganda company incorporated in November 2008. The company deals in design, supply, installation and maintenance of reliable and affordable solar energy systems, power backup systems, electrical services, wind energy systems, power protection systems and other renewable energy solutions to the population of Uganda and the neighboring East African countries.
Aptech Africa	Uganda	Aptech Africa Ltd. is an EPC company with focus on solar energy and water pumping in Africa. It has offices located in South Sudan, Uganda, Central African Republic, Sierra Leone, Niger, and Liberia. Aptech Africa was founded in 2011 as a distribution and installation company for brands from Europe and the US. It developed a reputation for distributing high quality products and installation services which allowed it to expand to multiple countries. Aptech Africa's services include complete assessments, design, supply, installation, and after sales services by their expert team of engineers and technicians. It covers off-grid and hybrid solutions, energy storage technology, solar water heaters, solar streetlights, borehole drilling, water pumping and distribution, water treatment, irrigation, power transmission, substation maintenance, and power distribution.
Starsight Energy	Kenya	Founded in 2015, Starsight Energy is a leading technology-enabled African Commercial & Industrial (C&I) energy-as-a-service provider. It has deployed 41 MW of installed generating capacity, 33 MWh of battery storage, and 16,320 HP in cooling capacity across 547 sites in all Nigerian states and Ghana. Starsight delivers an end-to-end service, from assessing a client's energy needs to the installation and maintenance of a renewable energy solution to ongoing technical support.
Equator Solar Group	Uganda	EQUATOR SOLAR is a leading solution provider for solar PV and Energy Efficiency in the East African Market. The company's services cover the entire project life cycle – ranging from project development to engineering and system design through to installation and commissioning. It provides high quality solar PV solutions for residential, commercial, industrial, and utility scale customers.
GRS	Uganda	GRS Commodities Ltd is a Ugandan business which focuses on building decentralized energy systems such as off-grid mini-grids, captive solar PV for Commercial and industrial users, and deployment of productive use equipment such as flake ice machines. The company also offers consultancy services for electricity demand stimulation through cold chain management.
E power solutions	Uganda	E-Power Solutions Ltd was started 10 years ago by Ugandan electrical engineering graduates to provide electrical installation services. The company supplies, designs, installs, and provides post sales services for solar PV systems, water pumping solutions, air conditioners and power backup solutions. Its clients are mainly Local government, not-for profit institutions, commercial entities, and individuals. E-Power Solutions also offers consultancy services in site assessments, electrical systems design and installations and project management.
OFGEN	Kenya, Uganda	OFGEN Africa has been active in the commercial and industrial solar market since 2014. The company utilizes state of the art technology and offers turnkey (on balance sheet) and funded (off balance sheet) solutions. The company has extensive experience in design, procurement, construction, financing, and management of solar power projects. To date, the company has 6.2 MWp of solar capacity and 9.3 MWh of battery power under management across Eastern Africa. There is a further pipeline of 15 MWp at various stages of development in the region.
Solar Now	Uganda	SolarNow is a for-profit business established in 2010 providing high quality energy solutions. Initially it focused on solutions for rural homes and small businesses but has since evolved into an energy solution provider supporting productivity increases for businesses, farmers, and institutions such as schools, hospitals, corporations, and non-governmental organizations.
ITAL Trade	Uganda	Ital Trade is a leading solar company provider established in 1996 as the first solar power initiative in Uganda. The company designs, installs and maintains power back up, standalone solar and hybrid systems.
Orb Energy	Kenya, India	Orb Energy is a vertically integrated solar company with in-house manufacturing plants. Orb was founded in 2006. It designs, manufactures, delivers, installs, and services its own range of solar PV panels, rooftop solar systems, and solar water heating systems. Orb has sold more than 160,000 systems to date, with cumulative installations of more than 110MW of rooftop solar systems globally. Orb has two factories in Bangalore: one producing solar photovoltaic panel and one producing solar water heating systems. Orb started Africa operations in Africa in 2013 and operates from its head office in Nairobi, Kenya.
Green Power International	Uganda	Green Power International (GPI) is a multinational company operating across the global solar industry covering many places such as Southeast Asia, Africa, and Europe. In Africa, the business is headquartered in Uganda. GPI aims to be a leading service provider of integrated service provider of solar power' covering large scale/distributed solar power stations, intelligent micro, and mini grid system as well as off-grid solutions to serve customers in the different segments – residential, institutions (offices, health, and education), commercial businesses such as, hotels and industries, commercial parking lots. GPI offers its clients solutions to the entire process of power generation, supply, conversion, distribution, optimization, and other additional services.
Village Energy	Uganda	Founded in 2009 to manufacture solar systems in Uganda, Village Energy eventually shifted to distribution and installation of solar products. With a network of trained technicians across the country, the company provides tailor made and reliable energy source to meet its client's needs. In partnership with financial institutions, the company can offer solar loans for up to 5 years. Village Energy's solutions are targeted for schools, health centres, hotels, farms, offices, and other institutions in both rural and urban areas.
ATC Uganda	Uganda	American Tower provides outdoor and indoor wireless infrastructure, both in urban and rural locations. ATC Uganda operates 3,600 telecommunication tower masts in Uganda of which 6% of the mast are powered by renewable energy sources. In the future, it plans to have all masts powered by renewable energy.

