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Clean captive power: Understanding the uptake and growth of commercial and industrial (C&I) solar PV in Kenya

Bhamidipati, Padmasai Lakshmi; Gregersen, Lucy Ellen

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Understanding the uptake and growth of commercial and industrial (C&I) solar PV in Kenya

Preface

The UNEP-DTU Partnership, with support from DANIDA, is implementing a three-year project, The Technology, Markets and Investment for Low Carbon and Climate Resilient Development (TEMARIN) in two African countries, namely Kenya and Uganda. This project aims to: 1) analyse successful case studies of market-led interventions and mechanisms in Kenya, and identify key learnings; 2) support technology transfer partnerships in respect of a selected 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 knowledge and recommendations in Kenya and Uganda.

This report contributes to the project's aim by undertaking a detailed analysis of clean captive generation through solar PV in Kenya. It provides an analysis of the market mechanisms involved in the diffusion of technology and the key drivers and determining factors which led to this uptake, and shares lessons and recommendations. This example shows how the captive PV segment has evolved in Kenya, through which actors and supporting factors, and by what means in terms of support structures, enabling environment, policy incentives etc. 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 to further market expansion. The conclusion summarizes key lessons and takeaways.

Authors

Padmasai Lakshmi Bhamidipati
Lucy EllenGregersen

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Contents

1. Introduction

Growing urban populations, industrial parks and large infrastructural projects in Sub-Saharan Africa (SSA) have led to a rapid growth in energy demand. There is an urgent need for policy-makers to address the lack of access to electricity and, most importantly, the unreliability of the electricity supply. While these problems have led to the increased deployment of utility-scale PV and distributed solar PV, among other renewables, there have been several challenges in and barriers to their uptake.

Industrialization is gaining pace in many SSA countries, and industries and businesses continue to be hampered by unreliable electricity supply (IEA, 2019). Inadequate and expensive electricity provision is reported to "increase costs, disrupt production, and reduce profitability". According to the World Bank Enterprise Survey Report for Kenya (2019), based on their findings from 1001 firms in Kenya, nearly 4.3% of reported lost sales are due to power outages. Typically, these businesses end up relying on back-up diesel generators using expensive fuels during outages and related supply shortages. This combination of unreliable power supply, high utility grid tariffs and the high costs of diesel-based back-up power is leading to reductions in the competitiveness and efficiency of these industries and commercial businesses.

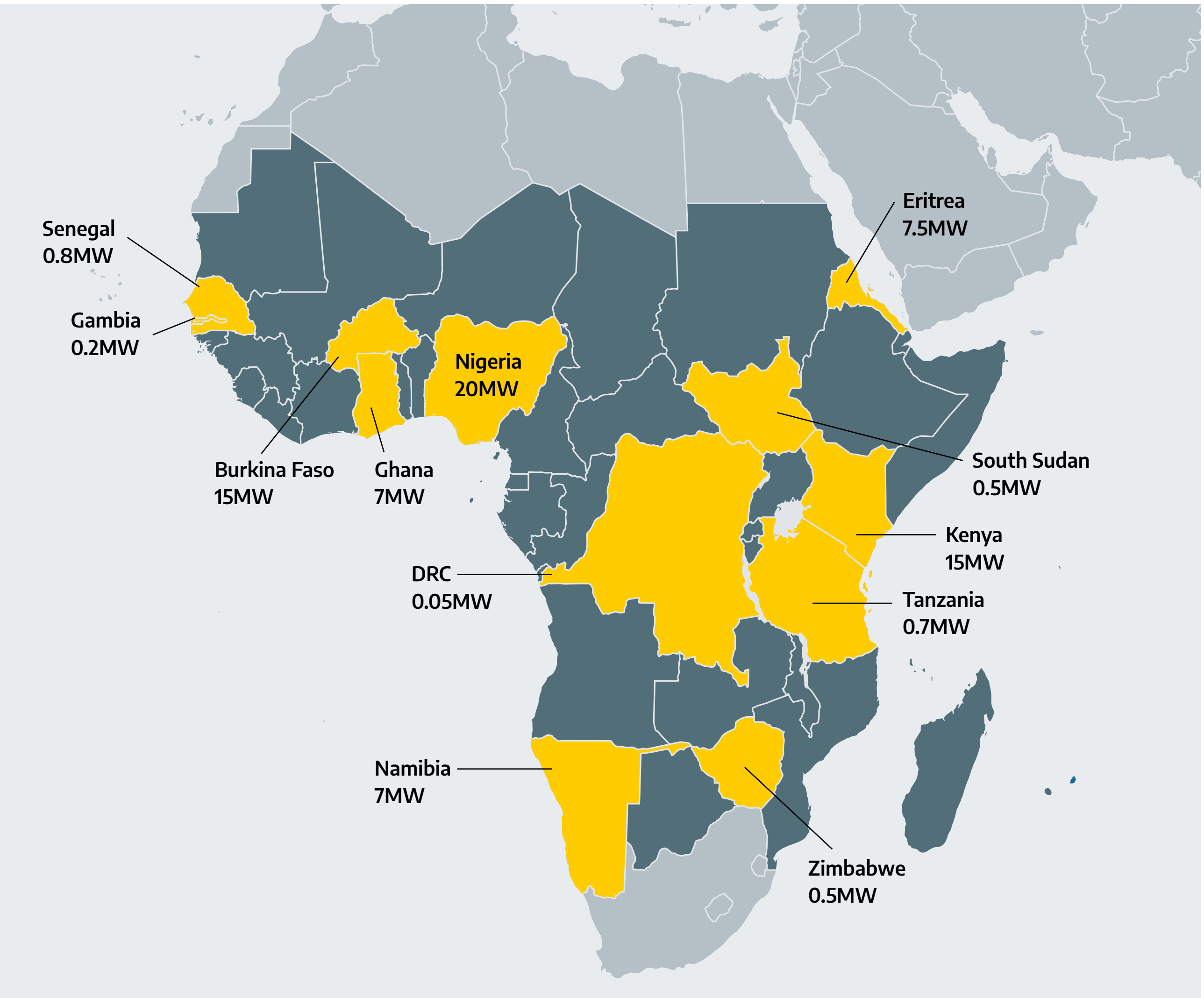
Solar PV is rapidly emerging as a viable source for industrial and commercial entities to complement the grid, switch from diesel generation or adopt fully off-grid solutions complemented by battery storage. This process is understood through different but synonymous terminologies: captive electricity generation (or self-generation), embedded generation (involving self-generation and sale of surplus power), rooftop solar PV (not requiring additional land resources) and commercial and industrial PV (PV systems for industry). All of these broadly refer to the decentralized power installations owned by industrial, commercial entities and public institutions, which generate electricity for their own consumption and may have an option to export energy to the national distribution network. In this report, we refer to this as "captive PV" generation for industry, but we also use these terms interchangeably.

In SSA, most large businesses rely on the grid for power, with diesel generation as backup. A recent Bloomberg Finance Report (BNEF 2019) undertook a review in SSA and found that there has been a surge in PV-based captive electricity generation and use by industrial and commercial entities. The recorded installed capacity as of January 2019 in the commercial and industrial (C&I) solar PV sector in SSA was 74MW (BNEF, 2019). Furthermore, nearly 80% of this installed capacity was added only in the past two years, encouraging projections that this capacity will double in the near future (Kawahara, 2019).

Figure 1 shows installed capacity in different SSA countries as of January 2019 (outside of South Africa, which has the highest installed capacity in Africa). The capacities are highest in Nigeria, Kenya and Burkina Faso (each on or above 15MW), followed by Ghana, Namibia and Eritrea. According to BNEF (2019), the C&I solar sector is growing "not because of regulatory support, but because of economics". Most of the installations are designed in such a way that the targeted facility consumes all the electricity generated, typically entailing a mix of solar, battery storage and diesel generators. Net-metering schemes are yet to be fully implemented across countries in SSA, and hence the incentives to supply surplus electricity to the grid by decentralized power generators (or prosumers) are yet to be worked out.

These are significant figures compared to the total installed capacity of these countries, and a lot of the developments in the captive PV segment catering for industry and commercial entities have taken place within a short time-frame. It is relevant to pause here

FIGURE 1. Countries with C&I solar projects in Sub-Saharan Africa



Source: BloombergNEF. Noto: Countries coloured in yellow indicate that there are known C&I solar projects plus installed capacity that developers reported to BNEF.

and question what we know about this emergence and rapid growth, how this has market evolved, who and what have been the key drivers, and how the uptake has been driven beyond just the economics being right.

Based on a background review, we find that there is little coverage of these developments in either the grey literature or academic outputs. While the BNEF report provides a detailed overview of the sector and the trends in SSA, it also opens up many questions that are left unanswered and under-researched. This report therefore seeks to investigate this captive PV generation in support of industrial and commercial enterprises guided by the broad question: How has the captive PV market for industries evolved? This is supported by two subsidiary questions: What have been the key drivers? And how did the PV firms leverage on this growing market?

We are exploring these questions by undertaking an in-depth case study of Kenya, which BNEF identified as one of the SSA countries with the highest C&I installed capacity. As Kenya is also one of the countries with the highest installed capacity of decentralized solar PV systems (off-grid), this case study presents a unique opportunity to gather lessons and learn about the drivers in one of the most vibrant PV markets in Sub-Saharan Africa.

This introductory section is followed by Section 2, which explains the methodology and the methods employed for carrying out this study, followed by

Section 3, which provides a detailed description of the demand and supply side of the captive PV market. Section 4 provides an analysis of the main drivers on the supply side and the multifaceted ways in which actors provide impetus to this market segment, followed by a discussion in Section 5 of the barriers to wider market growth. The report concludes by discussing some key highlights, issues and challenges, as well as future trajectories in Section 7.

2. Research Methodology

This report is based on primary and secondary data collected between July and December 2019 in order to highlight the drivers and evolution of the commercial and industrial PV segment in Kenya. As already mentioned, we focus on Kenya because it is one of the SSA countries with the highest PV installation capacity and has a large market potential (BNEF, 2019).

As the first stage, a desk-based background review was conducted to describe the context, the problem, how the captive PV market developed in Kenya, and the issues and challenges surrounding it. We identified a lack of readily available public information on this market segment in Kenya except for the BNEF report, firms' websites and media articles on commissioned projects.

This led us to identify the information or primary data required to obtain interesting insights. A broad interview guide was developed with thematic sections. We approached relevant stakeholders through emails and phone calls to schedule Skype or in-person interviews. Subsequently, multiple interview guides were developed targeting specific actor-groups: that is, separate interview guides were developed for Engineering, Procurement and Construction (EPC) firms, private financiers and Energy Service Companies (ESCOs), as well as the Energy and Petroleum Regulatory Authority (EPRA). These questions were also revised, altered and sharpened as we gathered more information in order to keep them relevant and to capture more targeted responses where possible.

The majority of the interviews were undertaken in-person during a one-week field visit to Nairobi between 23rd and 27th September 2019, as well as by Skype and telephone. In total, 21 semi-structured interviews were conducted with private-sector firms, financiers and investors, ESCOs, sub-contractors, consultants and the electricity regulatory authority. The list of stakeholders interviewed is detailed in *Annex I*. All interviews were accompanied by extensive note-taking, preparing detailed interview transcripts and identifying missing data. Follow-up emails and questions for clarification were also sent to interviewees. A thematic data analysis was carried out to identify the broader patterns, themes, explanatory factors relating to the market, how actor networks are organized and the barriers and challenges surrounding them.

Furthermore, we attempted to consolidate a list of all captive PV projects that had been implemented to date, based on a range of primary data sources and various secondary data sources. The secondary data sources included published reports (Hankins 2019) and media articles (Norton 2017; Kwahara 2019; Njanja 2019). However, information on only thirty (30) projects could be gathered through such secondary data. Primary data mainly include the data from all the interviewees who have shared their project lists, and in some cases we have also cross-verified and added projects from company or installer websites. Only those projects have been included in the list which could either be validated by the firm itself or where it has included the project as part of its online project portfolio. The total number of projects gathered as a result is 173 (equating to 30.2 MW) and under-construction projects are 11 (equating to 9.2 MW). A detailed list of projects is given in *Annex V*.

3. What is the captive PV market, and how is it organized in Kenya?

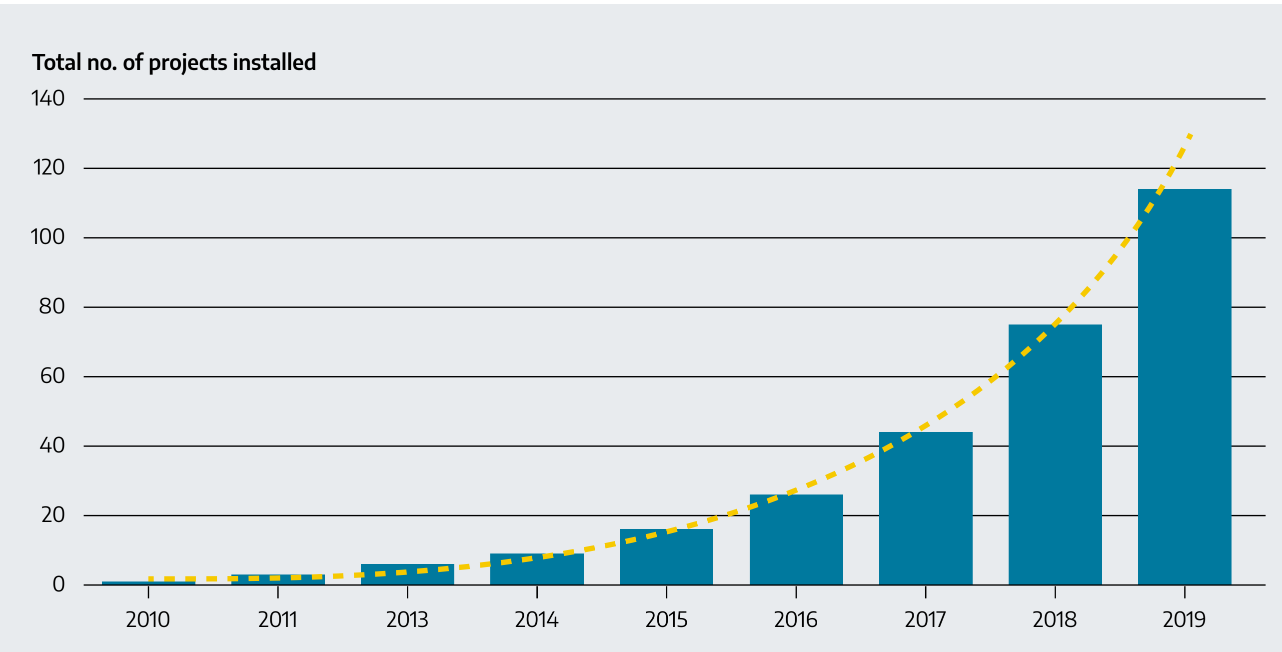
3.1. Captive PV power generation in Kenya

The KPLC Annual Report (2018) stresses that there were nearly 3900 large commercial and industrial power consumers in Kenya in 2018, of which 10% were the most energy-intensive. The World Bank's Enterprise Survey for 2013 estimates that 57 percent of Kenyan manufacturing firms use a diesel generator to provide 15 percent of their electricity. This means that many of these businesses could potentially benefit from installing solar PV systems and generating electricity for self-consumption.

