GHANA COUNTRY STUDY **2021**

CLEAN CAPTIVE INSTALLATIONS FOR INDUSTRIAL CLIENTS IN SUB-SAHARA AFRICA

Kpone (340 MW) gas-fired power plant.
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Solar farm to support the Accra facility.
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CICSA
CLEAN CAPTIVE INSTALLATIONS FOR INDUSTRIAL CLIENTS IN SUB-SAHARA AFRICA

Frankfurt School
FS-UNEP Collaborating Centre
for Climate & Sustainable Energy Finance

UN environment programme

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The electronic copy of this report can be downloaded at *captiverenewables-africa.org*.

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SUMMARY OF PUBLICATION

This country report presents the state of the clean captive installations market in Ghana as of year-end 2019, with a focus on the commercial and industrial market and solar photovoltaic (PV) technology.

The project team collected stakeholders' views on their experiences with: a) the current clean captive installations for the commercial and industrial sector; b) the perceived barriers for its development; c) potential synergies between their activities and the project; and d) industry sectors and technologies to be targeted under this project (for modelling support and to initiate a pilot project). For the purposes of confidentiality, the names of persons and/or institutions have not been included in this report.

The information presented in this report was collected during the last quarter of 2019 and is valid as of that date. The Ghanaian energy and captive market and its regulatory framework are changing rapidly. Readers are invited to consider any evolution that may have taken place since year-end 2019.

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1/ ABBREVIATIONS AND ACRONYMS

AFD	Agence Française de Développement
BNEF	BloombergNEF
BPA	Bui Power Authority
BTU	British thermal unit
CEADIR	Climate Economic Analysis for Development, Investment and Resilience
CEFECAB	Clean Energy Finance Expert Capacity Building
DSE Group	Dutch / Danish Sustainable Energy group
EC	Energy Commission of Ghana
ECG	Electricity Company of Ghana Limited
ECOWAS	Economic Community of West African States
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
EnDev	Energising Development
EPC	Engineering, procurement and construction
ESCO	Energy service company
GDP	Gross domestic product
GHS	Ghanaian cedi
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GRIDCo	Ghana Grid Company
GW	Gigawatt
GWh	Gigawatt-hour
HV	High voltage
IPP	Independent power producer
KfW	Kreditanstalt für Wiederaufbau
kWp	Kilowatt-peak
LED	Light-emitting diode
LI	Legislative instrument
LNG	Liquefied natural gas
MV	Medium voltage
MWe	Megawatt-electrical
MWp	Megawatt-peak
NEDCo	Northern Electricity Distribution Company
PFAN	Private Finance Advisory Network
PPA	Power purchase agreement
PURC	Public Utilities Regulatory Commission
PV	Photovoltaic
SAPP	Sunon Asogli Power Plant
SLT	Special load tariff
SREP	Scaling-up Renewable Energy Programme
TAPCO	Takoradi Power Company
TICO	Takoradi International Company Limited
TT1P	Tema Thermal Power Plant 1
TT2P	Tema Thermal Power Plant 2
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
VALCO	Volta Aluminium Company Limited
VRA	Volta River Authority
Wp	Watt-peak

2/ INTRODUCTION

This report is published under the project titled "Clean Captive Installations for Industrial Clients in Sub-Sahara Africa" developed in four partner African countries: Ghana, Kenya, Nigeria and South Africa.

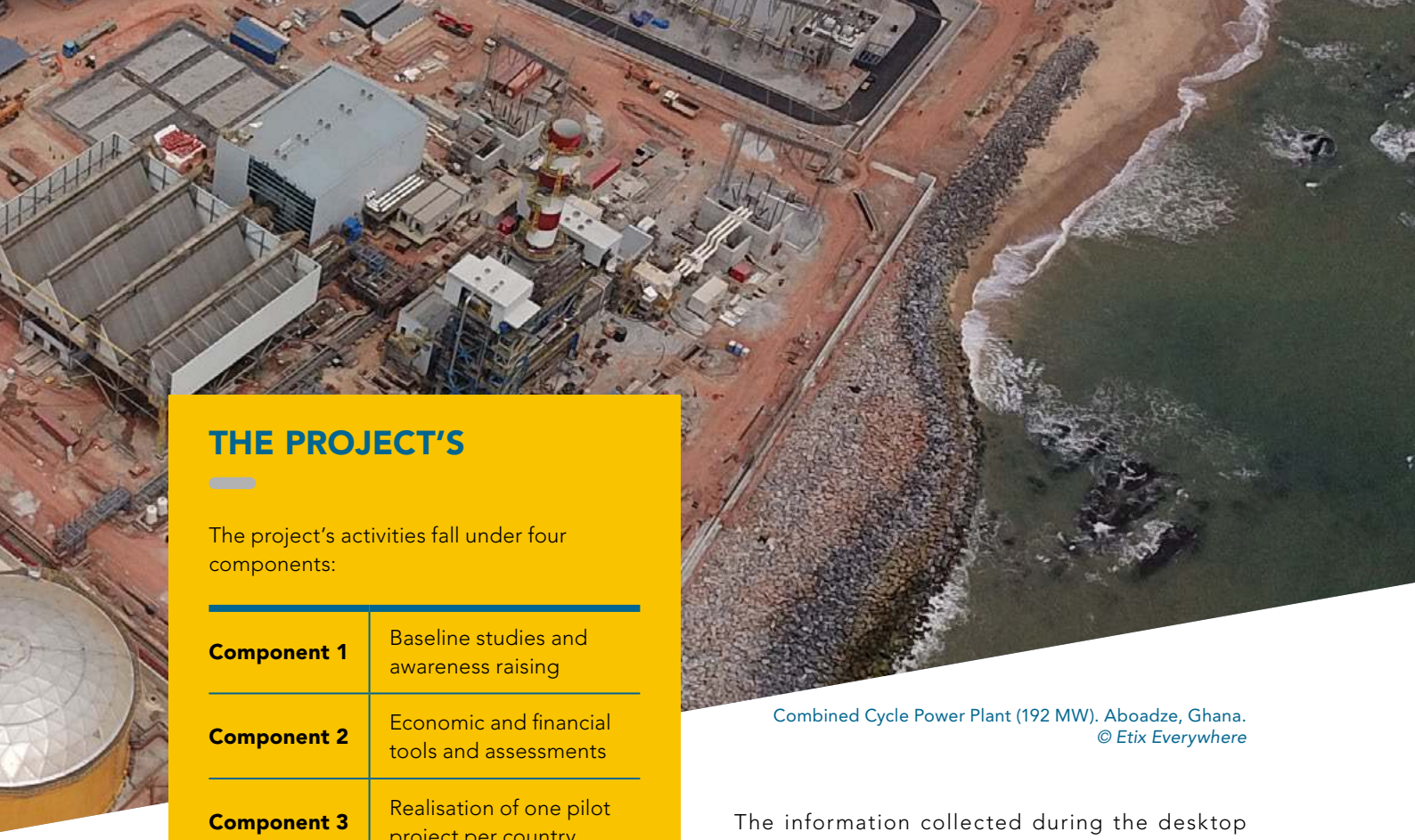
The project aims to demonstrate the economic and financial viability of clean captive energy installations for industries and to enhance their adoption in the four partner countries and beyond to the entire continent. Captive energy installations are electricity generation facilities that are used and sometimes also managed by a commercial or industrial energy user for their own energy consumption. Captive power plants can be operated off-grid or can be connected to the grid to feed in excess generation wherever regulations allow for it.