Annex 3: List of Captive solar PV installations in Uganda

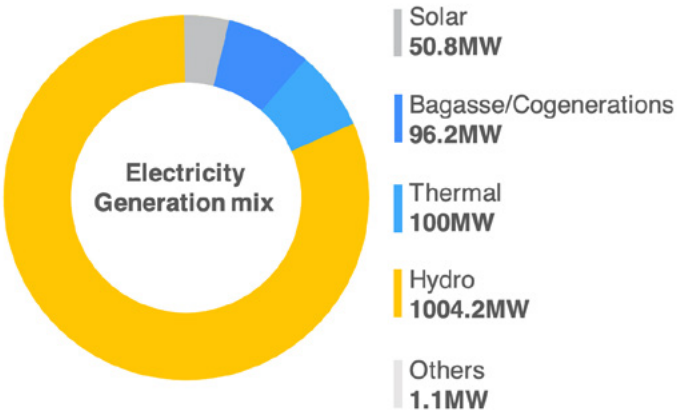
	Project Name	Developer	Category	Sector	Type	Size (kWp)	Date	Financing Model
1	Amugo Technical Institute	All in Trade	Commercial	Education	Off-grid	10	2013	Direct purchase
2	Kiryandongo Computer Training Access	All in Trade	Commercial	Education	Off-grid	10	2015	Direct purchase
3	Lubaga Hospital	Equator Solar Systems	Commercial	Health	Grid-tied - batt	72	2016	Direct purchase
4	Oscar industries	Unknown	Industrial	Stationary	Grid-tied	30	2017	Direct purchase
5	Aarum Roses	Unknown	Commercial	Horticulture	Grid-tied	30	2017	Direct purchase
6	Gulu College	Unknown	Commercial	Education	Grid-tied	31	2017	Direct purchase
7	Luwero Training	Unknown	Commercial	Education	Off-grid	72	2017	Direct purchase
8	Kampala Hospital	Unknown	Commercial	Health	Grid-tied - batt	52	2017	Direct purchase
9	Entebbe Hospital	Unknown	Commercial	Health	Grid-tied - batt	289	2017	Direct purchase
10	Orphanage	Unknown	Commercial	Office building	Grid-tied	15	2017	Direct purchase
11	GoU panyamur	Unknown	Commercial	Office building	Off-grid	15	2017	Direct purchase
12	The Community Technology Access	All in Trade	Commercial	Education	Off-grid	10	2017	Direct purchase
13	Skyland High school	E-power Solutions	Commercial	Education	Grid-tied	30	2017	Direct purchase
14	Women Workshop	Erik Giertsen	Commercial	Office building	Grid-tied	17	2019	Direct purchase
15	UCMTI Institute	Equator Solar Systems	Commercial	Office building	Grid-tied - batt	12	2017	Direct purchase
16	Nagalama Hospital	Equator Solar Systems	Commercial	Health	Grid-tied - batt	12	2019	Direct purchase
17	Buluba Hospital	Equator Solar Systems	Commercial	Health	Grid-tied	12	2019	Direct purchase
18	Nagalama Hospital	Equator Solar Systems	Commercial	Health	Grid-tied - batt	22	2021	Direct purchase
19	WFP Arua- office	Green Powered Intl	Commercial	Office building	Grid-tied	10	2019	Direct purchase
20	Bosco Uganda - office	E-power Solutions	Commercial	Office building	Grid-tied	30	2019	Direct purchase
21	NUCAFE	Village Energy	Industrial	Coffee Processing	Grid-tied	172	2020	Direct purchase
22	Nakawa Vocational Institute	Village Energy	Commercial	Education	Grid-tied	10	2020	Direct purchase
23	Dairy Farm	Solar Pipo	Industrial	Dairy	Off-grid	19,5	2020	Rent-to-own
24	Baitambogwe Dairy Cooperative	Solar PiPo/All in Trade	Industrial	Dairy	Off-grid	19,5	2020	Rent-to-own
25	Buyanja Dairy Cooperative	Solar PiPo/All in Trade	Industrial	Dairy	Off-grid	10	2020	Rent-to-own
26	Kyarushebeka Dairy	Solar PiPO	Industrial	Dairy	Off-grid	19,5	2020	Rent-to-own
27	Aquarius Hotel	GRS/ Equator	Commercial	Hotel	Grid-tied	30	2020	Power Purchase Agreement
28	UGACOF	Orb Energy	Industrial	Coffee Processing	Grid-tied	100	2020	Direct purchase
29	Ministry of Defence/Kololo Airstrip	Nexus Green	Commercial	Office building	Grid-tied - batt	516	2021	Direct purchase
30	Dairy Farm	Equator Solar Systems	Industrial	Dairy	Grid-tied	200	2021	Direct purchase
31	Factory	Village Energy	Industrial	Food processing	Grid-tied	25	2021	Direct purchase
32	Midigo Health Centre IV	All in Trade	Commercial	Health	Off-grid	15	2021	Direct purchase
33	Kitalya Prison	Green Powered Intl	Commercial	Office building	Off-grid	10	2021	Direct purchase
34	Toyota Kampala	OFGEN	Commercial	Automotive	Grid-tied	60	2020	Direct purchase
35	Toyota Namanve	OFGEN	Commercial	Automotive	Grid-tied	90	2020	Direct purchase
36	Yumbe Hospital	OFGEN	Commercial	Health	Grid-tied - batt	90	2020	Direct purchase
37	Kayunga Hospital	OFGEN	Commercial	Health	Grid-tied - batt	81	2019	Direct purchase
38	African Child Trust	OFGEN	Commercial	Education	Off-grid	50	2020	Direct purchase
39	Arua Market	OFGEN	Commercial	Trade	Grid-tied	35	2020	Direct purchase
40	Several installations	Solar Now	Commercial	Large Agric Farms, Fuel stations, Office buildings	Grid-tied, off-grid	1,120	2020-2021	Rent-to-own