In line with the broader SSA trend in the C&I sector, Kenya has witnessed an increase in the captive solar PV segment over the past few years. Currently, this segment represents approximately 1% of Kenya's total electricity generating capacity (at midday) (Hankins, 2019). In an electricity market such as Kenya's, where the national utility struggles to deliver reliable power to its consumers, self-generation has become an attractive option for power-consuming industries and institutions that depend on stable power supplies.

As Figure 2 shows, Kenya has experienced impressive growth in number of captive PV project installations, especially since 2014, with an average project size of 175 kW. This figure is based on the data (primary and secondary) compiled for this study, which includes a total of 173 projects (plus 11 projects are under construction as of 2019), though we lack information on the commissioning date for 59 projects. We can, however, assume that most of these 59 projects were also installed in the same period between 2015 and 2019. While this is representative of the overall trend, these data are not exhaustive, as they are based on a total of only 114 projects.

FIGURE 2. Cumulative Captive Solar PV Installations in Kenya



Source: authors' own elaboration (covers 114 out of 173 installations for which commissioning date is known)

3.2. The power consumers

A majority of the demand for electricity self-generation through solar PV is driven by manufacturing industry, the horticultural sector and commercial entities such as malls, warehouses, office buildings and public institutions (universities, hospitals). They all require a reliable, stable and affordable electricity supply, which the national utility cannot always provide.

In Kenya, three different types of PV integration are taking place, as highlighted in the box. The first points to the consumers who are already connected to the grid and who have high power requirements during the daytime. For these users, PV is connected to the facility's main distribution board and thus displaces some of the electricity intake from the main grid. Many of the manufacturing, commercial and horticultural systems fall into this type of consumer. The second type is PV with diesel generation as back-up, where PV mainly replaces diesel-produced electricity. Those in this group of consumers are either completely reliant on diesel generators or have a very unreliable grid connection. Many of the lodges and a few flower farms are of this type. The third type is a complete off-grid set-up with primary generation from a PV system coupled with battery storage for continuity of supply. This has mainly been adopted by lodges located around national parks that cater to tourists.

Box I: Type of captive PV options

- PV grid-tied solar system: if consumers have high electricity consumption during the day and are connected to the grid, this PV system will supplement the day-time consumption (most manufacturing and commercial facilities).
- PV-diesel hybrid system (grid-tied or off-grid): if consumers are running diesel generators as their main power source or have an unreliable electricity grid, they couple a PV system to the diesel generator (Masai Mara lodge, flower farms etc.)
- PV battery-storage hybrid (off-grid): if consumers are not connected to the electricity grid. (Amboseli lodge)

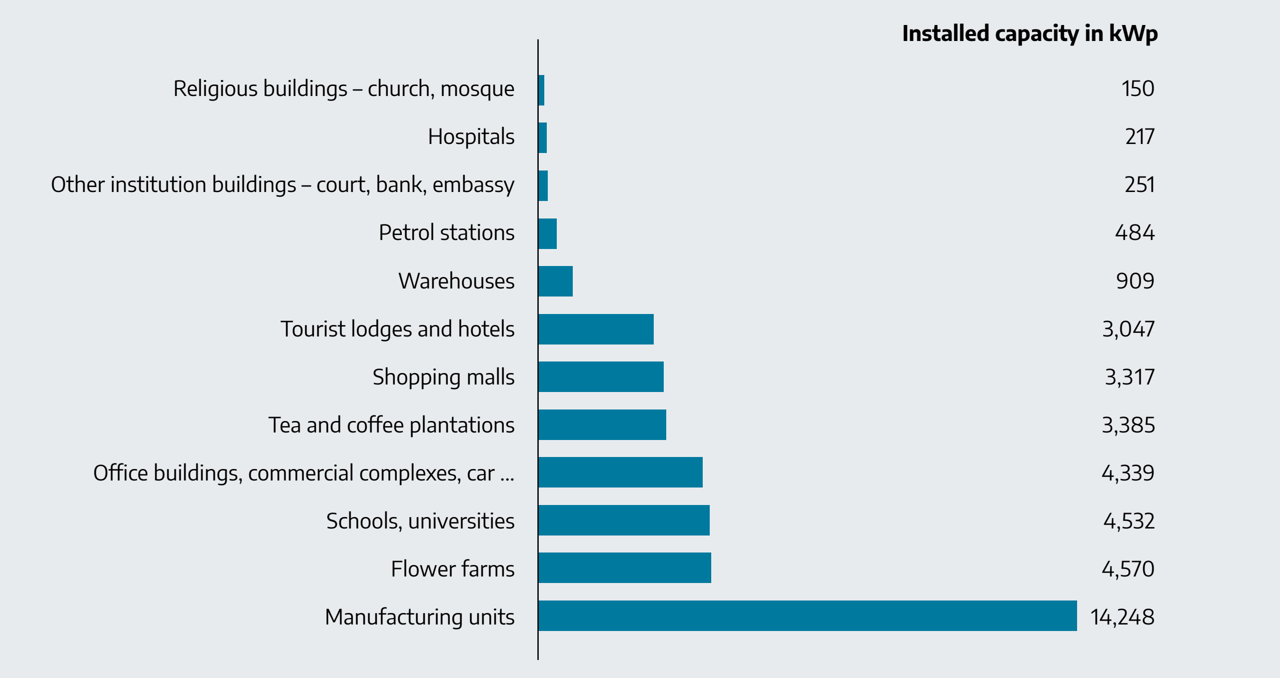
Based on interviews, we find that at present a majority of the projects installed are grid-tied (first type), with very few being off-grid or PV-diesel hybrid/PV battery storage projects (second and third type). Our findings also suggest that the user category of those installing captive PV systems primarily comprises manufactur-

TABLE 1. Installed capacity and number of projects for various user categories

User category	Installed capacity (in kWp)	Projects (nos.)	Average system size (kWp)
Industrial units, manufacturing, factories, processing units	14,248	39	365
Flower farms (roses etc.)	4,570	29	158
Schools, universities, colleges, skill centres	4,532	15	302
Office buildings, commercial complexes, car showroom, residential	4,339	24	181
Tea and coffee plantations	3,385	5	677
Shopping malls	3,317	7	474
Tourist lodges, hotels, resorts	3,047	18	169
Warehouses, cargo facilities	909	3	303
Petrol stations	484	30	16
Other institution buildings - court, bank, embassy	251	4	63
Health Centres, clinics, hospitals	217	8	27
Religious buildings- church, mosque	150	2	75
Total	**39,449**	**184**	**214**

Source: authors' own elaboration

FIGURE 3. Installed PV capacities for different user categories



Source: authors' own elaboration

TABLE 2. Installed PV capacity for the main sectors

No.	Sectors	User categories	kWp	%
1.	Industrial	small and medium-scale enterprises: rolling mills, steel pipes, glassware, plastics, salt, distillers, oil refineries etc.	14,278	36%
2.	Commercial	malls, lodges, hotels, safari camp sites, cargo facilities, airports, warehouses, office buildings, food-processing units, petrol stations etc.	11,531	29%
3.	Horticulture	tea plantations, flower farms, coffee plantations etc.	7,905	20%
4.	Institutional	public institutions such as schools, hospitals, universities, embassy buildings, mosques etc.	5,735	15%
Total			**39,449**	**100%**

Source: authors' own elaboration

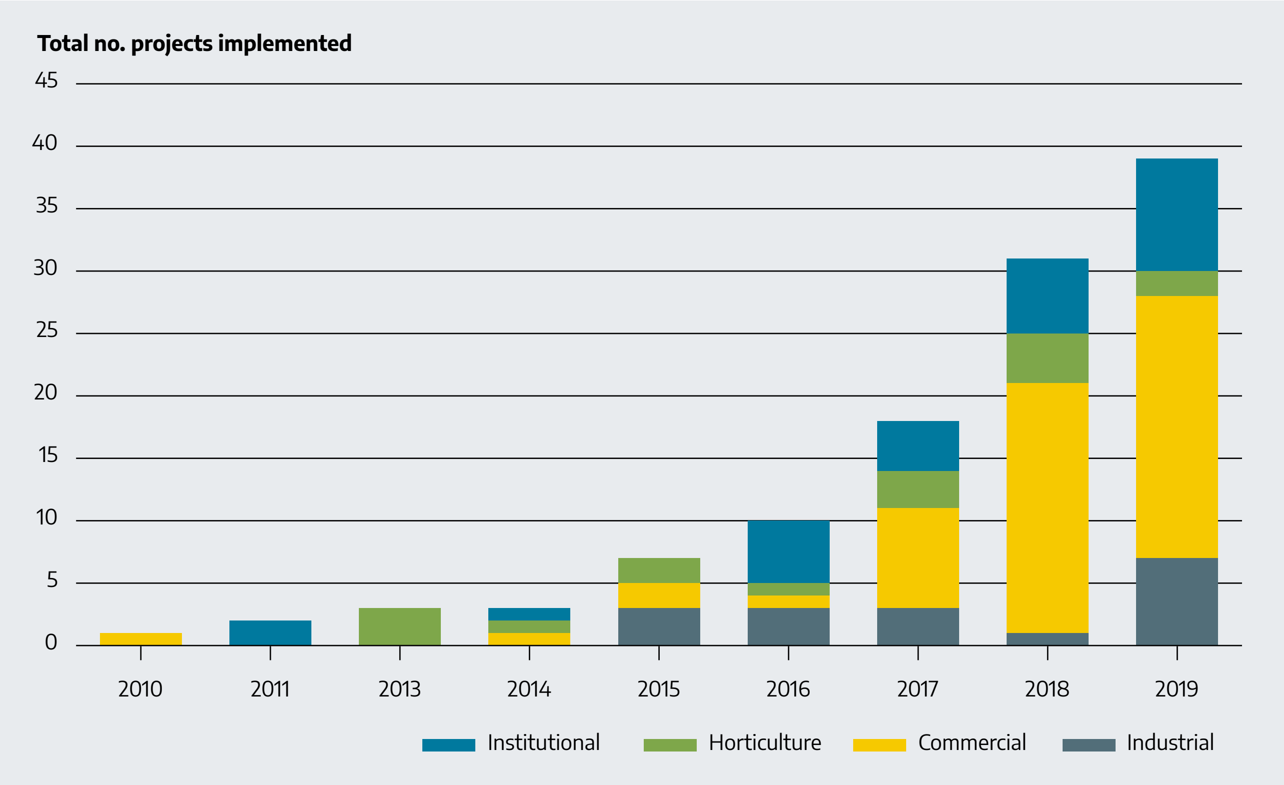
ing industry, horticulture (flower farms), malls, factories, tea estates, hotels, and universities. These are relatively high energy-consuming users (in comparison with residential or domestic consumers) with potentially a greater willingness to pay higher prices for electricity in exchange for a more stable and reliable power supply.

Based on our data of 173 projects, the total installed capacity as of December 2019 is nearly 30.2 MW. In addition, we also have primary data on 11 projects which were under construction in 2019, totalling 9.2 MW, making it a total of nearly 40 MW of installed capacity for captive PV installations in Kenya. Detailed information about the installed capacity and the number of captive PV projects for various user categories are shown in Table 1. This includes both the projects implemented and those under-construction as of 2019.

Figure 3 provides a graphic presentation of installed capacity per user category from Table 1.