Renewable energy captive installations alleviate the pressure to generate electricity from national grids and reduce industrial clients' needs to rely on private supplementary fossil-fuelled generators, which are expensive to run. These clean captive installations are frequently referred to as the second generation of renewable energy business models, as they do not rely on national governments' incentivizing policies to enhance the deployment of clean energy technologies.

The project will strengthen the ability of partner countries to move towards low carbon-emitting development strategies. It also contributes to several Sustainable Development Goals, including Climate Action (SDG 13), Responsible Consumption and Production (SDG 12), Affordable and Clean Energy (SDG 7) and Industry, Innovation and Infrastructure (SDG 9). The project will raise awareness among industry players, financiers and governments, and will support the dissemination of clean modern energy technology through business models tailored to the national contexts and beyond throughout sub-Saharan Africa.

This project is part of the International Climate Initiative (IKI) of Germany. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety supports this initiative based on a decision adopted by the German Bundestag.

The implementing team of the project comprises the United Nations Environment Programme (UNEP) in partnership with its collaborating centre at Frankfurt School of Finance & Management (Frankfurt School), together with locally hired consultants who provide local market and captive power expertise.



Combined Cycle Power Plant (192 MW). Aboadze, Ghana.
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THE PROJECT'S

The project's activities fall under four components:

Component 1	Baseline studies and awareness raising
Component 2	Economic and financial tools and assessments
Component 3	Realisation of one pilot project per country
Component 4	Knowledge dissemination and outreach

This country report is part of Component 1. Initial desktop research was conducted followed by extensive consultation by the project team of local public and private sector stakeholders through a week-long scoping mission.

The scoping mission in Ghana took place from 23 September 2019 until 27 September 2019. The official kick-off meeting was held at the Ministry of Energy of Ghana on 24 September and gathered 23 stakeholders from 10 institutions. Following this in-depth discussion of the Ghanaian market with public stakeholders, the project team met with 48 private sector stakeholders throughout the week.

The project team collected stakeholders' views on their experiences with: a) the current clean captive installations for the commercial and industrial sector; b) the perceived barriers for its development; c) potential synergies between their activities and the project; d) industry sectors and technologies to be targeted under this project (for modelling support and to initiate a pilot project). For the purpose of confidentiality, the names of persons and/or institutions have not been included in this report.

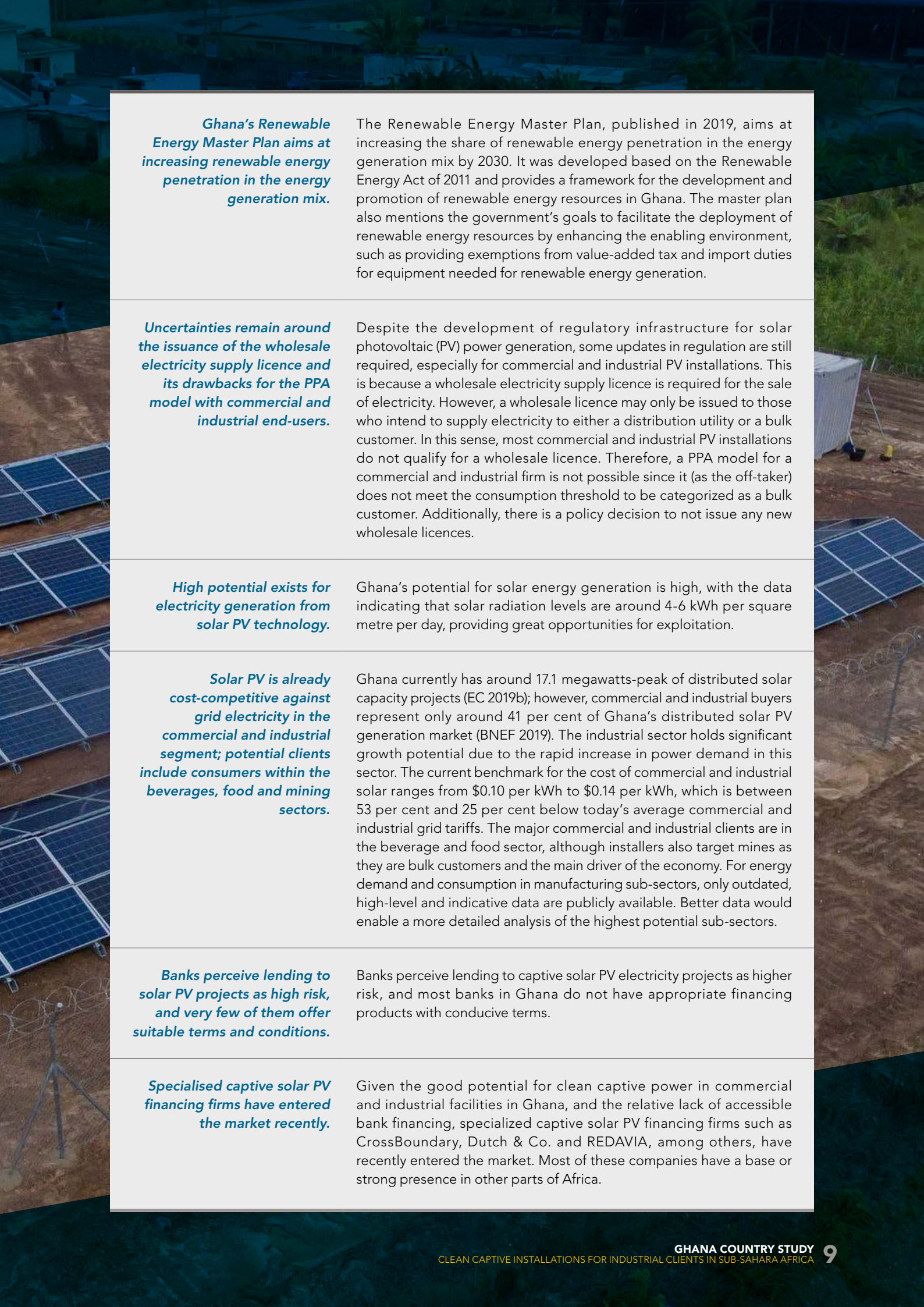
The information collected during the desktop research and in-person interviews will inform the overall design and guide the implementation of the project. This country report presents the state of the clean captive installations market in Ghana as of year-end 2019 with a focus on the commercial and industrial market and solar photovoltaic (PV) technology.