Annex 4: Highlights on Electricity Generation, Transmission & Distribution

Electricity Generation

Uganda's electricity generation is diversified across four sources, namely, hydro, thermal, cogeneration, grid connected solar PV, and others. As indicated below[37] , hydro is the main source of electricity generated with 1004.2 MW, thermal at 100 MW, bagasse/cogeneration at 96.2MW, grid connected solar at 50.8MW and others at 1.1 MW.

FIGURE 9. Uganda's generation mix for the FY 2019/2020



Source: MEMD Annual Report 2019-2020

In 2019/2020, a total of 72 MW was added to the power generation mix. This followed the commissioning of Achwa II (42 MW) hydropower plant on 30 September 2019, and three GET FiT (Global Energy Transfer Feed in Tariff) projects: Ndugutu hydro power plant (5.9 MW), Kyambura (7.6MW), and Siti II (16.5 MW) hydropower plants. This led to the country's installed generation capacity to peak at 1,252.4 MW compared to the 1,182.4 MW in the previous reporting period of 2018/2019. Of the total installed capacity of 1,252.4 MW, 1,246.5 MW supplied the main grid while 5.9MW was off grid. The total installed generation capacity is expected to increase to over 1900 MW following the commissioning of the 600 MW Karuma hydropower plant and other small hydro plants under construction[38].