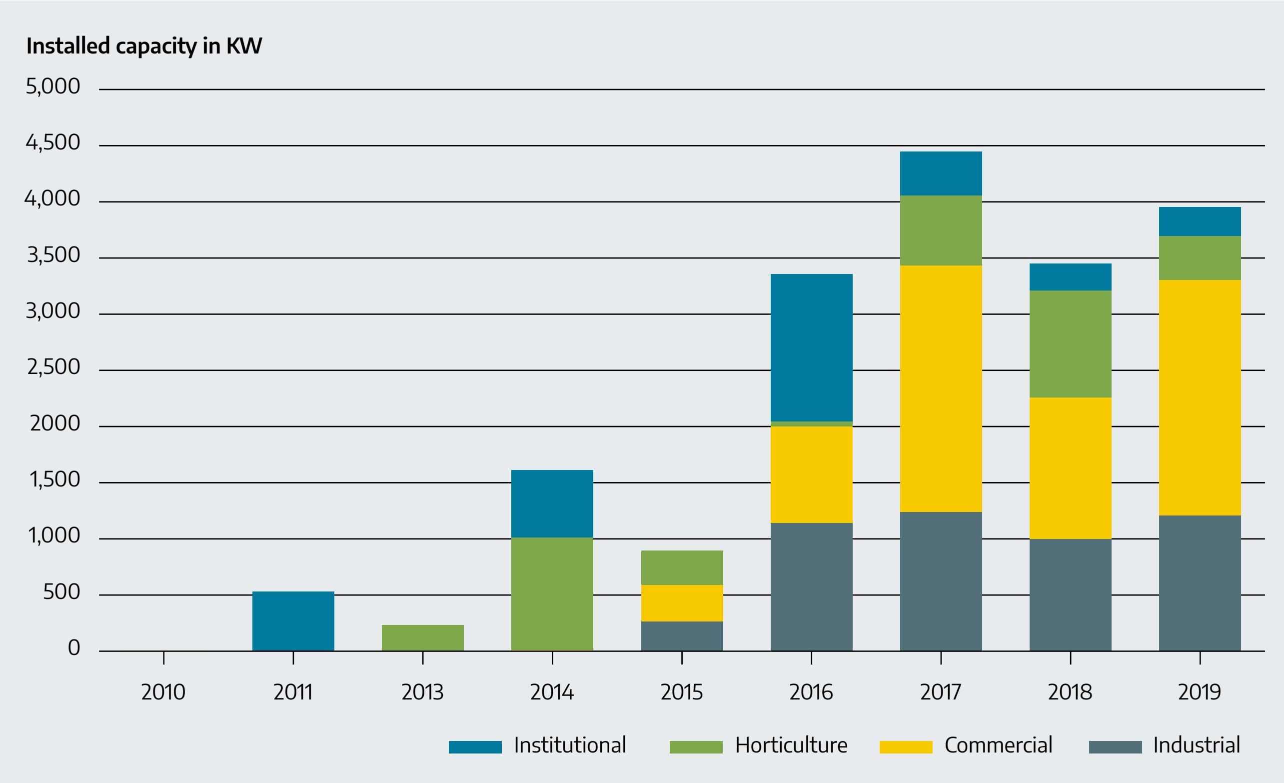
In Table 2 we consolidate the disaggregated data and bundle up the projects into four sectors: industrial, horticulture, commercial and institutional. While for tariff purposes, there are only two categories in Kenya

FIGURE 4. Installed number of projects in the four sectors (2010-2019)



Source: authors' own elaboration

FIGURE 5. Installed capacities (in kW) in the four sectors (2010-2019)



Source: authors' own elaboration

i.e. commercial and industrial, we have disaggregated it further in order to understand the consumers and the sources of demand. The specific type of users have been defined in this report for each of the sectors (see Table 2).

The table shows that nearly 36% (~14.2 MW) of the captive PV capacity is concentrated in the industrial sector. 29% (~11.5 MW) of the capacity has been installed in the commercial sector, followed by 20% (~8 MW) in the horticultural sector and 14% (~5.7 MW) in the institutional sector. The industrial sector is clearly the dominant user category for adopting grid-tied captive PV systems, however the commercial sector is also emerging as a very dominant category, particularly when we add the projects under construction as of 2019. The average system sizes (kWp) are much higher for commercial projects such as shopping malls when compared to manufacturing units, as also evident in Table 1.

Figure 4 and 5, show the year-on-year growth for these four sectors based on the 114 projects/plants for which we have commissioning data. Figure 4 shows the total projects commissioned and Figure 5 shows installed capacities added over time.

There are a few interesting points to note about these two figures. While the total number of industrial projects seem to be low as per Figure 4, the installed capacities seem to be relatively high as indicated in the Figure 5 (e.g. oil refineries). Similarly, while there is a linear progression in the institutional projects from 2016 onwards, the installed capacities fluctuate and seem to be of lower kW capacity (typically the case for small health centres etc.). The commercial and industrial sectors capture bulk of the projects as well as installed capacities. There has been a surge of commercial projects, particularly shopping malls, hotels and lodges, petrol stations, and office complexes. The industrial consumers employed solar PV to their grid-tied installations primarily from 2016 onwards, and many industrial clients followed suit. Word-of-mouth referrals have been an effective way to grow demand and secure more power consumers.

It is interesting to note that about 72% of projects have a capacity below 200 kW. Of these, 37% are below 50 kW (mostly petrol stations, health centres and schools), while the other 35% fall in the range of 50 – 200 kW. This category includes a mix of flower farms, lodges and resorts, manufacturing units and hospitals. In the midrange between 200 and 500 kW we find 14% of the projects, while for the two upper-end categories, between 500 and 1000 kW we find 10% and above 1000 kW, we find only 4%. This amounts to seven projects, which includes a Kapa oil refinery, the Two Rivers Mall, the ICIPE scientific research centre, Kenya school of monetary studies, a tea estate and a factory.

This section explained the demand for integrated PV systems, the types of consumer that form this market, and the numbers of users and installed capacities according to various types, sizes and categories, and yearly progression. It showed that 30.2 MW of projects have been installed, mainly in the industrial and commercial sectors, and that adding the 9.2 MW under construction in 2019 would add up to nearly 40 MW. In the next section, we focus on analysing the supply-side dynamics and how is it organized to respond to the increasing demand for PV systems.

TABLE 3. Number of projects and installed PV according to project size

Size in kWp	Number of projects	Share %	Installed capacity kWp	Share %
0-49	68	37%	1,408	4%
50-199	64	35%	6,031	15%
200-500	26	14%	7,231	18%
501-1,000	19	10%	14,495	37%
>1,000	7	4%	10,284	26%
Total	**184**	**100%**	**39,449**	**100%**

Source: authors' own elaboration

3.3. The supply side

On the supply side, the main sets of market actors include: i) project developers, project finance advisors and consultants; ii) the engineering, procurement and construction company (EPC) that designs, procures and installs the system; iii) the operations and maintenance company (in most but not all cases these tasks are performed by the EPC); iv) international financiers that provide finance in the form of grants, loans, project finance and working capital to solar PV firms and Energy Service Companies (ESCOs); v) and ESCOs that finance, build, own and operate the system and either sell electricity directly to the consumer (through a contract agreement) or lease the system (operating lease or a rent-to-own lease) and provide a service for which a monthly fee is charged, thereby treating it as a service offering.

Here we define an ESCO as a legal entity, the owner of the project that either sells electricity directly to the customer (i.e. it functions as an independent power producer (IPP), through the power purchase agreement (PPA) model) or provides a service by leasing equipment (operating lease or rent-to-own). An ESCO could be set up as a so-called single-purpose vehicle (SPV), that is, a company established with the sole purpose of owning and operating or leasing the system in question. The SPV will have equity funding from a single investor or a group of investors, which may be a hardware supplier, an EPC or a strategic investor, or debt finance from banks, institutional finance institutions or donor finance. There is at least one such case of an ESCO/EPC SPV model. On the other hand, some EPCs could also function as an ESCO, owning and operating the PV system. The ESCO may be operating its own investment fund, with finance pooled from various sources.

As an alternative to engaging with an ESCO or financier, consumers can finance, own and operate a PV system themselves, engaging an EPC contractor to design, procure and install the system, as well as a company to maintain the system when needed.

Across the PV value chain, there are a number of processes and different types of roles and responsibilities that are shared by the developers, the EPC firm, the sub-contractors and the ESCOs or financiers. *Annex II* and *III* provides a list of key financiers, EPC firms and subcontractors in the captive PV market.

Since Kenya is a relatively mature market for PV diffusion in SSA across off-grid, mini-grid and grid-scale segments, a number of market actors already exist that specialize in designing PV systems procuring equipment, system installation and maintenance services, as well as in providing financing options through ESCO. While some solar PV firms have the capacity to carry out all activities from consultancy to installation to operation and maintenance, others rely on either other EPCs or sub-contractors to carry out certain specialized activities.

Based on interviews, we find that in many cases it was the EPC firm that undertook the role of finding potential clients, preparing proposals to convince the consumer of the various modalities involved and also bearing the responsibility of finding a financier/ESCO to own and operate the system, assuming it is not a direct purchase. In these cases, the system-design (engineering), equipment-procurement and installation services are mainly provided by EPC firms while the system is owned and operated by the ESCO, which enters into an official contract with the customer for sales of power or leasing the equipment.

We have identified 21 solar PV firms (EPC, O&M) with a track record of PV advisory, installation and maintenance services in the captive PV market, and 11 sub-contractors which support these PV firms with specialized services (such as construction or maintenance or providing additional human resources). Of the EPC/O&M firms, two (2) are no longer active in the market (Azimuth Power and East African Solar). Nearly 50% of these firms are of Kenyan origin, the remainder being foreign-owned but operating locally. These include firms or founders from Uganda, India, Netherlands, USA, UK and Germany. A brief profile of the EPC firms and the number of projects installed is provided in *Annex II*.

So far this report has described the main users and industry consumers of the captive PV market segment and the supply-side actors, showing how different roles are assumed. The next section describes the various financing modalities through which captive PV projects are implemented, the type of engagement that the actors have and the types of contract involved.

TABLE 4. List of key financiers, firms and subcontractors in the captive PV market

No.	ESCOs/ International Financiers/Local Banks	Project Developers/ EPC/ O&M Firms	Subcontractors
1.	Actis Private Equity	Astonfield	Equatorial Energies (not operating at present)
2.	Ariya Leasing	Azimuth Power	IMEX
3.	Berkeley Energy	CP Solar Resources Ltd	Sunspot
4.	Crossboundary Energy	Davis & Shirtliff	Trans Ambientala
5.	Ecoligo	East African Solar	Paragon
6.	Inspired Evolution	Equator Energy	Klinga Base
7.	Japan's Joint Crediting Mechanism	Gosolar	Tamara
8.	Maris	Greenspark	Naima Construction
9.	Mettle	Harmonic Systems	Shaw Energy
10.	ResponsAbility	Knights Energy	Perpetual Energy
11.	Solar Africa Platform	OFGEN	Mazard Engineering Ltd.
12.	Solarise Africa	Orb Energy	
13.	Sunfunder	PowerGen Renewable Energy	
14.	AFD SUNREF	Premier Solar Solutions	
15.	DWS	Resol	
16.	Local Commercial Banks – Prime Bank, Cooperative Bank, DTB, Equity Bank.	Smart Solar Solutions	
17.		Solarcentury	
18.		Questworks	
19.		Strauss Energy	
20.		Solarise Africa	
21.		Solar Africa	

Source: authors' own elaboration (based on various sources)

3.4. Implementation and financing models

While in many instances industry consumers have opted to self-finance their PV systems through bank loans or upfront cash payments, some users have relied on ESCOs, EPCs or financiers to finance the entire investment, in return for a long-term contract and monthly payments for electricity. The implementation models are further described below.

Direct purchase (consumers own and operate model)
In this model, consumers buy, own and operate the solar system, which is typically installed by an EPC contractor. The consumer finances the installation through balance-sheet financing, bank loans and/or donor finance channelled through local commercial banks (SUNREF/AFD). The advantage of this model is the option to reap all the profits from the investment, instead of sharing the potential profit with an ESCO or EPC. The disadvantage is that the end-user is responsible for financing the whole system, operation and maintenance, as well as assuming the investment risk. Some of these risks, however, might be mitigated by contractual agreements with the EPC that installed the system or a service company.

ESCO Power Purchase Agreement (PPA) model (consumer pays fee for electricity)
In this model, the consumer buys power from the ESCO at a fixed price per kWh for a certain period

(typically ten to twenty years). In this case, the monthly payment may not be fixed and may be dependent on the actual energy consumed (kWh) per month. In some cases, the monthly payment is also based on an agreed minimum offtake per month. The minimum offtake minimizes the risk for the investor in enterprises with only a seasonal demand, such as lodges, schools and institutions. For example: a lodge will sign a minimum offtake of 80% of its baseline consumption for the entire duration of the contract. These contracts, signed between the financier (ESCO) and the consumer, typically include project maintenance, insurance and performance guarantees.

The ESCO is required to inform the Energy and Petroleum Regulatory Authority (EPRA) about the sale-purchase agreement, pay tax and use the PPA format as approved by EPRA. In this case, the consumer can get some assurances, e.g. seeking legal redress, readjusting tariffs in relation to grid tariffs, equipment guarantees, involving the regulatory authority in cases of dispute etc.

ESCO leasing model (consumer pays leasing fee)

Leasing is a relatively easy way to get around the regulatory process. With a leasing contract, the ESCO continues to own the system. The consumer pays a monthly lease for using the system, and consumes the electricity produced. In most cases the leasing company is responsible for system maintenance. In some cases consumers make an upfront payment, and thereafter make monthly payments till the end of the contract period. Based on whether it is a rent-to-own model or an operating lease, ownership may or may not be transferred at the end of the contract period.

In practice, there is little difference between PPA and leasing. The difference is between selling power directly and leasing the system which produces power. Leasing is reported to be a hassle-free alternative to PPA in that it avoids some of the regulatory requirements and having to obtain the approvals that would otherwise be needed from the electricity regulatory authority.

In the ESCO leasing model, the ESCO takes the financial risk and the technical risk of electricity production by the system. Depending on the precise contractual details, the ESCO also assumes the risk of default or bankruptcy on the part of the consumer. When signing the contract the consumer is informed about the future costs of purchasing electricity, so the consumer risk is that the grid tariff falls in the future. To share the risks between the ESCO and the consumer, PPAs have a variety of clauses, such as those to deal with fluctuations in inflation and exchange rates, and changes in the tariff for grid-connected electricity.

Discussion

Of these models, direct purchase is reported to predominate[1], followed by ESCO leasing or PPA. Industrial consumers with an interest in installing larger PV systems prefer ESCOs to take on the responsibility for financing. Larger projects have witnessed financing through private equity funds (such as the 858kW Garden City Mall), while some smaller projects have been financed through crowd-funding. An example is a 118.9 kWp solar project supplying a flower farm in Kenya, for which €144,000 was raised through Ecoligo investments in just ten days. In this case, the money is provided as a loan to the ESCO Ariya Leasing (BNEF 2019).

[1] Nearly 65-70% of the projects are secured through outright purchases by the customers themselves.