The information collected will also support the development of a robust financial model to be used as a tool to prove the financial viability of clean captive PV technology installations. Relevant and key information about the clean captive markets in the four partner countries and the project progress will be shared through the project website: *www.captiverenewables-africa.org*.

The information presented in this report was collected during the last quarter of 2019 and is valid as of that date. The Ghanaian energy and captive market and its regulatory framework are changing rapidly. Readers are invited to consider any evolution that may have taken place since year-end 2019.

3/ KEY FINDINGS

Ghana's total installed electricity generation is far above the country's peak power demand. Despite that, supply reliability is weak.	While Ghana has a high total installed electricity capacity compared to its peak demand (5,085 MW and 2,525 MW in 2019, respectively) (EC 2019a), supply reliability is weak. The bulk of the capacity is thermal plants (around 61 per cent) and large hydropower (around 38 per cent).
Ghana's overdependence on thermal resources poses a severe power supply risk to the country.	Ghana has faced severe electricity supply challenges over the past decade that have led to a daily average loss of production of $2.1 million (Kumi 2017). This loss can be attributed to: natural gas supply difficulties, as most thermal plants are gas-powered; low headwater levels in reservoirs for hydropower due to droughts; transmission line capacity constraints; and local currency depreciation, as tariffs are denominated in Ghanaian cedis while fuel and electricity purchases are paid for in U.S. dollars.
Universal access to electricity can be reached in 2025 if, and only if, around 2.2 per cent of the population without access is connected to the grid each year.	As of December 2018, 84.3 per cent of the Ghanaian population had access to electricity. The government has set a target for 100 per cent electrification by 2025, indicating its commitment to enhancing the electricity infrastructure. To overcome Ghana's electricity challenges related to infrastructure and shortage of supply due to high dependency on thermal resources, generation from different types of renewable resources could be considered as a viable solution to achieving the electrification target.
A high level of transmission and distribution losses and a debt-ridden power sector result in high grid downtime.	Transmission line constraints and a high level of distribution losses and network bottlenecks coupled with high legacy debt in the power sector further increase the vulnerability of Ghana's power sector and have led to high grid downtime and outages in recent years. Outages have had negative economic impacts on Ghanaian businesses.
Ghana has very high end-user electricity tariffs. They are expected to remain high for local businesses and industries operating in the country.	Ghana has one of the highest average end-user tariffs among comparable developing countries (Ministry of Energy 2019), an additional factor that is hindering the competitiveness of Ghanaian businesses (GEA 2017). Commercial and industrial customers pay more than $0.18 per kilowatt-hour (kWh). Net arrears for the energy and gas sector in Ghana are projected to increase to $12,524 million in 2023 from $2,748 million in January 2019. Those are likely to contribute to even higher electricity tariffs in the near future (Ministry of Energy 2019).
Feed-in tariffs or net metering schemes are not currently applied for new solar PV systems.	The Renewable Energy Act of 2011 provides the legal framework for feed-in tariffs, the grid code, net metering and a master plan to boost renewable energy in Ghana. Since the development of the Renewable Energy Act, the electricity distributor ECG has signed numerous power purchase agreements (PPAs) with a combined capacity of more than 2,000 MW, resulting in higher capacity than needed. This oversubscription of PPAs has forced the government since 2017 to halt new agreements and to suspend net metering due to concerns raised by the major electricity distribution companies.



Ghana's Renewable Energy Master Plan aims at increasing renewable energy penetration in the energy generation mix.	The Renewable Energy Master Plan, published in 2019, aims at increasing the share of renewable energy penetration in the energy generation mix by 2030. It was developed based on the Renewable Energy Act of 2011 and provides a framework for the development and promotion of renewable energy resources in Ghana. The master plan also mentions the government's goals to facilitate the deployment of renewable energy resources by enhancing the enabling environment, such as providing exemptions from value-added tax and import duties for equipment needed for renewable energy generation.
Uncertainties remain around the issuance of the wholesale electricity supply licence and its drawbacks for the PPA model with commercial and industrial end-users.	Despite the development of regulatory infrastructure for solar photovoltaic (PV) power generation, some updates in regulation are still required, especially for commercial and industrial PV installations. This is because a wholesale electricity supply licence is required for the sale of electricity. However, a wholesale licence may only be issued to those who intend to supply electricity to either a distribution utility or a bulk customer. In this sense, most commercial and industrial PV installations do not qualify for a wholesale licence. Therefore, a PPA model for a commercial and industrial firm is not possible since it (as the off-taker) does not meet the consumption threshold to be categorized as a bulk customer. Additionally, there is a policy decision to not issue any new wholesale licences.
High potential exists for electricity generation from solar PV technology.	Ghana's potential for solar energy generation is high, with the data indicating that solar radiation levels are around 4-6 kWh per square metre per day, providing great opportunities for exploitation.
Solar PV is already cost-competitive against grid electricity in the commercial and industrial segment; potential clients include consumers within the beverages, food and mining sectors.	Ghana currently has around 17.1 megawatts-peak of distributed solar capacity projects (EC 2019b); however, commercial and industrial buyers represent only around 41 per cent of Ghana's distributed solar PV generation market (BNEF 2019). The industrial sector holds significant growth potential due to the rapid increase in power demand in this sector. The current benchmark for the cost of commercial and industrial solar ranges from $0.10 per kWh to $0.14 per kWh, which is between 53 per cent and 25 per cent below today's average commercial and industrial grid tariffs. The major commercial and industrial clients are in the beverage and food sector, although installers also target mines as they are bulk customers and the main driver of the economy. For energy demand and consumption in manufacturing sub-sectors, only outdated, high-level and indicative data are publicly available. Better data would enable a more detailed analysis of the highest potential sub-sectors.
Banks perceive lending to solar PV projects as high risk, and very few of them offer suitable terms and conditions.	Banks perceive lending to captive solar PV electricity projects as higher risk, and most banks in Ghana do not have appropriate financing products with conducive terms.
Specialised captive solar PV financing firms have entered the market recently.	Given the good potential for clean captive power in commercial and industrial facilities in Ghana, and the relative lack of accessible bank financing, specialized captive solar PV financing firms such as CrossBoundary, Dutch & Co. and REDAVIA, among others, have recently entered the market. Most of these companies have a base or strong presence in other parts of Africa.