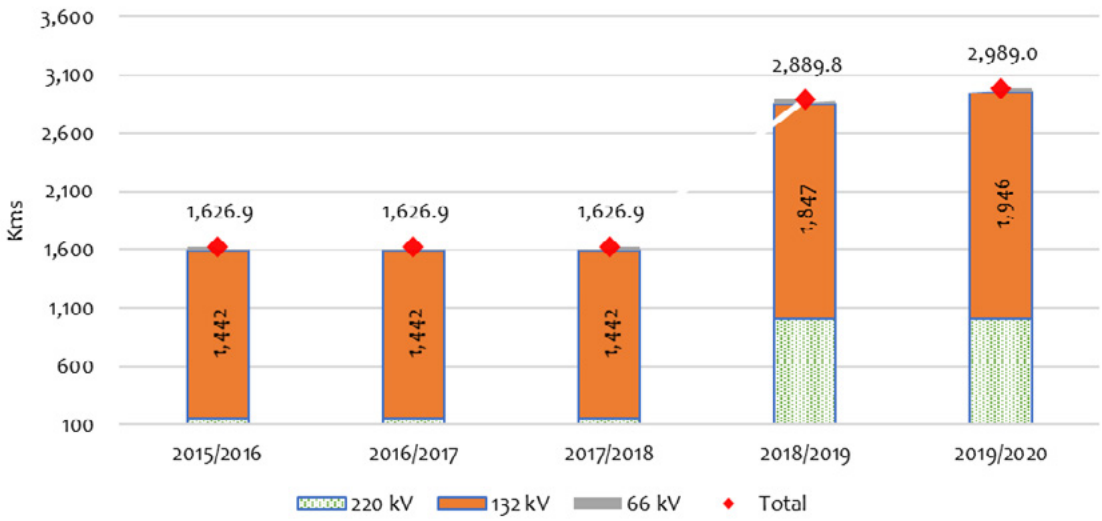
Electricity Transmission

Uganda's Electricity Transmission is managed by the single operator of the Transmission System - the Uganda Electricity Transmission Company Ltd, which directly executes Power Purchase Agreements with Independent Power Producers and manages the scheduling and actual dispatching of Power Plants.

The Uganda Electricity Transmission Company Ltd holds a License for the operation of the High Voltage Transmission Grid, the Transmission System Operator License, the Export and Import of Electricity License, and the Bulk Supply License. The total number of units of electricity sold by Uganda Electricity Transmission Company Ltd increased by 7.5% from 3,929 GWh in 2018 to 4,225 GWh[39] in 2019.

37 https://www.era.go.ug/index.php/sector-overview/uganda-electricity-sector
38 MEMD Annual Report 2019/2020
39 2020 Statistical Abstract, Uganda Bureau of Statistics – Pages 77-79

FIGURE 10. Breakdown of Uganda's Transmission Network



Source: ERA

The national transmission grid infrastructure[40] has been systematically upgraded since 2015 with 150 km of high voltage 220 kV power lines, 1443 km of high voltage 132 kV power lines and 32 km of 66 kV power lines. The 132 kV network extends to Tanzania and Kenya and is linked to the Kenya-Uganda and Tanzania-Uganda Interconnector Projects as part of the Eastern Africa Power Pool[41].

Electricity Distribution

Due to a conducive regulatory environment created by ERA, improvements in transmission and distribution of electricity as well as advances in technology have resulted in a remarkable improvement in the distribution of electricity in Uganda. Energy Losses have been reduced from over 30% at liberalization in 2001 to 17.5%[42] in 2020.

As a way of growing access to clean energy across the country, ERA has licensed several Electricity Distribution Operators across the Country to serve the hitherto unserved and predominantly rural community. The number of Electricity Distribution Companies now stands at Nine (9).

The Distribution Companies are: Umeme Limited, West Nile Rural Electrification Company (WENRECo), Uganda Electricity Distribution Company Limited (UEDCL), Bundibugyo Electricity Cooperative Society (BECS), Kyegegwa Rural Energy Co-operative Society (KRECS), Pader-Abim Community Multi-Purpose Electric Co-operative Society (PACMECS), Kilembe Investments Limited (KIL), Hydromax, and Kalangala Infrastructure Services Limited (KIS). These companies are operating in various regions of the Country, which has increased Access to Electricity. The total number of electricity customers in 2018 increased by 14.6% from 1,372,166 customers to 1,572,605[43] customers in 2019. There has been an increase in UMEME customers (14%), Kyegegwa Rural Electricity Cooperative Society (KRECS) (57.7%) and Northwest Service Territory (NWST) (22.6%). The total amount of electricity generated has increased by 9.2% from 4,038.8 GWh in 2018 to 4,384 GWh in 2019.