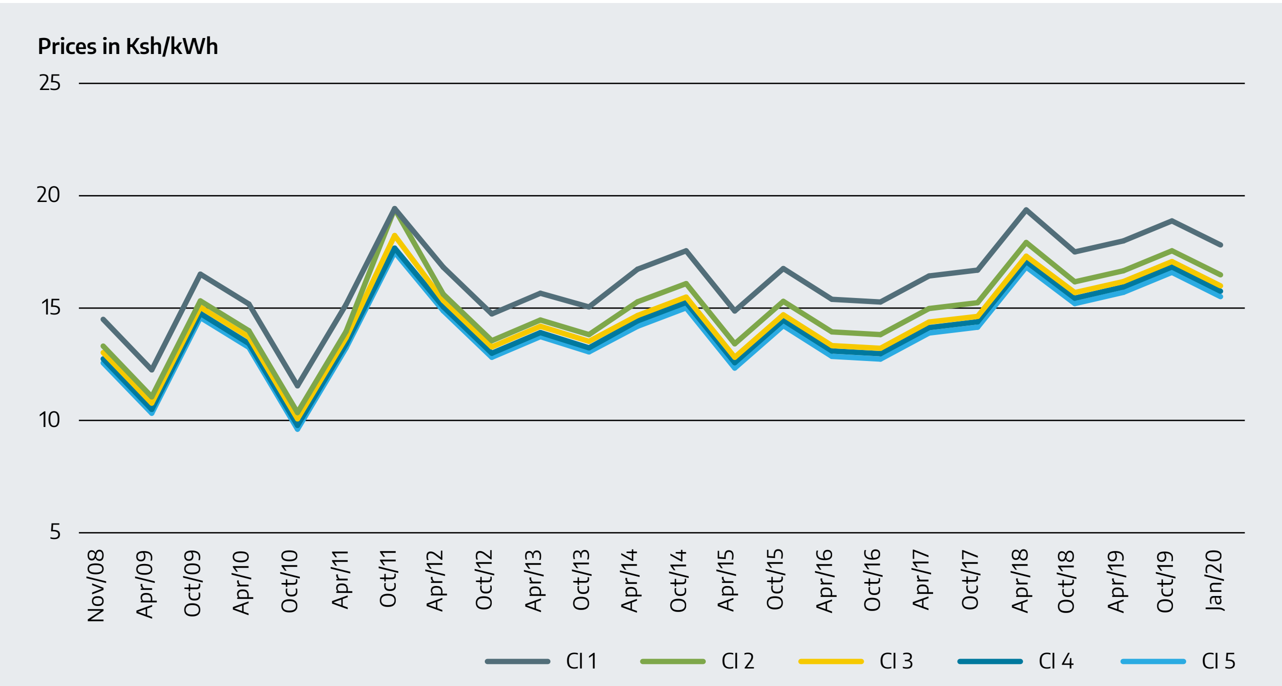
4. How has the market evolved? What are the main drivers?

4.1. Energy cost savings

According to interviews, a reduction in electricity bills is the main motivating factor for most captive PV power users. The business case for the self-generation of power is strong when the cost of self-generation is less than the cost of electricity from the grid and/or other existing sources (such as diesel generators). Furthermore, interviewees stress that it is more attractive for the EPC and ESCOs to engage in projects that have an energy demand during the daytime on all days of the week (such as lodges and some industrial units), unlike institutions such as schools, which do not operate during weekends and in the holidays and end up with idle PV generation during these periods. The higher the energy consumption and the better the time-wise match between production and consumption, the easier it is to make a cost-savings case for a grid-tied captive PV system.

The electricity grid tariffs for commercial and industrial consumers (C1 to C5) typically vary between 12 and 17 KES, but in some instances, the tariff rate has been as high as 22-23 cents, particularly for industrial consumers. The tariffs indicated in Figure 5 exclude the fixed and demand charges on the tariffs, which raises the price further. Based on a historical assessment of tariffs for C1 to C5 consumers, the peak tariffs have varied from 12 to 13 US cents in 2008 to 14-15 cents in 2012-13 and 17-19 cents in 2018-20. Interviews with a number of firms and financiers revealed that the tariff level for captive PV projects is below 10 cents, being in

FIGURE 6. Historical grid electricity prices in Ksh/kWh for C1 to C5 commercial consumers (2008-2020)



Source: authors' own elaboration based on data retrieved from https://stima.regulusweb.com/historic (base charge)

the range of 7-9 cents. Overall, there is an expectation among captive PV power consumers that at least 3-5 cents can be saved vis-à-vis current grid tariffs.

Based on the trajectory of the grid tariffs so far and the financial situation of the national utility (KPLC), several interviewees report that they do not perceive any reduction in future grid tariffs, which has also prompted many to explore alternative opportunities for cost reductions. A KPLC representative reported that they obtain nearly 80% of their income from commercial, industrial and other high energy-consumers, so increasing captive consumption might have a negative effect on the revenues of the national utility company, KPLC. While the tariff projections cannot be fully ascertained, they anticipate that in the long term (owing to expectations of low-cost electricity from coal and renewables) tariffs could go down, but maybe not so much in the short term (owing to high inflation and index costs).

For a difference between the baseline scenario (grid) and solar PV, some EPCs report a direct reduction of 20% to 30% in energy bills compared to grid connection. However, conservative estimates also indicate a maximum of 10% overall savings (as solar accounts for only 25%-30% of the total power consumption). These figures could increase further if PV is compared to the scenario where diesel generator back-up is used during power outages.

However, very different claims are made about electricity savings or percentage reductions in electricity bills, this being difficult to validate based on precise calculations. Furthermore, as a few interviewees pointed out, if a user reduces the power consumed from the main grid, there are other indirect advantages as well, which also reduce their bills. For example, the utility puts a cap on power consumption (capacity) in order to manage the demand, but if users exceed this cap, they have to pay a high penalty charge to the utility. Fr horticultural farms, their highest demand for power is during the daytime, and several of them exceed their cap on consumption. By switching to solar, the amounts paid in penalty charges are thus reduced or removed.

Example: Sharing the energy cost savings experience by Bilashaka rose farm, of capacity186 kW- commissioned in 2018

28% direct savings on the kWh intake from the grid (energy generated by the solar system) – this figure is given by the solar system online portal (real measurement).

An additional 6% savings on the energy bill due to lowered demand charge penalty – this can be derived from the monthly electricity bill (by comparing with other months/years).

The demand charge penalty is to be paid when a company shoots over its contracted ceiling of power consumption. E.g. they can purchase electricity up to 100 kW of the agreed kWh price. If they use 200 kW for a minimum time period, then they have to pay penalty for this 200-100 kW=100 kW amount. In Kenya it is about US$8 per kW consumed more in a certain month.

(Source – Based on an interaction with an EPC firm responsible for this project)

4.2. Financing readiness, availability and investment opportunities

While a number of users have self-financed their PV systems, whether installed on roof tops, on carports or ground-mounted, many others have also struggled to make bulk payments upfront or take out bank loans to cover these payments. In order to reach out to a wide range of users, a number of projects increasingly involve external financing. We have identified fifteen international financiers that are currently active in the captive PV market (see Table 4). These include DFIs, government embassies, impact investors, family offices, foundations, high net-worth individuals and other institutional investors. Additional details on the financiers, their profiles, types of investment and financing sources have been included in *Annex III*. The international financiers typically provide either debt or equity financing or blended finance, which includes a share of both debt and equity. Based on the interviews, the international financiers operating in the captive PV market can be consolidated into the following types:

1) Development finance institutions (DFIs) providing grants either directly or channelled through (concessional) commercial bank loans. Examples: AFD, USAID and Japan's JCM.

2) Financiers operating a dedicated investment fund created for a specific purpose by pooling finance from sources consisting of both debt and equity.

Examples include Crossboundary energy (ESCO) and the DWS fund.

3) Financing companies specialized in giving financial advice, fund and investment management, asset leasing, asset management and funding pooled from various sources. Examples: Inspired Evolution, Ariya Leasing, Faber Capital, Mettle, ResponsAbility and Berkeley Energy.

4) Crowdfunding debt platforms. Example: Ecoligo.

5) Targeted solar financing companies and ESCOs (includes project financing and leasing). Examples: Sunfunder, Solarise Africa, Solar Africa and Ecoligo.

Due to gaps in the data, it has been difficult to ascertain how many of the 173 projects are self-financed and in how many cases the consumer relies on external financing. However, we do have information on financiers for one hundred and three projects based on our primary data. Of the 103 projects (13.4 MW), nearly 73 are financed by the consumers themselves (4 MW), either by balance-sheet finance or by taking out local bank loans for capital expenditure. While the number of self-financed projects are relatively high, these are smaller sized (on average nearly 54 kW).

Twelve projects (4.6 MW) are financed by development finance institutions, international governments' agencies (including the EU, the French Development Agency AFD SUNREF, Japan's credit mechanism, the German government etc.). The remaining eighteen projects (4.8 MW) include those of dedicated investment funds and primarily private capital, such as Crossboundary, Solar Africa, Ariya Leasing, Mettle Solar, and crowd-funding platforms like Ecoligo. Of these, 8 projects (2 MW) are funded by SUNREF program of AFD, and 5 projects (2.2 MW) by Crossboundary Energy. The installed capacities of the projects financed by external financiers (either DFIs or private capital) is 317 kW on average.

With regard to external financing, we find that the two most important financiers playing a catalytic role are: i) AFD's (French Development Agency) SUNREF Program along with local commercial banks; and ii) Crossboundary Energy (supported by USAID, OPIC and impact investors). The two have very different types of financial offering (donor grant and equity investment).

The SUNREF program channels AFD funding as a loan or guarantee through a partner bank (commercial banks in host countries) to private companies tailored to promote green investments and seeking to develop their green finance portfolios. For little or no cost, AFD (with support from the French government, the EU and other partners) also provides technical assistance to private companies on strategy development, capacity-building and providing feedback on the profitability aspects of potential green projects (SUNREF, 2018). Interviewees reported that their technical assistance component is unique among all financiers and that it has provided valuable inputs for system design etc. AFD's main strategy has been to mobilize local banks and companies to support the green-growth agenda in emerging economies. AFD has already supported at least eight to ten captive PV projects in Kenya. Three local Kenyan commercial banks (such as DTB Kenya) have financed C&I solar projects under the SUNREF program developed by the AFD, allowing C&I consumers to install on-site solar at an interest rate of 4-6% Euros (BNEF, 2019). This has also been crucial in building local banks' capacities to finance their activities sustainably. A representative stressed that through local banks the SUNREF program is able to offer finance at very low interest rates, thereby outcompeting many alternative options. At the same time, other financiers have pointed out that there are several shortcomings to SUNREF's operations, which includes time lags in funds disbursement, predetermined funding allocations, and challenges with capacity building at local banks, among others.

Crossboundary Energy (CE) is part of a larger Crossboundary group that facilitates investments in emerging markets. Over the years, it has identified a host of institutional, corporate and development impact investors keen to invest in solar PV in Africa. The idea for a dedicated fund began in 2013, and in two years CE acquired ten or eleven impact investors and DFIs (USAID) for financial commitments, offering blended finance. CE was initially set up as a solar financing company with a $10 million equity fund dedicated to promoting PV diffusion among commercial and industrial consumers in SSA. CE currently operates as an ESCO through a partnership model, tying up with EPCs, and entering into contract agreements with power consumers to sell electricity through a PPA with fixed tariffs over a fifteen- to twenty-year period. In Kenya, CE has a long-term partnership with Solar

Century (an EPC firm) to implement PV projects. As reported in an interview with Solar Century, CE had already acted as an ESCO for five captive PV projects as of 2018, and several others were under construction in 2019.

We also briefly review a number of other international financiers, and ESCOs that have recently extended support to the captive PV segment in Kenya. Berkeley Energy is focused on investing in captive PV C&I projects in SSA. Currently in Kenya they have a pipeline of projects rated at nearly 3 MW (includes three projects above 500 kW). They are working with a range of EPC firms (including Astonfield, Harmonic Systems etc.).

Sunfunder provides debt funding for solar PV ESCOs in SSA by raising funds from institutional investors, family offices and foundations. Its main focus is providing funding to off-grid PV for rural electrification, and currently it has begun to provide funding to captive PV suppliers as well. Sunfunder has launched a $1.2 million debt facility with an EPC partner, Questworks, to implement projects. Inspired Evolution and Management, a Mauritius-based fund, and the DWS fund (supported by Deutsche Bank), Solarise Africa, an ESCO with origins in the Netherlands (provides equipment leasing and blended finance), are in their early stages of exploring and investing in the market. These international financiers mainly operate through and with support from the EPC firms in implementing captive PV projects. In the following we analyse further how the supplier industry has played an important role in driving the market.

4.3. Existing solar PV supplier industry leveraging to cater to the market

The energy cost savings have been a crucial driver for this market, but diffusion and uptake were to a large extent driven by a range of solar PV firms that aggressively pursued this market, supplemented their existing resources, experimented with new models of implementing projects, reformulated their business strategies, went beyond their typical roles and explored new partners, all to leverage the low-hanging fruit in this expanding market. Some of these PV firms have existed in the solar PV market in Kenya for a long period, whereas some others were new entrants aiming to create a lucrative part of the market consisting of high energy-intensive consumers such as industries, flower farms, malls etc.

Some of these firms engage in the entire spectrum of services entailed in a PV project installation, which includes technical advice, project finance advice, system design, procurement, installation, operations and maintenance, whereas other firms provide specific or specialized services such as only installation and/or construction, and/or system design and consultancy, while sub-contracting other phases, including O&M services due to lack of an in-house team. The different types of firms identified include a mix of ESCOs, full EPC firms, part-EPCs and sub-contractors, and O&M companies. These firms have pursued different kinds of business strategies and partnerships, and are engaged with different financiers to expand their growth in the captive PV market segment. In many ways, these firms have been responsible for crafting as well as expanding the market.

Based on project data and interviews, Harmonic Systems, Azimuth Power and Astonfield Solar were among the earliest solar PV firms to offer project advisory and maintenance services, as well as designing, procuring and installing PV systems in this market. They have been implementing projects since 2014, mainly through different partnerships with ESCOs. This was followed by a slew of international EPC firms such as Solar Century, Greenspark and local firms such as OFGEN starting to engineer, procure and construct projects from 2015 through 2016-17. Subsequently, the market peaked through 2018 and 2019 when a number of firms were implementing projects, including SPS, Equator Energy, Knights Energy, Davis & Shirtliff and CP Solar. While each of these firms has pursued its own individual trajectory to expand growth and revenue, it is interesting to note the various ways in which they engaged in this captive PV market. Based on several interactions with firms and their development trajectories, we have identified three important ways in which these firms have strategized and scaled up their operations.