4/ GHANA KEY SOCIO-ECONOMIC INDICATORS

SOCIO-ECONOMIC INDICATOR	RESULT	DATE	SOURCE
Population	30.7 million	2019	World Population Review
Population growth	2.2%	2019	World Population Review
Female population share	50.1%	2018	World Bank
Youth population share (<15 years)	38%	2018	Index Mundi
Gross domestic product (GDP)	US$65.6 billion	2018	World Bank
GDP growth	6.5%	2019	World Bank
Average GDP growth	5.0%	1990-2010	Trading Economics
Contribution to GDP growth	Service (46%) Industry (34%) Agriculture (20%)	2018	World Bank
GDP per capita	US$ 5 192	2018	World Bank (constant local currency units)
Total labour force (share of total population >15 years)	67%	2018	World Bank (International Labour Organization estimate)
Female labour force (share of female population >15 years)	64%	2018	World Bank (International Labour Organization estimate)
Unemployment rate	6.7%	2018	World Bank
Inflation rate	9.4%	Year to August 2019	Trading Economics
Corruption perception index	41/100 points 78/180 ranking	2018	Transparency International
Ease of doing business	**118/190 ranking**	**2019**	**World Bank**

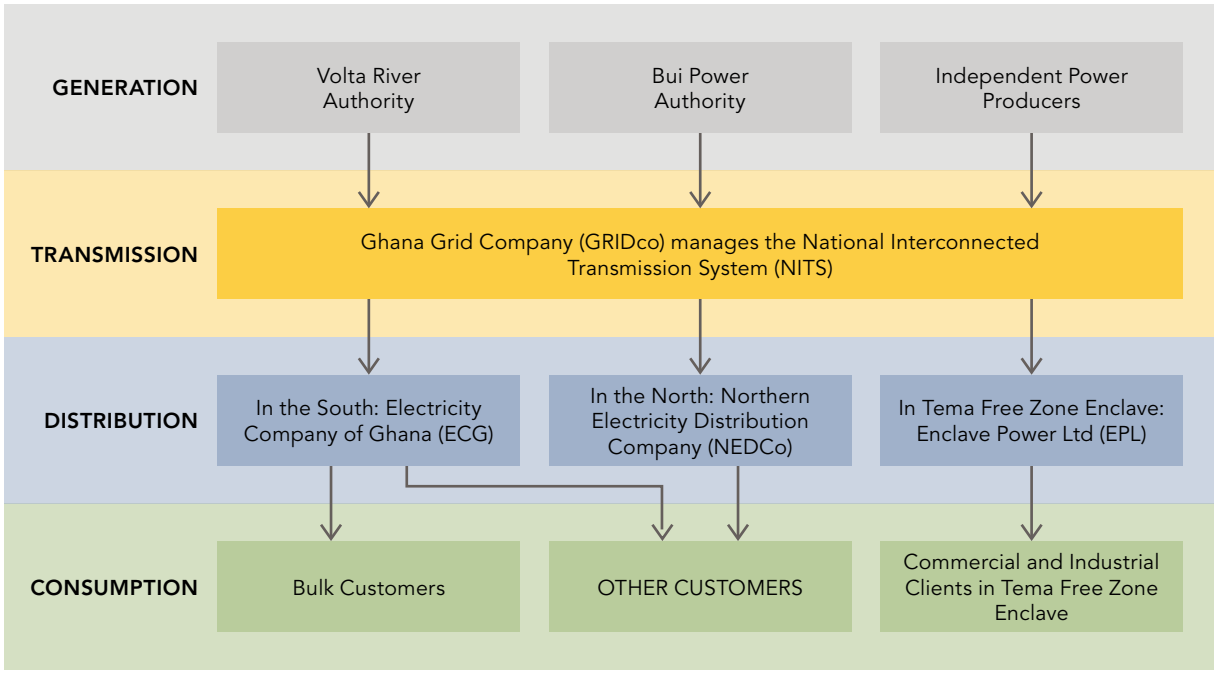
5/ ELECTRICITY MARKET

This section provides an overview of the electricity sector in Ghana, with a focus on electricity generation, transmission and distribution. Electricity demand as well as grid availability are also discussed.

Among the various stakeholders of the electricity market in Ghana, the public sector plays a dominant role. The government of Ghana unbundled the electricity sector as part of the power sector reforms in 2005. Figure 1 illustrates the current structure of the electricity market.

The Volta River Authority (VRA) and the Bui Power Authority (BPA) are responsible for electricity generation together with independent power producers that are mainly private sector players. The Ghana Grid Company (GRIDCo) is responsible for managing the National Interconnected Transmission System (NITS). The Electricity Company of Ghana Ltd. (ECG) manages the distribution of electricity for the southern part of Ghana, and the Northern Electricity Distribution Company Ltd. (NEDCo) manages the distribution of electricity for the northern part of Ghana. A third private distribution company, Enclave Power Ltd, is licensed by the Energy Commission to distribute and sell electricity to commercial and industrial customers only within the Free Zone Enclave in Tema (a major city in the Greater Accra region of Ghana).