40 GET Invest Market Insights – Uganda: Captive Power Developer Guide, 2019.
41 IRENA (2021), Planning and Prospects for Renewable Power: Eastern and Southern Africa, International Renewable Energy Agency, Abu Dhabi.
42 UMEME Annual Report 2020.
43 Ibid

Annex 5: Uganda's Energy Policy and Regulatory Framework

The Electricity Act, 1999 (Cap 145)

The Act governs the activities of the Electricity Supply Industry. The Act provides for the establishment of an Independent Regulator with the mandate to regulate the generation, transmission, distribution, sale, export, import and distribution of electrical energy in Uganda. The enforcement of the Act is supplemented by Statutory Instruments and Guidelines approved by ERA. Other organs such as the Electricity Disputes Tribunal, the Rural Electrification Agency (REA) and Rural Electrification Board (REB) were established under the Act to provide guidelines for resolution of sector disputes, and promote, support, and provide for rural electrification programs respectively[44].

The Electricity (Isolated Grid systems) Regulation, 2020

Also known as the statutory instrument No: 138 applies to interested investments that fall in these two categories, namely:

i) Generating stations for commercial purposes with a generation capacity that does not exceed 0.5 Megawatts and

ii) Isolated grid systems that generate not exceeding 2 Megawatts. The Instrument is categorical in guiding production of captive power first from defining "Commercial Purposes" to mean; "electricity that is generated with the primary objective of supporting commercial or industrial activities through captive power". Such clarity creates confidence to invest in captive power stations or projects.

The Statutory Instrument guides any investor who seeks to develop or operate a generating station for commercial purposes through the various regulations and sub regulations. From application for registration, certificate of exemption, technical frameworks to tariffs on tariff computation, and approvals. The statutory instrument further provides options on interconnection of the main grid, among others.

Draft Energy Policy, 2020

The guiding policy governing the overall energy sector in Uganda is the Energy Policy for Uganda. This draft policy addresses shortfalls of the Energy Policy, 2002 that needed a stronger focus on biomass as the primary energy source to curb inefficient use and related environmental degradation. The policy also had limited consideration for off-grid energy solutions, climate change mitigation actions, and emergency thermal power generation during the energy crisis. The draft Energy Policy, 2020 aims to have a stronger focus on gender and climate change mainstreaming in sector activities. Considerations for occupational health and safety mainstreaming will likewise be important.

Renewable Energy Policy, 2007

The policy is a subcomponent of the Energy policy for Uganda which was developed in 2002 to sustain the economic growth the country had achieved in the last decade and to ensure widespread access to affordable modern energy. The overall objective of the Renewable Energy Policy was to diversify the energy supply sources and technologies in the country. In particular, the policy goal was to increase the use of modern renewable energy from 4% in 2007 to 61% of the final energy consumption by the year 2017. By the end of 2017, the use of modern renewable energy comprised 35%[45] of final energy consumption.

Feed in Tariffs

The Uganda Renewable Energy Feed-in Tariffs are guidelines meant to provide clarity and guidance to project developers, investors, and key institutional stakeholders, on the key components and operational structure of the Renewable Energy Feed-in Tariff (REFIT). The overall aim of the REFIT is to encourage and support greater private sector participation in power generation from renewable energy technologies through the establishment of an appropriate regulatory framework.

44 http://www.era.or.ug/index.php/opportunities/investment/renewable-energy-investment-guide

45 Public Review of Draft Energy Policy, 2019

TABLE 7. REFIT Phase 5 Tariffs, O&M Percentage, Capacity Limits and Payment Period[46]

Facility	Category	Number	Size (kWp)
Fish processing	Industrial	1	30
Hotel	Commercial	1	100
Packaging	Industrial	1	1500
Industry	Industrial	1	200
Mall	Commercial	1	20
Agro processing	Industrial	2	138
Health Centres	Commercial	2	39
Total		**9**	**2027**

Source: Authors' elaboration

Energy Efficiency and Conservation Bill

The Ministry finalized the development of the Energy Efficiency and Conservation Bill and the Regulatory Impact Assessment (RIA) to justify the Energy Efficiency and Conservation legislation. The RIA report was approved. In that regard, submissions to the Cabinet Secretariat include a Cabinet Memorandum, RIA report, and the Energy Efficiency and Conservation Bill. MEMD awaits a response on when the Minister can present to Cabinet. The awareness strategy and roadmap for the Energy Efficiency and Conservation Bill has been developed to ensure that all stakeholders obtain sufficient information regarding the Bill (MEMD Annual Report, 2019-2020).