1. Building on strong interactions, networks, partnerships and collaborative operations

This refers to the process by which firms have managed to establish themselves, strengthen their resources and build on their existing capacities. The range of interactions for firms involves engaging in formal and

informal partnerships with business developers, other EPC firms, financiers, ICT companies and technology (equipment) suppliers, among others. Other forms of partnership include forming an SPV ESCO (between a supplier firm and a financier), or opting for mergers, acquisitions or joint ventures (JV) for the joint implementation of projects. We found that this strategy was employed by a number of firms in the Kenyan captive PV market. We discuss a few supporting examples of this strategy.

When Solar Century entered into the captive PV market in Kenya in 2013, they teamed up with a Kenyan partner for support with business development, and soon afterwards acquired a Kenyan firm that specialized in PV installations in order to acquire a raft of new clients. Furthermore, SolarCentury also formed a long-term formal partnership with Crossboundary Energy, which led to the successful implementation of projects. Harmonic Systems (HS) sees its leverage in maintaining strong technology partnerships with SMA (invertors), Jinko Solar (PV modules) and Hoppecke (controllers). HS also provide repair services for SMA inverters at their facility in Nairobi. Davis & Shirtliff specialize in product distribution and also boast of long-term partnerships with wholesale technology and equipment providers. OFGEN formed an SPV in Kenya along with Mettle Solar (a subsidiary of Mettle, an SA-based financing company) and Sustainable Power Solutions (SPS), an EPC company in which Mettle holds a 50% stake. As OFGEN lacked contracting experience or EPC skills for large projects, both are provided by Mettle and SPS through their partnership. Together, they have implemented six projects so far. Greenspark (originating in the Netherlands) entered into a partnership with a horticultural company (Dutch-Kenyan owned) in order to integrate PV into the horticultural value chains. Solarise Africa is a recent entrant into the captive PV market: in order to compete in it, they partner exclusively with Premier Solar Solutions (PSS) in Kenya. PSS has an EPC team in Kenya and has strong networks with businesses owned by the Kenyan-Indian community. It is implementing three projects at present. Equator Energy is a joint venture (JV) of two companies, Maris and Nvision, which combines the strengths of both an EPC (Nvision is a German-owned developer, installer and operator of PV plants) and a financier (Maris is a diversified investment holding company that provides initial financing, pipeline projects and operational support). This JV (ESCO) has already implemented nearly fifteen projects in the captive PV market segment in Kenya. Astonfield is entering into a formal partnership with Adrian Kenya Ltd. to form a new entity in order to add value to their business through an added element of ICT and digitization support to their existing and new clients. Astonfield has partnered with Knights Energy for servicing petrol stations and support them with O&M services. Many of these firms also have partnerships (formal and informal) with a range of sub-contractors supporting them with specialized tasks. These interactions, partnership, and networks also have the advantage of being able to mobilize the varied resources (skills, technical know-how and capital) required to implement projects and grow in the market.

2. Targeted business strategy to capitalize on niche advantages

In order to carve out a niche for themselves and to reduce direct competition, several firms have opted to focus on either a specific category of users or a specific type of consumer, or even certain project sizes. Examples are a focus only on the manufacturing industry and/or only on corporate multinational clients or clients in the horticultural sector. This also includes firms focusing on project sizes below 200 kW, or below 500 kW, or only above 500 kW. We discuss a few supporting examples of this strategy.

OFGEN has created a speciality for servicing blue-chip entities such as Tourism Promotion Services (Serena Hotels), Williamson Tea, UAP Old Mutual or multinational entities such as Toyota, GlaxoSmithKline and Swissport Cargo Services, among others. CP Solar exclusively targets clients in the industrial sector based in the industrial parks in and outside Nairobi. This involves leveraging on the ease of access to the industrial sector (as they are a subsidiary of a manufacturing unit, CnP Shoes Industries Ltd.) and also being able to network with the Indian-Kenyan owners of many manufacturing companies (as CnP is run by an Indian-Kenyan family). A majority of their projects are under 300 kW. A similar model is also followed by Premier Solar Solutions (Indian-Ugandan), which targets clients in the industrial sector only through South Asian networks, by building trust. Solar Century, a UK-origin multinational company, prefers to operate in the market above 500 kW, where it has a competitive edge due to its size. Furthermore, having implemented a number of rooftop projects for international clients

in Europe and the UK, it has leveraged on getting access to transnational companies (such as Unilever). Harmonic Systems (HS) prefers to implement projects with a minimum of 100-150 kW and leverage on the size ranges between 200 kW and 1 MW. For HS, procurement is an issue if they focus on smaller projects below 100kW, but it plans to set up a warehouse facility to manage bulk procurement and carry out even smaller projects in the range of 30-50 kW. Greenspark Kenya (Dutch-origin) started mainly operating in the C&I market through a focus only on the horticultural sector, which helped it establish its own niche. It has also implemented projects mostly below 100 kW and in the range of 100-200 kW. Astonfield (Indian origin) was one of the earlier entrants into this market, having implemented nearly forty projects so far. Nearly 50% of these projects were for petrol stations and the rest for institutional clients (schools, hospitals and office complexes). These are mostly projects below 100 kW. Going forward, Astonfield continues to target mainly institutional clients as its own niche.

3. Innovative and/or diversified product and/or service offering

Another strategy employed by several firms was to include additional services in with the captive PV service (diversified offering). Additional services included: i) conducting energy audits and implementing identified energy-efficiency measures, ii) providing ICT and digitalizing support to consumers through smart meters, battery storage and auto load management solutions; and iii) providing an advisory service on data analytics and data intelligence for consumers to keep track of their energy data and perform continuous evaluations. In addition, a few firms also provided unique and innovative product offerings distinct and different from those of all other suppliers.

In the following we present a few supporting examples under this strategy. OFGEN (Kenyan) has been conducting full energy audits (which includes switching to renewable fuels in industrial production) mainly for industry consumers, supporting them in adopting energy-efficiency measures and also installing PV systems for them. OFGEN has been able to leverage on this in order to reach out to a larger clientele and market share. In addition, OFGEN is among the very few firms in the market to offer PV + battery storage solutions (Tesla Energy Storage Systems) to those who are mainly off-grid power consumers (lodges, safari camps). Like OFGEN, Harmonic Systems (Kenyan) also provides consultation on energy efficiency (through energy audits), pitching itself as a one-stop shop for all energy-related solutions and services, along with PV installations targeted at industrial clients. Equator Energy provides an in-house support tool called "energy.dashboard" which acts as a business intelligence platform to monitor real-time energy data. This includes monitoring production by PV systems and consumption from the grid, as well as monitoring electricity consumption in various functions of the business and calculating energy bills. Astonfield also provides a range of digitalization support tools to their clients and is currently expanding its ICT service provision (also for O&M) in order to capture additional growth in the market, targeting particularly institutional clients. Furthermore, Strauss Energy (Kenyan) is the only firm in the market that has strategized offering a unique product (Stima roof tiles). It also offers building-integrated PV (BIPV) on roofing, glass, paving, warehouses etc. In addition, it uses a Tesla Power wall and air-compression technology to store electricity.

Table 5 summarizes the analysis and highlights the key points and examples identified under each of the three strategies pursued by the firms to scale up and capture a larger share of the PV supplier industry.

In addition to these three key strategies, other strategies which firms are pursuing include expanding regionally and geographically to implement projects in other SSA countries such as Uganda, South Sudan, Eritrea and Rwanda. This is geared towards being able to leverage on new and emerging markets.

4.4. Indirect policy support and incentives

In addition to electricity cost savings, financing readiness and the supplier industry's push to drive this market, a range of indirect policies and regulations have also played a role in creating a favourable enabling environment for the market to scale up. These policies and incentives have not been directly or deliberately introduced to support this captive PV market segment per se, but nonetheless they have stimulated market uptake indirectly and positively. This is in addition to the fact that the EPRA has introduced license and permit exemptions (although a few regulations still apply) for firms' building projects which are less than 1 MW

TABLE 5. Summary of the analysis of strategies pursued by private firms

Types of strategy	Disaggregated	Description	Examples of firms pursuing this strategy
Building on strong interactions, networks, partnerships and collaborative operations	Strong/unique partnerships and working models	rmal partnerships with other firms, financiers, ICT companies, technology suppliers etc. developing new structures for implementation (SPV model) long-term partnerships/agreements, or track record of implementing more than one or two projects together	• Ofgen-Mettle SPV • Questworks-Resol-Sunref • Equator Energy-Maris-Nvision • Solarise Africa-Premier Solar-Faber Capital • Knights Energy (Knights & Apps) • Solar Century-Crossboundary • Harmonic Systems-Multiple financiers • Greenspark-Hortigreenhouse • Astonfield-Knights
	Tie-ups with other EPCs for additional resources	competing but also working collaboratively to join forces and implement projects (at a time when the market was growing, and employing more full-time staff may not be a feasible idea)	• Ofgen – SPS Kenya • Harmonic Systems – Azimuth • Astonfield – Azimuth • Azimuth Power – Astonfield • Solar Century – Greenspark
Targeted business strategy to capitalize on niche advantages	Niche markets and/or targeted clients	industrial units only, corporates mainly, lodges or off-grid mostly, institutional clients	• CP Solar • Solarise Africa – Premier Solar Solutions • Astonfield
	Targeted markets	(either small only below 200 kW or large only beyond 500 kW or 1 MW) or PV + storage	• OFGEN • Solar Century • CP Solar • Davis & Shirtliff • Greenspark • Astonfield
Innovative and/or diversified service offering	Providing a host of integrated services	Energy-efficiency audits, energy analytics, energy intelligence, ICT support, in-house O&M team etc.	• OFGEN • Harmonic Systems • Astonfield • Equator Energy • Astonfield • Knights Energy
	Innovative product offering	Custom-developed solar PV roof tiles compressed air energy storage (instead of battery storage)	• Strauss Energy

Source: authors' own elaboration

of installed capacity. For building projects in the range of 1-3 MW, firms are supposed to acquire a permit for electricity generation, and beyond 3 MW they must acquire a full license, which entails longer regulatory procedures. A few interviewees highlighted that this has also been a reason for avoiding larger sized projects (other than resource and capacity limitations) or preferring to stick to projects below 1 MW. However, there are new rules in place as per the Energy Act 2019, which state that even projects below 1MW need to apply for a permit. We have included a review of the regulatory environment in *Annex IV*.

Based on a number of interviews, we have identified two key policy drivers:

1) Statutory Energy Audits. As part of the Energy Management Regulations gazetted in 2012, industrial, commercial and institutional energy users are subject to mandatory energy audits. These users are designated based on their kWh consumption, i.e. only those users are covered that have a minimum consumption of 15,000 kWh/month or 180,000 kWh/per annum. A number of interviewed firms that conduct energy audits stressed that such audits have increased consumer awareness pertaining to their energy consumption, energy bills and ways of being more energy efficient. Especially the sub-component of this audit that focuses on switching to renewable fuels has contributed to growth in the captive PV market. The energy audit

regulation includes an annual compliance report to be filed with EPRA, and as it is required to achieve at least 50% of the energy savings within three years of the initial audit, this regulation has created a positive impetus for the captive PV market.

2) Investment deductions for industrial construction and equipment purchases. As a tax incentive for businesses, the Kenya Revenue Authority (KRA) provides an investment deduction: those "who incur capital expenditure on building and/or machinery used for manufacture are entitled to an investment deduction equal to 100% of the cost, and for capital expenditures (…) exceeding sh. 200 million, if the investment is outside Nairobi the investor can claim up to 150% allowance" (KRA, n.d.). Reportedly, the investment in PV equipment installed in the building is considered to be part of this capital expenditure. However, as reported during the interviews, in most cases the extent of the allowance is much lower, as the Kenya Revenue Authority (KRA) also evaluates this against the industry consumer's tax history and compliance status. Hence, this is only a relatively smaller incentive than what is anticipated, but it still allows some users to benefit from it.

To sum up, we have identified four different factors (economics/consumer savings, financing readiness, supply-side business and policy incentives) that have driven the market in a significant way during the last five years. In addition, the demand for climate-friendly products and services in the global North has also increasingly become a driver for captive PV in Kenya. In the horticultural sector (flower farms), the ability to meet CO_2 emission targets documented in "sustainability indexes" leads to higher prices in the international market, to which the bulk of the produce is exported. Using captive PV hence contributes to improving the sustainability index and increases the price of horticultural products. Similarly, for lodges eco-tourism is an increasing market, and switching to solar PV from diesel provides greater comfort in terms of quietness and higher eco-standards, thereby increasing demand.

5. Challenges and Risks

In spite of the impressive development of the captive PV market described above and the strong drivers identified in this report, interviewees revealed a number of barriers that are constraining the further expansion of the market. We will describe these barriers in the following paragraphs.

Several interviewees reported that in 2020 and 2021, the captive PV market is set to consolidate, and perhaps also slow down a bit. Some claim that the initial phase (2014-2019) has been marked by a market rush and overly optimistic expectations of the electricity cost savings of captive PV compared to grid electricity. A few bad examples have led to some distrust in the market with regard to cost savings, and power consumers face a challenge in reaching an agreement with ESCOs, as the offers and proposals highlight varying numbers. Others note that for customers some of the PPAs that have been signed for the long term (ten to fifteen years) at a fixed electricity price involve the risk that this price could seem too high in five years' time if the grid tariffs come down. Yet others mention discrepancies in the legal conditions included in the PPAs and the leasing contracts due to the lack of a standardized template.