Figure 1: Electricity market structure



Source: Author compilation

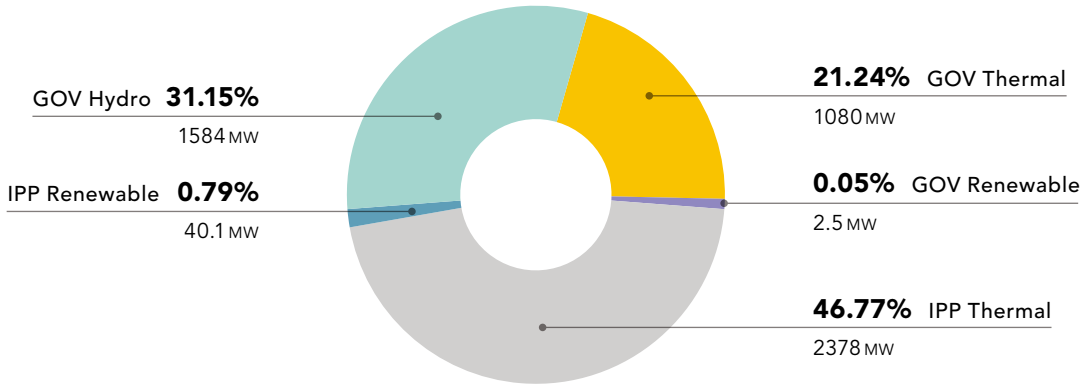
5.1/ ELECTRICITY GENERATION

This section explores the current electricity generation mix in Ghana, which relies increasingly on fossil fuels. Ensuring natural gas supply for electricity generation has proven to be challenging and hence is reflected in increasingly high electricity tariffs.

5.1.1/ ELECTRICITY GENERATION MIX

The total installed electricity generation capacity in Ghana at the end of 2019 was an estimated 5,084 megawatts (MW), of which 52.4 per cent was generated by government-owned companies and 47.6 per cent by independent power producers from the private sector (EC 2019a). The government of Ghana mandated the Volta River Authority, Bui Power Authority and several independent power producers to build, operate and control electricity generation facilities. The breakdown of installed generation capacity in 2019 is detailed in Figure 2.

Figure 2: Electricity generation installed capacity mix as of 2019



Source: EC 2019a

The figure indicates that 68 per cent of the total installed electricity generation capacity in 2019 was from thermal sources that rely on oil, natural gas and diesel as fuel. Independent power producers owned the majority of the thermal power plants (46.77 per cent of the total installed electricity generation capacity), while the government owned 21.24 per cent of them. Hydroelectric plants owned by the government accounted for most of the remaining installed power generation capacity, with 31.15 per cent of the total in 2019. Electricity generation from renewable energy accounted for only 0.84 per cent of the total installed capacity that year.

As of 2019, the Volta River Authority operated and managed 1,180 MW of hydroelectric plants, 1,080 MW of thermal plants and 2.5 MW of utility-scale solar PV plants (see Table 1). The Bui Power Authority managed one 404 MW hydroelectric plant. In addition, 15 independent power producers had one or more generating plants, with 10 of these plants – AKSA, Amandi, Ameri, CENIT, CENPower, Genser, Karpowership, Sunon Asogli (SAPP161, SAPP330) and Trojan – being thermal plants with a combined capacity of 2,378 MW. There are three renewable energy independent power producers: Safi Sana (biogas), BXC (solar) and Meinergy (solar). Almost all independent power producers operate on the basis of "take-or-pay" power purchase agreements.

Table 1 details the total installed capacity and dependable capacity in Ghana by power plant. It also illustrates the forecasted and actual availability factor of some of the power plants. The table shows that thermal power plants in general recorded much lower availabilities than were forecasted for 2019. This is due mainly to the unavailability of the fuel needed for their operation, as discussed in section 5.1.2. The forecasted and actual availability factors of independent power producers' plants were not reported.

Table 1: Grid-connected electricity generation Installations (operational and expected online) capacity mix as of December 2019

Plant	Installed Capacity (MW)	Dependable Capacity (MW)	Technology	Forecasted Availability (%)	Actual Availability** (%)***
HYDRO					
Akosombo – VRA	1 020	900	Hydro	90	94
Bui – BPA	404	360	Hydro	72	80
Kpong – VRA	160	105	Hydro	72	71
Subtotal	**1 584**	**1 365**			
THERMAL					
Karpowership – IPP	470	450	Heavy fuel oil; gas		
AKSA – IPP (AKSA Phase II expected in 2019)	370	350	Heavy fuel oil	90	72
Sunon Asogli Power (Ghana) 2 Company Limited (SAPP 330) – IPP	360	340	Gas	90	62
CENPower – IPP	360	340	Light cycle oil / gas	NA	NA
Takoradi International Company (TICO – T2) – VRA	340	320	Light cycle oil / gas (mainly Gas)	85	75
Takoradi Power Company (TAPCO – T1) – VRA	330	300	Light cycle oil / gas (mainly gas)	65	54
Ameri Plant – IPP	250	230	Gas	90	71
Kpone Thermal Power Plant – VRA	220	200	Gas / diesel	85	64
Sunon Asogli Power (Ghana) Company Limited (SAPP 161) – IPP	200	180	Gas	90	62
Amandi – IPP (expected from 2019)	192	190	Light cycle oil / gas	NA	NA
Cenit Energy Limited (CEL) – IPP	110	100	Light cycle oil / Gas	90	33
Tema Thermal 1 Power Plant (TTIPP) – VRA	110	100	Light cycle oil / Gas	85	56
Tema Thermal 2 Power Plant (TT2PP) – VRA	80	70	Gas	85	54
*Trojan – IPP	44	39.6	Diesel / gas	NA	NA
*Genser – IPP	22	18	Gas	NA	NA
Subtotal	**3 458**	**3 227.6**			
RENEWABLE					
*BXC Solar – IPP	20	0	Solar	NA	NA
*Meinergy Solar – IPP	20	0	Solar	NA	NA
*VRA Solar – VRA	2.5	0	Solar	NA	NA
*Safi Sana Biogas – IPP	0.1	0	Waste	NA	NA
Subtotal	**42.6**	**0.1**			
TOTAL	**5084.6**	**4592.7**			

Note: VRA = Volta River Authority; BPA = Bui Power Authority; IPP = independent power producer; NA = not available.

** Embedded plants are connected at 33 kilovolt (kV) and 11 kV voltage levels within the ECG and NEDCo network.*

*** Actual availability is rounded to the first decimal place and based on the figures reported in the 2020 Electricity Supply Plan for Ghana for the values recorded in 2019.*

**** The plant availability factor is calculated based on the dependable capacity and the fuel availability.*

Source: EC 2019a

The participation of independent power producers in Ghana has continued to grow since the thermal Takoradi Power Station was first built in Aboadze in 2004. in capacity terms, independent power producers are quickly catching up to public generation, and their installed electricity generation capacity represented 46.77 per cent of the total as of the end of 2019 (OBG 2018). The government of Ghana added emergency power plants post-2014 in order to meet shortfalls, and these are mainly independent power producers. These plants, along with other independent producers, have contributed to excess installed electricity generation capacity. Power purchase agreements associated with most independent power producers have become a source of burden to the government of Ghana (BWP 2020).