Institutional Framework

In early 2021, the Cabinet re-approved a plan to merge several government ministries, departments and agencies including Ministry of Energy and Mineral Development and its Agencies. The cabinet decision recommended the merger of UETCL, UEGCL and UEDCL into one company and for REA to be made a department under MEMD. This will affect the current institutional framework as described below.

Ministry of Energy & Mineral Development (MEMD):

The Ministry is the lead Government entity concerned with oversight for the energy sector, custodian of energy policy and responsible for the formulation, enforcement, monitoring, and evaluation of the impacts of energy policy and its selected policy actions. Previously, the Ministry did not concern itself with project implementation save for select pilot projects, leaving the bulk of the project implementation to its constituent agencies and the private sector.

Electricity Regulatory Authority (ERA) is a statutory body established in 2000 in accordance with the Electricity Act 1999, with the purpose of regulating the generation, transmission, distribution, sale, export and import of electricity in Uganda. For investing in captive power, ERA supervises licensed renewable energy generators and verifies electricity production from the licensed renewable energy power generators. They develop, manage, and review appropriate regulations for grid connection and wheeling of renewable energy. ERA is also mandated to guide the liberalization process of the electricity industry in general, through managing of licensing, set up rates, monitor safety and other matters concerning the industry. It also ensures sustainable electricity supply by creating conducive regulatory environment and incentives aimed at diversifying the country's generation mix[47].

46 https://www.era.go.ug/index.php/decisions-notices/notices/649-refit-2021-2023

47 https://www.era.go.ug/index.php/sector-overview/uganda-electricity-sector

Uganda Energy Credit Capitalization Company

The Uganda Energy Credit Capitalisation Company (UECCC) was operationalized in 2009 to manage and administer the Uganda Energy Credit Capitalization Trust. A major objective of the Trust is to provide financial, technical, and other support to unlock renewable energy and/or rural electrification projects for development. The Company is mandated to mobilize resources to capitalize the Trust to contribute to the sector's financing requirements, with focus on facilitating private sector participation. UECCC solicits the bulk of its funds from bi-lateral and multi-lateral partners, development financial institutions, and donor partners. UECCC works through participating financial institutions to provide Finance institutions with capital for both user loans and lender loans.

Rural Electrification Agency

The Rural Electrification Agency (REA) is a semi-autonomous body that was established in 2003 as the Secretariat of the REB responsible for managing the implementation of rural electrification projects. The REB also provides it with policy guidance. It is mandated to facilitate the government's goal of increasing rural electrification in the country.

Gaps and uncertainties in the current framework

There is need for additional clarity on some elements of the policy and regulatory framework, particularly pertaining to decentralized power generation, including captive power. In particular, the draft Energy Policy (2019) states that there is lack of an enabling framework for the export and sale of surplus captive power from self-generation facilities to the national grid.

The following points are to be noted where captive power systems are concerned:

- **Implication of new Policy & Regulations** – The Ministry and ERA have taken great strides in ensuring that electricity regulations and policies are streamlined and representative of the present times. Uganda has for several years topped the Electricity Regulatory Index Report published by the African Development Bank[48]. However, the draft Energy Policy (2019) continues to remain a draft and has not been operationalized yet.

- **Further Clarity in the Electricity Act** – The Electricity Act Section 51 (1) and (2) seem to contradict each other. One states the requirement of a generation license for a generating station equivalent to or greater than 0.5 MW while the other states registration of a generating station for commercial purposes whose capacity should not exceed 0.5 MW. With captive power plants ranging from 0.1 – 2 MW, these regulations are countering each other. There is a need for clarity between licensing and registration and whether presence of one negates the need for the other or if both are needed regardless. As it stands, it is open to interpretation.

- **Net metering** – there is no specific regulation guiding or governing net metering. The government is planning a pilot to live-test the initiative and design appropriate regulations based on the testing data. Some internal discussions (ERA, MEMD & REA) are ongoing on the matter. A new metering code is being developed.

- **Planned merger of Government entities** - Uncertainty over the ongoing implementation of the long-planned merger of REA, UETCL, UEGCL and UEDCL creates grey areas in terms of the responsibilities of the merged actors and coordination of planned support for the sector.

48 https://www.afdb.org/en/news-and-events/press-releases/uganda-tops-african-development-banks-electricity-regulatory-index-fourth-consecutive-year-47734

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