Our findings also indicate that EPC firms and power consumers alike had not paid sufficient attention to the operation and maintenance (O&M) phase of their systems. A number of interviewees, including the regulatory authority representative, stated that a few complaints have been received from power consumers with regard to issues with system design, sizing, and installation, system failures and low performance levels. This is owing to both limited expertise and skills in servicing, repairs and maintenance among the maintenance companies and insufficient awareness by the consumers of the need to invest in proper maintenance.

Finally, there is an overwhelming consensus among all the stakeholders in the market that access to finance is still one of the greatest barriers or challenges to future growth. External financing and international investors (development finance, private capital) have played a catalytic role in promoting the captive PV market segment, but they also continue to be one of the biggest barriers. This is expressed particularly strongly by some of the Kenyan solar PV companies that have faced difficulties in obtaining access to debt financing for projects and in supporting customers with high upfront payments. They also point to the lack of credit histories, profiles and working capital in order that firms can expand their operations and hire more employees. Only a limited number of financiers offer debt-funding, and many Kenyan firms do not meet some of the criteria, conditions and international standards that they are subject to in order to obtain international finance. In particular, Kenyan-owned firms also mention that there are constraints in accessing external finance due to weak balance sheets, the lack of long professional track records, the lack of a partner to support them with guarantees or working capital, the risks associated with consumer payment defaults etc.

Further, in order to promote industrialization and reduce the burden of electricity tariffs, in July 2019 EPRA introduced a tax rebate for the manufacturing industry, which could also act as a potential barrier. The tax rebate per annum is 20% of the electricity costs (30% in the first year), paid unconditionally as long as the required documents and other evidence are submitted. Subsequently, to benefit one has to meet the following requirements: i) growth in revenues of 10% per annum; and/or ii) increased production capacity; and/or iii) an increase in the number of employees. With this, policy-makers have introduced subsidized tariffs for industrial facilities with the intention of driving greater energy demand. However, this could also act as a potential disincentive for industry consumers to switch to self-generation, though it is still too early to study the implications of such a policy decision.

Lastly, a potential risk could also be emerging from the reluctance among the energy authorities and public utilities to see their large high-intensive (with a high ability to pay bills) power customers substitute a part of their electricity demand via captive PV installation, thereby lowering their grid intake. This is an added pressure on the utility (KPLC) which is already under severe financial distress.

6. Conclusion

The aim of this report has been to show how the captive PV market in Kenya evolved over a short period of time, and to identify the key drivers on both the demand-side (power consumers) and the supply-side (project developers, EPC firms, O&M firms, DFIs, ESCOs etc.). The policy and regulations have also played a peripheral supporting role in allowing this market to grow with limited rules and rigid guidelines.

In Kenya, we find that captive PV or captive generation through solar PV is economically viable for most high energy-intensive consumers, the majority of which own and operate their PV systems themselves. The market has gained in momentum strongly, particularly since 2015, and there are a number of competing EPC firms and investors/ESCOs seeking to grow and expand their market share. Kenya is among the largest captive PV markets (with 40 MW of installations) currently in SSA, and perhaps among developing countries worldwide. This has been enabled by innovative implementation and financing models which include offering direct purchase option to the consumers, or signing a PPA contract with a fixed tariff for a 20 year period with an ESCO, or an ESCO equipment lease option with minimum off-take, among other modalities.

The main drivers for this growth in the captive PV market include: i) the incentive for power consumers to reduce electricity expenditure and increase reliability of power supply; ii) the availability and readiness of external financing support and mechanisms to fund captive PV clients; iii) the strong local solar PV industry, aggressively pursuing the market and leveraging on the demand; iv) the indirect policy support and incentives in the form of energy audits, investment deductions; and v) an increasing drive towards greener production, achieving higher sustainability ratings and eco-tourism etc.

Our data indicates that the total capacity for captive PV installations currently in Kenya is 40 MW (including completed projects and those under-construction as of 2019). This is likely to be higher in reality assuming this data is not fully comprehensive. A majority of the systems have been installed by industrial consumers (39 projects, 14 MW). Given that there are 1,200 manufacturing companies in Kenya (960 based in Kenya), there still seems to be a potential for further market expansion. Interviewees also report further potential among commercial, horticulture and institutional consumers. According to Kenya Power, there are nearly 3,900 power consumers that fall into the commercial & industrial tariff category (as of 2018). The overall feedback continues to be largely positive regarding captive PV uptake by consumers, as has also been pointed out by the Kenya Manufacturing Association, which has been actively lobbying for additional tax breaks for manufacturers to support rooftop PV installations.

Having said this, a number of barriers need to be removed in order to unlock the potential in this market. These include: limited adequate debt finance and working capital finance, unrealistic contract and tariff offerings, limited focus on the O&M services, and shortcomings in the local technical capacities (pertaining to designing and sizing the systems), among others.

Among the key takeaways and recommendations from the captive solar PV market in Kenya are:

1. Electricity cost savings play an important role in the initial uptake of technologies, but market growth was only sustained through a larger ecosystem of skilled technology providers, installers and servicing professionals that could cater readily to consumer demand.

2. External donor finance (e.g. AFD) channelled through commercial banks with low interest rates and dedicated investment funds catering to specific market segments served as a catalyst in the market.

3. The regulator could and should act as an important bridge between the PV companies, financiers, ESCOs and power consumers to work jointly towards standardizing the contractual and legal conditions, as well as easing entry barriers.

4. There is a need for more independent advice and standardized presentations of costs, billing calculations, payback periods, performance ratios, penalties etc. in order to induce trust among power consumers and also to reduce information asymmetries in the market.

5. There is a need for more disaggregated data on high energy-intensive consumers to supplement better market analysis.

6. There is a need for national utilities and planning bodies to integrate grid-tied captive PV systems into the assessments of demand and supply, and electricity projections for future.

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Annex I. Stakeholder interviews conducted

No.	Designation / Role	Organization	Stakeholder Category	Type of Interview	Date
1.	Chief Operations Officer	CrossBoundary Energy	Financier	Zoom call	22-08-2019
2.	Research Master's Student/Intern	Ministry of Foreign Affairs, Netherlands	Independent	Skype	27-08-2019
3.	Founder and Independent Consultant	Energy Net	Independent Consultant	Skype	28-08-2019
4.	General Manager, Africa	Solar Century	Private Firm	Skype	28-08-2019
5.	Managing Director	Harmonic Systems	Private Firm	Zoom	04-09-2019
6.	Regional Head of Programmes	Energy4Impact	Consultancy Firm	In-person	23-09-2019
7.	East Africa General Manager	Solar Century	Private Firm	In-person	24-09-2019
8.	Co-founder and Director	OFGEN	Private Firm	In-person	24-09-2019
9.	Investment Officer	Sunfunder	Financier	In-person	25-09-2019
10.	Deal Principal East Africa	Inspired Evolution Investment Management	Financier	In-person	25-09-2019
11.	Solar Projects Engineers	Davis & Shirtliff	Private Firm	In-person	26-09-2019
12.	Independent Consultant	Independent (formerly, Equatorial Energies)	Private Firm	In-person	26-09-2019
13.	Technical Associate and Consultant	Berkeley Energy	Financier	In-person	26-09-2019
14.	Project Manager	CP Solar	Private Firm	In-person	27-09-2019
15.	Senior Renewable Energy Officer	Electricity Regulatory Commission / EPRA	Government	In-person	27-09-2019
16.	Owner, Director	Greenspark Kenya	Private Firm	Skype	16-10-2019
17.	Co-founder and Director	Solarise Africa	Private Firm	Skype	17-10-2019
18.	Investment Manager	DWS	Financier	Skype	18-10-2019
19.	Founder and Chief Executive Officer	Astonfield	Private Firm	Skype	18-10-2019
20.	Project Coordinator *	Kenya Power and Lighting Company (KPLC)	Utility Company (transmission & distribution)	In-person	01-12-2019
21.	Energy Officer *	Kenya Association of Manufactures (KAM)	Private Sector Association	In-person	17-12-2019

*These two interviews were conducted by our project partner, Strathmore Energy Research Centre.

Annex II. EPC firm profiles

Sr. No.	EPC Firms/ ESCOs	Origin of the firms	About the firms (brief) – 2-3 lines	Total projects installed C&I	Total capacity installed (kW)
1.	Astonfield	India	Astonfield has mostly had its projects financed through CapEx or SUNREF. They currently prefer projects below 300 kW, but have done one above 1 MW. Are setting up a joint venture for civil works and installation with Adrian Kenya Ltd (manage telecom towers) in January 2019.	39	3658
2.	Azimuth Power	UK Not operating anymore	One of the first farms to enter the market, but has closed down operations according to respondents. Azimuth developed a system of solar leasing and containerized solar equipment. Mainly operated in sizes between 50 kW to 1 MW.	4	1437
3.	CP Solar Resources Ltd	Kenya	CP Solar was formed when C&P Shoes acquired Smart Solar Resources in June 2018. Owner has good network with Indian-Kenyan manufacturing industries. Prefers 200 kW system, but doing a few projects over 1 MW. Usually does direct purchases.	27	6664
4.	Davis & Shirtliff	Kenya	Has been selling solar products since 1980. Although they do solar, they are predominantly distributors. Usually do direct purchases, systems in range of 50-200 kW. Would rather supply systems to existing EPCs than become a core EPC company.	4	128
5.	East African Solar	Kenyan (not operating anymore)	Guy Lawrence founded East African solar in 2011, which was later absorbed by Solarcentury.	2	1072
6.	Equator Energy -- JV of Maris and Nvision	German-Mauritius-London	Equator Energy is a joint venture of two companies, Maris and Nvision, which combined have over a decade of experience operating in Africa. Three projects above 250 kW, rest are below this size.	17	4209
7.	Gosolar	Kenya	Founded in 2003, 15 years' experience with RE solutions in Kenya. Does system design, procurement, distribution, constructions and commissioning, and O&M.		
8.	Greenspark (Kenya)	Netherlands	Greenspark Kenya is a separate entity from Greenspark NL, with funding from the directors. Greenspark does outright purchases and focuses on 100 kW systems. Success has been in horticulture business. Current staff of seven, hires in more for larger projects.	10	1286
9.	Harmonic Systems	Kenya	Local installer of PV projects, started in 2009. Has partnered with Astonfield on a number of projects. Likes to do systems between 100kw-5MW. Currently staff of ten, hires in more for larger projects.	9	1503
10.	Knights Energy	Kenya	Local Kenyan company owned by Knights and Apps Ltd, a business partner in ICT. Provides residential and off-grid power solutions, as well as C&I systems and O&M.	1 (maybe more)	60

Sr. No.	EPC Firms/ ESCOs	Origin of the firms	About the firms (brief) – 2-3 lines	Total projects installed C&I	Total capacity installed (kW)
11.	OFGEN	Kenya	Ofgen is a spinoff from Strathmore University, founded in 2014. Offers energy audits as a service, solar PV as EPC services and is an asset owner as an ESCO. Has a partnership with Mettle in form of SPV Mettle Solar.	4	2,112
12.	Orb Energy	India	Orb Energy is an Indian solar energy company. It was founded in 2006 and has more than 50 branches in 8 cities in India; it started operations in Kenya in 2014.	1	
13.	PowerGen Renewable Energy	USA	PowerGen was founded in 2011. With a team of over 150 full-time employees and operations in four countries, PowerGen is delivering Commercial and Industrial solar projects across the continent. Covers project development and financing to construction and operations. Does PPAs or leasing.	1	75
14.	Solarise Africa	Mauritius	Pan African energy-leasing company for PV focusing on c&I clients. Focus on captive rooftop and ground-mounted solar from 100 kW – 2 MW.	maybe 3? (need to check)	
15.	Resol	Kenya	RESOL is a renewable energy company dealing in solar PV and solar hot water. With over 100 certified engineers. RESOL has been involved in a variety of projects since 2014 with projects such as the 600 kwp system in Strathmore.	4	2,730
16.	Solar Africa	USA	Solar as a service (solar finance) offering, also managed an investment fund with Crossboundary energy for captive PV.	4	1,943
17.	Smart Solar Solutions	Kenya	Absorbed by C&P Shoes to form CP Solar in 2018.		
18.	Solar Century	UK	Founded in 1998, one of the UK's largest PV companies. Has an MoU with Crossboundary Energy for work and thus frequently a partner. Only installs systems above 500kW, and long-term objective is to develop utility scale.	9	6,222
19.	Sustainable Power Solutions (SPS)	South Africa	SPS is a larger commercial rooftop solar PV EPC. It has over 30 years of expertise in the field. 50% owned by Mettle.	2	408
20.	Questworks	Kenya	Spin-off from Strathmore University, began in 2012 originally just on project management services. Later included engineering services and turnkey construction.	1	600
21.	Strauss Energy	Kenya	Kenyan start-up, producing BPV solar tiles integrated with solar cells. Instead of batteries, uses compressed air energy storage, water by-product. Received grant funding of USD 25000 from USADF.	-	

Source: authors' own elaboration (based on various sources)

Annex III. ESCOs, private financiers, local banks – investment and portfolios

No.	ESCO, Financier	Details about them (max. 3-4 lines) type of finance	Total investment (interviews, reports)	Source of finance/ investors (interviews-reports)
1.	Actis Energy	Actis is a large private capital investment and private capital real estate investor in Africa. Has USD 3.4 billion of assets under management in Africa, spread across real estate, private equity investments, energy and infrastructure.	August 2019 statement - to date Actis has invested USD 1.1b through 5.2 GW in the African energy sector. But so far, little C&I.	
2.	Ariya Leasing/ Capital	Provides leasing finance, fund management and invests in IPPs. On leasing side has partnered with African Solar Designs.		USAID, Embassy of Sweden, BMZ, Powering Agriculture, Sustainable Technology Invests Ltd, OPIC, Duke Energy
3.	Berkeley Energy	Recently started investing in captive power (e.g. Azimuth Power developer/EPC) offering debt and equity finance. Prefers the PPA model. Has a pipeline of 3 MW, first projects starting in November 2019.	AREF (fund for Africa), no. I support hydro and II solar. AREF II funds size is 200 mil USD, 40% equity and 60% debt.	Institutional investors
4.	Crossboundary Energy	Part of the Crossboundary Group. USD 8m equity raised for Crossboundary Energy Fund 1 in 2015. USD 6m debt facility with OPIC since 2018. Financed and manage 1.5 MW of captive PV in Kenya to date. Has a partnership with leading EPC Solarcentury.	Energy 1 Fund: USD 8.8m equity USD 6m debt facility with OPIC	SAID, Power Africa, impact investors (Blue Haven Initiative, Treehouse Investments, Ceniarth), Shell Foundation, ACEF
5.	Ecoligo	Crowd-funded debt sourced in EUR for individual projects under leasing/PPA. Financed 700+ kW in Kenya. Often works with Kenyan EPC Harmonic Systems.		Crowdfunding
6.	Faber Capital	Part of an international group of companies, including Premier Solar Solutions (Kenyan EPC) and can offer financing.		
7.	Inspired Evolution	Has not yet disbursed funding in Kenya. Provides equity investments in clean energy through its Evolution I and II funds.	Evolution II fund: 10-year close-ended equity fund, raised USD 124m. Evolution I Fund was fully invested in 2014 with 12 investments, 918 MW of RE generation assets.	Seven international investors for EF II.
8.	Japan's Joint Crediting Mechanism	The Joint Crediting Mechanism is a project-based bilateral offset crediting mechanism initiated by the Government of Japan to facilitate the diffusion of low-carbon technologies. It has had a bilateral agreement with Kenya since June 2013 and two projects registered in Kenya under the JCM Financing Programme by MOEJ.		
9.	Maris	Diversified holding company. Co-owns Equator Energy (Kenyan/German EPC), which enables EPC to offer financing.		