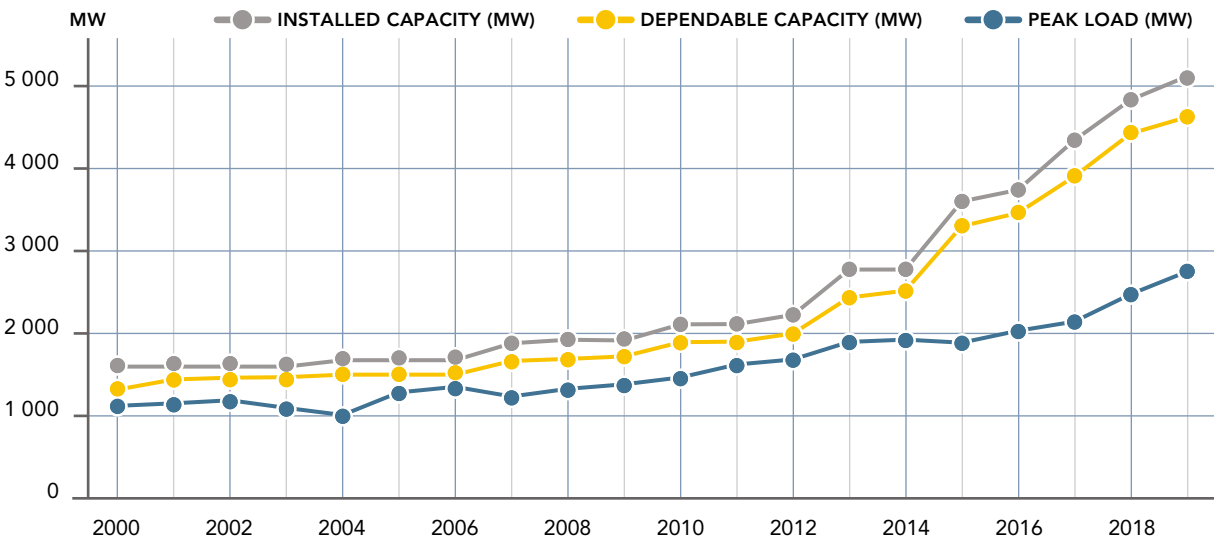
5.1.2/ HISTORIC CHALLENGES OF THE ELECTRICITY SECTOR

GHANA ENERGY CRISES

Since the early 2000s, the water levels of the hydroelectric plant at the Akosombo Dam, Ghana's biggest power station, and of the two other hydroelectric dams, Bui and Kpong, have consistently dropped below acceptable operational levels. As shown in Table 1, even though the installed capacity for the Akosombo Dam is 1 020 MW however the dependable capacity is 900 MW, and for the other two dams to 360 MW and 105 MW respectively, causing a major power supply challenge and leading to a severe national electricity crisis. This resulted in residential, industrial and commercial customers having electricity for less than 12 hours per day in 2015. The situation led to an emergency response from the government of Ghana, involving the costly procurement of emergency power plants and the construction of several thermal power plants running on mostly natural gas.

As shown in Figure 3, the generation capacity has increased year on year since 2015, due largely to the addition of thermal plants owned by independent power producers. The government of Ghana entered into take-or-pay contracts with private independent power producers, including three emergency producers during the 2014-2017 period. The additional procurement of electricity through take-or-pay contracts after 2014 has saddled the government with huge debt burdens (ACEP 2019).

Figure 3: Peak electricity demand versus installed and dependable generation capacity, 2000-2019

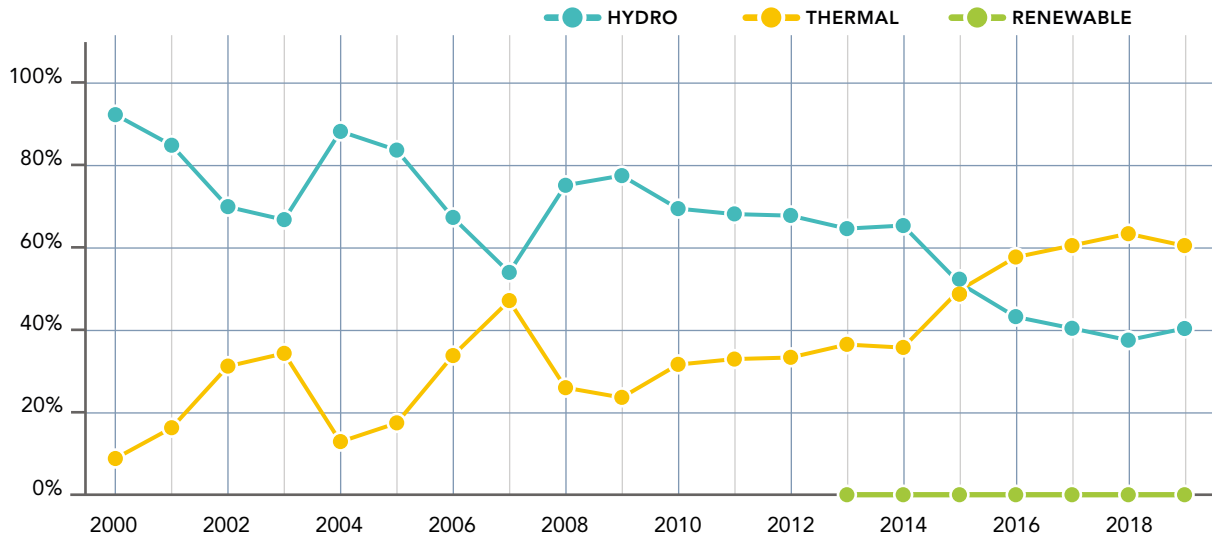


Source: EC 2020a

Figure 3 clearly indicates that total installed generation capacity, and accordingly the dependable operating capacity, far exceed the peak demand/load for most years. The excess generation capacity has been rising since 2014. The capacity addition has been mainly through independent power producers. The gap between the installed and generation capacities has been continuous over the years, ranging from 7 per cent to 19 per cent. Despite that, the supply is still considered unreliable due to the high dependency on thermal resources and technical constraints with regards to the grid.

Figure 4 shows the shifting point from hydropower to thermal sources in 2015 resulting from the emergency response from the government of Ghana. By December 2019, the total installed thermal capacity for both the Volta River Authority and independent power producers was 3,458 MW, of which around 89 per cent was either gas-fed only or fed with gas with other fuel alternatives (diesel, heavy fuel oil, light cycle oil). The performance of the electricity sector in Ghana is closely related to that of the natural gas sector.

Figure 4: Electricity generation mix in Ghana, 2000-2019



Source: EC 2020a

THE CHALLENGE OF GAS SUPPLY FOR THERMAL POWER PLANTS

Most of the installed generation facilities are not available for energy generation, as shown in Table 1. This is due to fuel supply challenges (Kumi 2017), as most of the natural gas supplied to these thermal plants is imported from Nigeria through the West African Gas Pipeline. However, the pipeline has proven to be unreliable for gas supply. This unreliability is caused by major external interruptions such as resource availability in Nigeria and by Ghana's inability to pay its debt obligations. These factors have consistently led to lower-than-agreed supply volumes to Ghana (Ministry of Petroleum 2016; US EIA 2018).

Nevertheless, three Ghanaian fossil fuel fields are making up for the deficits from the West African Gas Pipeline: the Jubilee field, the TEN field and the Sankofa field (EC 2019a). The Sankofa field is developed by ENI, which has signed a take-or-pay contract with the government of Ghana (USAID 2018a), while the other two fossil fuel fields, Jubilee and TEN, are not take-or-pay contracts. They were developed by Tullow Oil, with the Ghana National Petroleum Corporation (GNPC) having some share in them.

To date, these fields are operational; however, the transport of natural gas poses another challenge for fuel supply to thermal power plants. To address this issue, the Takoradi-Tema Interconnection Project was initiated and subsequently completed in 2019 to allow for the transport of gas produced by fields in the West to the thermal power plants located in the East. This may have improved the fuel supply challenges experienced by some of the thermal power plants; however, the challenge of fuel supply reliability persists as resources are insufficient to cover all of the needs of the thermal power plants (EC 2020b).

The demand for natural gas in Ghana is driven by the power sector. However, there has been a problem of non-payment by the power generation companies. For example, in August 2014 the Volta River Authority, a purchaser of gas in Ghana, stopped paying for the gas. The Volta River Authority was not receiving payment from its electricity distributors, who in turn were not being paid by most of their customers – the majority of the customer base being the government of Ghana (OIES 2018). As a result, a large debt was still outstanding in early 2016 despite the Volta River Authority having resumed paying bills since the third quarter of 2016.

In addition to the gas imports from the West African Gas Pipeline and the country's three national gas fields, Ghana has contracted supplies of liquefied natural gas (LNG)[1], which were planned to be available in 2020 and 2022 through the Tema LNG and Takoradi[2] LNG projects. According to the Energy Sector Recovery Program, Ghana's excess gas supply was to grow significantly in 2020 with the arrival of the first LNG supplies. This may improve electricity generation, increasing the availability of thermal plants and potentially having an impact on the cost of electricity.

In a previous attempt to generate power from LNG in 2016, the prices for gas-to-power generation were estimated to cut the cost of electricity in Ghana by 35 per cent when compared to generation from light-cycle oil (International Power 2015). However, the lack of proper infrastructure for receiving and supplying the imported LNG at the time led to a failed effort, and as a result, West Africa Gas Limited paid $23 million in arbitration to the LNG supplier (US EIA 2018; International Power 2015). Accordingly, the impact that these new attempts at generation from LNG will have on the cost of electricity remains to be seen.

Table 2: Losses in the gas sector (in $ millions)

GAS SECTOR	2019	2020	2021	2022	2023
Under recovery	73	109	140	164	197
Sankofa take-or-pay	168	-	-	-	-
Tema LNG take-or-pay	-	411	822	822	822
Takoradi LNG take-or-pay	-	-	-	275	550
Annual losses	241	520	962	1 261	1 569
CUMULATIVE LOSSES	**241**	**761**	**1 723**	**2 984**	**4 553**

Source: Ministry of Energy 2019

Although the supply of domestic gas is growing, Ghana National Petroleum Corporation is also incurring a growing loss within this sector. GNPC has been purchasing gas at $9.42 per million British thermal units (BTUs) (Ministry of Energy 2019) and then selling the gas to the Public Utilities Regulatory Commission (PURC) at $7.29 per million BTUs due to the tariff imposed by the PURC.

From 2019, GNPC faced $168 million in Sankofa take-or-pay obligations for gas that was not being consumed. Beyond 2019, the full take-or-pay volumes of gas will be needed to meet supply. In the second half of 2020, GNPC faced take-or-pay obligations of $822 million annually for gas from the Tema LNG project that was projected to be in excess of supply. From 2022, GNPC faces additional take-or-pay obligations of $523 million annually from the Takoradi LNG project for gas that is projected to be in excess of supply (Ministry of Energy 2019).

Until the government of Ghana implements the necessary interventions, such as those outlined in the Energy Sector Recovery Program, the growing arrears in the gas sector will weigh heavily on the economics of the power sector and will result in high electricity tariffs for all customers, including commercial and industrial clients.

FINANCIAL CHALLENGES OF THE ELECTRICITY SECTOR

The financial challenges for Ghana's power sector were accentuated due to the procurement of high-cost emergency power plants during the energy crisis period of 2012-2015 (USAID 2018b). According to the 2019 Energy Sector Recovery Program report, $2,748 million of net arrears were outstanding in the energy and gas sectors as of January 2019. An additional $1,268 million was forecasted to be added to this deficit in 2019, and net arrears could grow to more than $12,524 million by the end of 2023 if no action is taken.

1 *Liquefied natural gas (LNG) is a composition of methane and some mixture of ethane used to convert natural gas to liquid form for ease and safety of storage transport. It is cooled to approximately –160 degrees Celsius (256 degrees Fahrenheit) so that it can be transported from countries with a large supply of natural gas to countries that demand more natural gas than they produce.*

2 *Takoradi is the capital city of the Western Region of Ghana where both gas fields and the additional power generation plants are located.*

The average "surplus generation capacity" in 2018 was 887 MW[3], as a result of the capacity addition leading to consumers indirectly paying for costly power plants (BNEF 2019). Consequently, many commercial and industrial consumers opted for captive power generation (using diesel gen-sets and solar PV systems) (EC 2018a). This helped consumers lower the cost of electricity and therefore lower their operating costs, while mitigating potentially unreliable grid power supply. The switch to self-generation greatly impacted utility revenues.