No.	ESCO, Financier	Details about them (max. 3-4 lines) type of finance	Total investment (interviews, reports)	Source of finance/ investors (inter-views-reports)
10.	Mettle Solar	Mettle was established in 1995 as a specialist financial services company, where one of its businesses is Mettle Solar. It has Mettle Solar Ofgen SPV with Ofgen, which enables EPC to offer financing. Owns 50% of SPS.	Gridworks is a new company in the CDC group, which will invest USD7.m equity to become a shareholder in Mettle Solar Investments.	
11.	ResponsAbility	Provides both equity and debt through various vehicles, and has a RE project development arm in Kenya. Has financed a captive power developer in Ghana but not in Kenya (yet).	USD 3b+ AUM globally.	
12.	Solar Africa/NVI Energy	Captive PV financing platform and partner of Crossboundary – no longer active?		
13.	Solarise Africa	Set up by former director of responsAbility. Has financed three captive projects, one of 1 MW. It is a leasing company.	Debt and equity on the portfolio level, otherwise operating leases or direct purchases.	
14.	Sunfunder	Established USD 1.2m working capital debt facility for Questworks (Kenya developer/EPC) in June 2018.	62 mil USD debt fund, in January the Solar Energy Transformation fund will close with over 100 mil USD investor debt capital raised.	Debt fund investors include: Ceniarth, Iberdola, Sant Foudnation, FMO, Treehouse Investments, Social Capital, Baldwin Brothers, Bio, calvert impact capital, Rocekefeller foundation, Leondardo Dicaprio Foundation, OPIC, David & Lucile Packard Foundation, Deutsche Bank
15.	AFD SUNREF	The regional programme-accredited SUNREF East Africa, promoted by AFD, provides Kenyan banks with a reduced-rate credit facility for RE and EE projects.	Has enabled 70m USD in lending to 30 RE and EE projects (the vast majority are captive plants or involve EE improvements in manufacturing facilities).	
16.	Local Banks - Prime Bank, Cooperative Bank	Some commercial banks are beginning to be interested in lending financing to RE projects, but the installations are not well understood and are perceived as high risk.		

Source: authors' own elaboration (based on various sources)

Annex IV. Regulatory environment

The regulatory environment in Kenya aims to promote renewable sources as an alternative source of energy, including generation of energy from solar. This is clear from both strategic documents developed by the Ministry of Energy (MoE), such as Vision 2030 (Kenya Vision 2030, n.d.), with which a number of other policies and regulations are aligned. This includes the Energy Act of 2006, which has been updated a number of times since, most recently in 2019. The Energy and Petroleum Regulatory Authority (EPRA) was created under the ratified Energy Act, 2019 (EPRA, 2019. as a successor to the Energy Regulatory Commission (ERC) established in 2007. EPRA is responsible for economic and technical regulation and enforcement. Collaboration with the private sector takes place mainly through independent power producers (IPPs), within which the C&I solar PV projects are represented. The Kenya Power and Lighting Company (KPLC) is the national electric utility company, managing metering, licensing, billing etc.

Licensing

For solar projects, the ERC/EPRA developed the Energy Solar Photovoltaics Systems Regulation (2012) to regulate the production, distribution, supply and use of solar. Concerning licensing, this regulation requires developers to obtain a generation license or permit, depending on their installed capacity (Brückner, 2015). A capacity below 1 MW requires no license, but above 1 MW either a license or a permit is required, as shown in Table X. However, “Kenya Power remains the sole distributor and retailer of electricity, suggesting that C&I solar projects have either stayed below the relevant thresholds or have used alternative contract structures that are not considered a PPA” (BNEF, 2019, p. 12).

Although projects below 1MW do not require the above licensing, they are regulated, and regardless of size or capacity they must:

- Obtain a permit from the National Construction Authority
- Obtain and submit an Environmental Impact Assessment to NEMA, which, depending on numerous factors, may require further permits
- Obtain local county approval (Rödl & Partner, 2018)

If a developer plans to connect an installation to the grid, a feed-in tariff-based PPA must be negotiated with a licensed purchaser, the Kenya Power and Lighting Company, in order to ensure that the contract is concluded in the interests of the end consumer (Rödl & Partner, 2018). In other countries local content requirements could pose an issue, but as there is no such regulation in Kenya, it does not do so there (van Os, Prédour and Harakawa, 2019). Some reports describe the Kenyan regulatory environment as relatively friendly towards C&I solar, as the process for obtaining a generating permit or license is described as transparent, predictable and as only taking two to three months (BloombergNEF, 2019; Brückner, 2015). Others consider it time-consuming, complex and costly, as many documents are required for permit or licensing applications, and experts must be involved at every stage (Rödl & Partner, 2018).

Net-metering

With the ratification of the 2019 Energy Act, as per Section 162 (1), the legislative support for net-metering and thus for consumers to supply excess capacity back to the grid is in place. There is an operations committee working on the various regulations in the Act,

TABLE 6. Licensing requirements for building and running solar generating, transmitting or distribution projects

Capacity	Licensing requirements	Application cost
<1 MW	None required	None
1-3 MW	Permit	None
>3 MW	License	10.000 KES

Source: Electricity Generation, n.d.

which are required to provide guidelines for how to operationalize it within two years (i.e. by 2021) of its ratification.

It is still unclear how it will be enforced, but it is worth noting that all licensed distributers will, upon application, have to make net-metering services available to any electricity consumer they supply (Rödl & Partner, 2019). The new Act also sets a cap of 1 MW, this being the maximum that can be installed and stored on any one project site (Energy Act 2019). Net-metering does not necessarily mean selling electricity back to the grid, it refers to what can be stored on site. What this will mean for projects that have already installed above 1 MW and want to benefit from the net-metering policy remains unclear. There is already a new grid code in place that already accounts for some of the expected intermittency that will be supplied. Several stakeholders want the net-metering policy to be implemented soon, but other regulatory challenges could be whether solar PV developers can sell electricity irrespective of whether it is produced on-site or sold via the distribution grid. This can be a hurdle if an asset is located at the customer site but owned by a separate service company (van Os, Prédour and Harakawa, 2019).

Other applicable energy policies and regulations

See below for an outline of the relevant policies for the Kenyan RE Sector:

Policy	Year	Main points
Vision 2030	2007	• The aim is to transform Kenya into a newly industrializing, middle-income country providing a high quality of life to all its citizens in a clean and secure environment. • The Kenyan government's Vision 2030 recognizes the upcoming conflict between a growing economy and population and consistent energy consumption. • Kenya must generate more energy and increase its efficiency in energy consumption. The government is committed to continued institutional reforms in the energy sector, including a strong regulatory framework, encouraging private power generators and separating generation from distribution. New sources of energy will be found through the exploitation of geothermal power, coal, renewable energy sources and connecting Kenya to energy-surplus countries in the region.
Energy Bill	2017	• Broadly the Bill covers all aspects of energy regulation except for the discovery, development and production of petroleum. • New regulatory supervision was created in the form of the REREC and RERAC, replacing the REA and forming new inter-ministerial committees. • The Bill provide that all renewable resources and geothermal resources are vested in the government. • One of the novelties is the introduction of net-metering. Net-metering allows consumers that own small-scale electric power generators to feed excess electricity into the grid. In return, they will receive a credit. The Bill provides that only producers generating less than 1 MW may participate in the net-metering system. They will be allowed to supply excess electricity only to distribution licensees or retailers. • The Bill proposes renewing feed-in tariffs for renewable energy. But the present 2012 FiT remains in place until the new system is implemented.
National Energy Policy	2018	• Vision: the overall objective of the Energy Policy is to ensure a sustainable, adequate, affordable, competitive, secure and reliable supply of energy at the least cost geared to meet national and county needs while protecting and conserving the environment. • Enhance exploration of geothermal resources. • Establishment of a Renewable Energy Resources Advisory Committee (RERAC). • Transforming the REA into the Rural Electrification and Renewable Energy Corporation.
Energy Act	2019	• The new Act establishes several new 'energy sector entities' to replace a number of existing ones and expands or repeals certain of the latter's mandates. • It has adopted the proposals of the 2017 Energy Bill with regard to the right to RE resources, royalties for geothermal extraction, net-metering, and the RE FiT system. • Introduces a system to penalize electricity suppliers and compensate consumers for unwarranted power outages or for the provision of poor-quality electricity which leads to damage to property or financial losses.

Annex V. Installed Captive PV Systems and additional details

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
1.	Enasoit	5.88	2010	Harmonic Systems		Ground-mounted / Off-grid
2.	IRC Hospital	14.7	2011	Harmonic Systems		Ground-mounted / Off-grid
3.	UNEP building	515	2011	Energiebau Solarstromsysteme GmbH		Rooftop PV / Grid-tied
4.	Tambuzzi Flowers	60	2013	Chloride Exide	Corporate Finance	
5.	Timaflor Flowers	100	2013	Azimuth Power		Ground-mounted
6.	Uhuru Flowers	72	2013	Azimuth Power / East African Solar	Corporate Finance	Rooftop PV
7.	Basecamp	11.52	2014	Harmonic Systems		Ground mount / Off-grid PV
8.	Strathmore University	600	2014	Questworks		
9.	Williamson Tea	1,000	2014	Azimuth / Solarcentury	Unknown	Ground-mounted
10.	Farm, Juja	48	2015	Greenspark	Self-financed	
11.	Kopchomo Tea	255	2015	Azimuth Power	Unknown	
12.	Tortillis Safari Camp- Ecolodge	277	2015	Harmonic Systems / SolarAfrica	SolarAfrica	Ground-mounted
13.	Insteel	11	2015	Astonfield / Harmonic Systems	Self-financed	Rooftop PV / Grid-tied
14.	Metsex Cables, Doshi Group, factory	123	2015	Astonfield	Self-financed	Rooftop PV
15.	Live Wire Pack Hall	50	2015	Ecoligo	Ecoligo	Rooftop PV / Grid-tied
16.	Kaysalt Ltd, Salt farm, Malindi	129	2015	Astonfield	Self-financed	
17.	Safal Group – Office Complex	8	2016	Astonfield	Self-financed	
18.	Farm, foodprocessing	65	2016	Greenspark	Self-financed	
19.	Farm, foodprocessing	85	2016	Greenspark	Self-financed	
20.	Garden City Mall	858.33	2016	Solarcentury	CrossBoundary Energy / Actis	Carport
21.	ICIPE	1,154	2016	Solarcentury	Swiss Dev Corporation	Ground-mounted
22.	Krystalline Salt Ltd.	991	2016	Solar Africa / Harmonic Systems	Japan's Joint Crediting Mechanism	Ground-mounted - Diesel / Grid-tied
23.	Rose farm, Naivasha	46	2016	Greenspark	Self-financed	
24.	Swiss Embassy, Nairobi	25	2016	Harmonic Systems		Rooftop PV
25.	MRM Group – Office Complex	22	2016	Astonfield	Self-financed	
26.	Church Missionary Karen	100	2016	Knights Energy		Ground-mounted + Battery 514kWh

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
27.	Bahari Beach Hotel	140	2017			
28.	Kiliguni Serena Safari Lodge	300	2017	SPS / Ofgen	MettleSolar	Off-grid, ground-mounted, 1340 ESS kWh
29.	Loisaba Conservancy	74.7	2017	Solar Africa / PowerGen	SolarAfrica / PowerGen Renewable Energy	
30.	London Distillers	1,000	2017	Solarcentury	Unknown	
31.	Office complex, Nairobi	24	2017	Greenspark	Self-financed	
32.	Office complex, Wilson Airport, Nairobi	83	2017	Greenspark	Self-financed	Rooftop PV
33.	Penta Flowers	250	2017		Ariya Leasing	
34.	Waridi & fresh catch, rose and fish farm	175	2017	Equator Energy		Rooftop PV / Grid-tied
35.	Swissport Kenya JKIA	104	2017	SPS / Ofgen	Mettle Solar	Rooftop PV / Grid-tied
36.	Lodge Nimara	40	2017	Automax Engineering Ltd		Off-grid, batteries
37.	Hydro Group of Companies	20	2017	Astonfield	Self-financed	Roof top PV / Carport
38.	Standard Chartered Bank HQ	103	2017	Knights Energy	Self-financed	Rooftop PV / Grid-tied
39.	Rosslyn Academy - International school, Nairobi	136.49	2017	Astonfield	Self-financed	
40.	International School of Kenya	148	2017	Astonfield	SUNREF	
41.	Maiyan Holiday Villas, Nanyuki	150	2017	Astonfield	Self-financed	Ground-mounted + Carport
42.	Waridi Flowers	201	2017	Astonfield	Self-financed	Ground-mounted
43.	African Steel Pipes Co. Ltd., Embakasi	220	2017	Astonfield	Self-financed	Rooftop
44.	Two Rivers Development - Mall	1280	2017	Astonfield / Powerpoint	SUNREF	Rooftop PV + Carport
45.	Shell Lusaka Road	11.88	2018	Astonfield	Self-financed	
46.	Total Kenya Eastern Bypass Station	12.28	2018	Astonfield / Knights	Self-financed	
47.	Total Kenya Ngong Road Station	12.75	2018	Astonfield / Knights	Self-financed	
48.	Shell Uhuru Highway	13.44	2018	Astonfield	Self-financed	
49.	Amboseli Serena Safari Lodge	600	2018	SPS / Ofgen	Mettle Solar	Off-grid, ground mounted (1300kWh ESS)
50.	Doormans Coffee, Tatu City	1,000	2018	Equator Energy		Rooftop PV
51.	Equinox, Flower Farm, Nanyuki, Kenya	100	2018	Harmonic Systems		Rooftop PV / Grid-tied
52.	Total Kenya Westend Station	17	2018	Astonfield / Knights	Self-financed	
53.	Interplant, Flower Breeder, Naivasha, Kenya	67	2018	Harmonic Systems		Rooftop PV / Grid-tied
54.	German School	18	2018	Astonfield	SUNREF	Rooftop PV
55.	Lake Elmenteita, Serena Camp	76	2018	SPS / Ofgen	Mettle Solar	Off-grid, ground-mounted

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
56.	Luxury Safari Lodge	46	2018		Crossboundary Energy	
57.	Total Kenya Thika Road Station	18	2018	Astonfield	Self-financed	
58.	Rose farm in Naivasha	186	2018	Greenspark	Self-financed	Ground-mounted
59.	Total Kenya Rabai Road Station	18.97	2018	Astonfield / Knights	Self-financed	
60.	Shopping mall	140	2018	Solarcentury/ Solar Africa	Crossboundary Energy	
61.	Total Kenya Hurlingham Station	19.62	2018	Astonfield / Knights	Self-financed	Grid-tied
62.	Total Kenya Limuru Road Station	19.62	2018	Astonfield	Self-financed	Grid-tied
63.	Tea plantation	600	2018	SolarAfrica	Crossboundary Energy	
64.	Total Waiyaki way Station	19.62	2018	Astonfield / Knights	Self-financed	
65.	Thika Coconut Grill Hotel	20	2018	Knights Energy		Grid-tied system
66.	Total Kenya South C Station	22.24	2018	Astonfield	Self-financed	
67.	Total Kenya Mombasa Road Station	22.56	2018	Astonfield / Knights	Self-financed	Rooftop PV
68.	Warehouse/office, Nairobi	24	2018	Greenspark	Self-financed	Rooftop PV / Grid-tied
69.	Sweetwaters Serena Camp	76	2018	SPS / Ofgen	Mettle Solar	Off-grid, ground-mounted
70.	Master Power Systems Ltd (office)	24.32	2018	Astonfield	Self-financed	
71.	Kenrub ltd	51.2	2018	Astonfield	Self-financed	
72.	Kenya Reinsurance Plaza	60	2018	Astonfield	Self-financed	Rooftop PV
73.	SOS Children's Village Mombasa	60	2018	German company, and Knights Energy for renovation	Delegation of German Industry	
74.	St Camilla Mission Hospital	81	2018	Astonfield	Self-financed	Ground-mounted
75.	Total Kenya Dagoretti Corner	13.08	2018	Knights Energy	Self-financed	Grid-tied
76.	Lukenya Academy	9.6	2019	Astonfield	SUNREF	
77.	Total Kenya Busia Station	10.3	2019	Astonfield	Self-financed	
78.	Total Kenya Eldoret Station	10.3	2019	Astonfield	Self-financed	
79.	Lukenya University	12.16	2019	Astonfield	SUNREF	
80.	Total Station Mbagathi	13.08	2019	Knights Energy	Self-financed	Rooftop PV
81.	Total Station Moi Road Naivasha	14.72	2019	Astonfield / Knights	Self-financed	Rooftop PV
82.	AutoXpress Limited	29.7	2019	Astonfield	Self-financed	
83.	Anjuman Burhani	53	2019	Davis &Shirtliff	Self-financed	
84.	Glaxo Smith Kline Kenya	240	2019	Ofgen	Self-financed	Grid-tied
85.	Kenya Ports Authority	300	2019	Ofgen	Self-financed	Rooftop PV
86.	Live Wire Water Supply	50	2019	Ecoligo	Ecoligo	Rooftop PV / Grid-tied
87.	Total ABC Place	35.96	2019	Knights Energy	Self-financed	Rooftop PV

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
88.	Total Gigiri	37.61	2019	Knights Energy	Self-financed	Rooftop PV
89.	Mara Serena Safari Lodge	640	2019	SPS / Ofgen	Mettle Solar	Off-grid, ground-mounted, 1,300 ESS kWh
90.	Ndau Community	15	2019	Davis & Shirtliff	Self-financed	
91.	Point Mall	43	2019	Ecoligo	Ecoligo	Rooftop PV / Grid-tied
92.	Rose farm in Naivasha	83.51	2019	Greenspark	Self-financed	
93.	SECCO	45	2019	Davis & Shirtliff	Self-financed	
94.	St. Francis Hospital Kasarani	15	2019	Davis &Shirtliff	Self-financed	
95.	Amiran Kenya Limited	64.68	2019	Astonfield	SUNREF	
96.	Warehouses in Nairobi	505	2019	Solarcentury / Greenspark		Rooftop PV / Grid-tied
97.	Toyota Kenya	180	2019	Ofgen	Self-financed	Rooftop PV / Grid-tied
98.	Lachuta Flower Farm	50	2019	Ofgen	Self-financed	Rooftop PV / Grid-tied
99.	Vienna Court	92	2019	Astonfield	SUNREF	
100.	Unilever Kericho Tea factory	619	2019	Solarcentury	Crossboundary Energy	Grid-tied, Solar PV - Diesel Hybrid
101.	Mayfair Holdings Ltd. - Sunblest Bakery	104.28	2019	Astonfield	Self-financed	
102.	MSCPL - College of Insurance	125	2019	Astonfield	Self-financed	Rooftop PV
103.	PJ Dave Flora Limited	308.88	2019	Astonfield	SUNREF	
104.	Sigma Feeds	102	2019	Knights Energy	Self-financed	Grid-tied
105.	SDP Karen Health Centre	15.41	2019	Knights Energy	Self-financed	Grid-tied
106.	The Skills Centre, Malaa	12.6	2019	Knights Energy	Self-financed	Grid-tied + Battery storage
107.	Secondary school	30.82	2019	Knights Energy	Self-financed	Battery storage + genset
108.	LEMAC	20.55	2019	Knights Energy	Self-financed	Grid-tied
109.	Total Kenya Baghati Mombasa	6.54	2019	Astonfield / Knights	Self-financed	Grid-tied
110.	Total Kenya Bombolulu Mombasa station	17	2019	Astonfield / Knights	Self-financed	Grid-tied
111.	Total Station Kiserian Station	9.1	2019	Knights Energy	Self-financed	Grid-tied
112.	Total Kenya Mai Mahiu Station	9.81	2019	Knights Energy	Self-financed	Grid-tied
113.	Total Kenya Machakos Station	10.14	2019	Knights Energy	Self-financed	Grid-tied
114.	KLM Air France Health centre	10.6	2019	Knights Energy	Self-financed	Grid-tied + Battery storage
115.	Butler Mission Hospital	11		Knights Energy		
116.	Total Station Eastern bypass	12.42		Astonfield / Knights	Self-financed	Rooftop PV
117.	Total Westend Nakuru	17		Knights Energy	Self-financed	Rooftop PV
118.	Total Rabai Road Station	18.96		Knights Energy	Self-financed	Rooftop PV
119.	Total Station Statehouse	20.55		Knights Energy	Self-financed	Rooftop PV
120.	Total Station Thika Road	20.928		Knights Energy	Self-financed	Rooftop PV

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
121.	Total Station South C	22.56		Knights Energy	Self-financed	Rooftop PV
122.	Mwangaza Retreat Center Karen	30		Knights Energy		Grid-tied system
123.	Eastern Africa Grain Council – NGO	50		Knights Energy		
124.	Karungu solar system Migori	50		Knights Energy		
125.	ABC Place, Shopping mall	30		CP Solar Resources Ltd		Grid-tied
126.	Abyssinia Prime Steel	540		CP Solar Resources Ltd		Grid-tied
127.	Africa Logistics Properties Solar Rooftop	500		Solar Century		PV-Diesel captive / Grid-tied
128.	Batian, flower farm	234		Equator Energy		
129.	Belfast Millers	75		CP Solar Resources Ltd		Grid-tied
130.	Best Western Executive Residency	80		CP Solar Resources Ltd		Grid-tied
131.	Bihi Towers	56		CP Solar Resources Ltd		Grid-tied
132.	Black petals, flower farm	175		Equator Energy		
133.	Blue Nile Rolling Mills Ltd	1,000		CP Solar Resources Ltd		Grid-tied
134.	Burn Manufacturing, factory	120		Equator Energy		Rooftop PV / Grid-tied
135.	C&P Shoe Industried LTd	200		CP Solar Resources Ltd		Grid-tied
136.	Capitol Printers	50		CP Solar Resources Ltd		Grid-tied
137.	Danco Plastics, factory	500		Equator Energy		Rooftop PV
138.	Eco-roses, flower farm	294		Equator Energy		
139.	Finlays Tea Kitumbe Factory	30				
140.	Golden Tulip, flower farm	60		Equator Energy		Rooftop
141.	Groove Flowers	75		Equator Energy		Rooftop PV
142.	ICIPE Muhaka	30		Questworks		Grid-tied
143.	Impala Glass Industries Ltd	250		CP Solar Resources Ltd		
144.	Jamia Mosque	50		CP Solar Resources Ltd		Grid-tied
145.	Kapa Oil refineries Ltd	1,500		CP Solar Resources Ltd		Grid-tied
146.	Kenya Sweets Ltd	200		CP Solar Resources Ltd		Grid-tied
147.	King Plastic Ltd	200		CP Solar Resources Ltd		Grid-tied
148.	Kirubi's Residence	100		Questworks		Rooftop PV
149.	Kubali, herb farm	60		Equator Energy		
150.	Laurel, flower farm	180		Equator Energy		
151.	Leisure Lodge Beach & Golf Resort	260		CP Solar Resources Ltd		Grid-tied
152.	Leisure Lodge Diani	200				
153.	Mombasa Moi International Airport	503		Solarcentury	EU funded	PV-Diesel Hybrid / Grid-tied + Battery Storage
154.	Napro Industries Ltd	250		CP Solar Resources Ltd		Grid-tied
155.	Nelion flower farm	60		Equator Energy		
156.	New KCC	10		CP Solar Resources Ltd		Grid-tied

No.	Power Consumer / Project	Installed Capacity kW	Commis-sion date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
157.	Osho Chemicals	100		CP Solar Resources Ltd		Grid-tied
158.	Ramco Court, Apartment Complex	31		CP Solar Resources Ltd		Grid-tied
159.	Rift Valley Roses	75		Ecoligo	Ecoligo	Rooftop PV / Grid-tied
160.	Silafrica Limited	337		CP Solar Resources Ltd		Grid-tied
161.	Spinners & Spinners, factory	1,200		Equator Energy		Rooftop PV
162.	Statpack Ltd	250		CP Solar Resources Ltd		
163.	Styroplast Ltd	250		CP Solar Resources Ltd		Grid-tied
164.	Subati Flowers	250		CP Solar Resources Ltd		Grid-tied
165.	Subati Group Phase 2 (flowers)	120		CP Solar Resources Ltd		Grid-tied
166.	Sun Floritech, flower farm	120		Equator Energy		
167.	Tile & Carpet Ltd	300		CP Solar Resources Ltd		Grid-tied
168.	Tropical Heat Ltd	100		CP Solar Resources Ltd		Grid-tied
169.	Tulaga, flower farm	60		Equator Energy		Grid-tied
170.	Utee flower farm	60		Equator Energy		Grid-tied
171.	Vitafoam Products Ltd	75		CP Solar Resources Ltd		Grid-tied
172.	Voi Wildlife Lodge	100		CP Solar Resources Ltd		Grid-tied
173.	UEA Barton University	180		Equator Energy		Grid-tied
	Total	**30,211**				

Source: authors' own elaboration (compiled from various primary and secondary sources)

No.	Power Consumer / Project	Installed Capacity kWp	Commission date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
1.	Diani Beach Hospital	48.64	Under-construction	Astonfield	SUNREF	
2.	Kenya School of Monetary Studies	2,000	Under-construction	Questworks		Rooftop PV
3.	Marco Borero	1,650	Under-construction	Astonfield		
4.	Nyali Centre	404	Under-construction	Astonfield	Stanbic Commercial Bank	
5.	Residential PV Solar Installation, Loresho, Nairobi	100	Under-construction	Questworks		Rooftop PV
6.	Rose Farms, Nakuru, Timau	1,000	Under-construction	Fontana/Greenspark	Self-financed	
7.	Standard Rolling Mills / Nyumba Group) Solar Farm	987	Under-construction	Solarcentury		Grid-tied
8.	Tononola Rolling Mills	975	Under-construction	Solarcentury		Grid-tied
9.	Total Kenya Kenyatta Ave Station	11.77	Under-construction	Astonfield	Self-financed	
10.	Galleria Mall	562	Under-construction	Solar Century		Grid-tied

No.	Power Consumer / Project	Installed Capacity kWp	Commission date	PV firm (including EPCs, O&M firms)	Mode of finance: self, DFIs, ESCOs	Remarks
11.	Kaimosi Tea Estate Kenya	1,500	Under-construction	Ofgen	Self-financed	Grid-tied, ground mounted 4,000 kWh
Total		**9,238**				

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