This has resulted in a high level of debt within the energy sector, which has affected the power supply chain and the financial sector (USAID 2018b). A combination of electricity tariff increases and/or sector stabilization payments[4] will be needed to bring the sector back into balance by 2023 and to prevent further accumulation of arrears. Thus, Ghana is likely to continue to rank as having the highest average end electricity cost across similar middle-income countries over the coming years. This could possibly result in commercial and industrial consumers selecting a captive electricity generation option.

5.1.3/ FUTURE PROJECTION

BOX 1: Ghana electricity consumption current and projected

According to estimates from the Electricity Supply Plan (ESP) Committee, the total electricity consumption of Ghana, including power exports to Benin, Burkina Faso, Mali and Togo, is projected to increase from 20,071 gigawatt-hours (GWh) in 2020 to 28,999 GWh in 2024, at a compound annual growth rate of around 9.6 per cent. This takes into account the natural growth and spot loads resulting from a) demand from Volta Aluminum Company Limited (VALCO), b) demand from mines and c) exports to Benin, Burkina Faso, Mali and Togo. The system peak demand is projected to increase from 3,073 MW in 2020 to 4,394 MW in 2024 (EC 2019a).

Table 3: Projected peak demand and generation capacity (MW), Ghana

PEAK DEMAND (MW)	2020	2021	2022	2023	2024
Domestic	2 656	2 853	3 076	3 291	3 524
VALCO	147	147	300	300	500
Exports	270	270	270	320	370
TOTAL	**3073**	**3270**	**3646**	**3911**	**4394**
GENERATION CAPACITY (MW)	**2020**	**2021**	**2022**	**2023**	**2024**
Total Existing Generation	3 925	3 818	3 960	3 800	3 800
Total Dependable Generation	4 278	4 208	4 718	5 058	5 058
SURPLUS/DEFICIT	**1205.26**	**937.99**	**1071.75**	**1147.35**	**664.42**

Source: EC 2019a

3 *Derived from average electricity demand.*

4 *A commitment by the government of Ghana to fund the annual sector shortfall from 2020 onwards until the sector is in balance to prevent further accumulation of arrears (Ministry of Energy 2019).*

5.2/ ELECTRICITY TRANSMISSION AND DISTRIBUTION

This section explores the current situation of the electricity transmission and distribution system in Ghana, which is characterized by a high level of commercial losses, technical losses and losses in revenue collection due to non-payment of bills by clients, the large majority of which are public bodies.

5.2.1/ CURRENT SITUATION

The electricity transmission and distribution network in Ghana, including mini-grids, covers most of the main population centres. Almost, if not all, of the country is covered; however, the transmission system experiences heavy losses and is found to be inadequate to meet Ghana's electricity demand. Map 1 shows the existing grid network in Ghana.

Map 1: Electricity transmission network in Ghana

Source: Ennison and Dzobo 2011

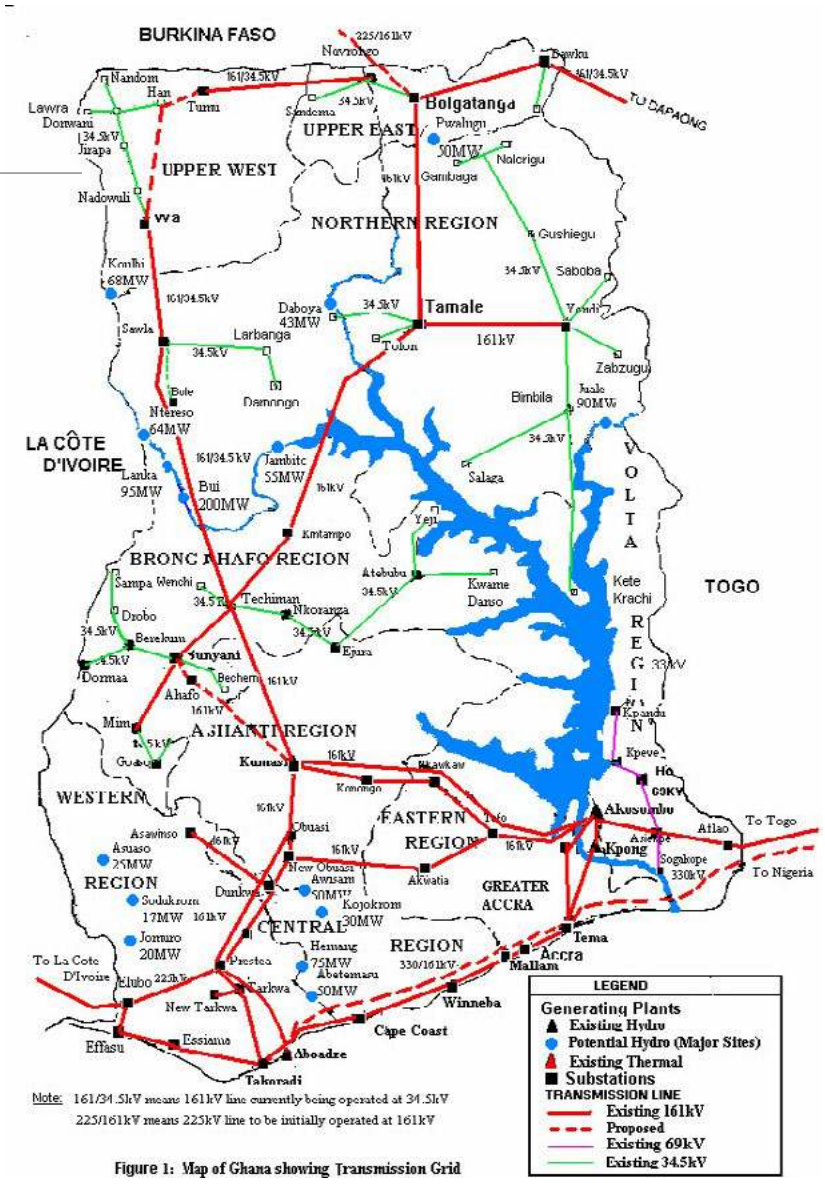
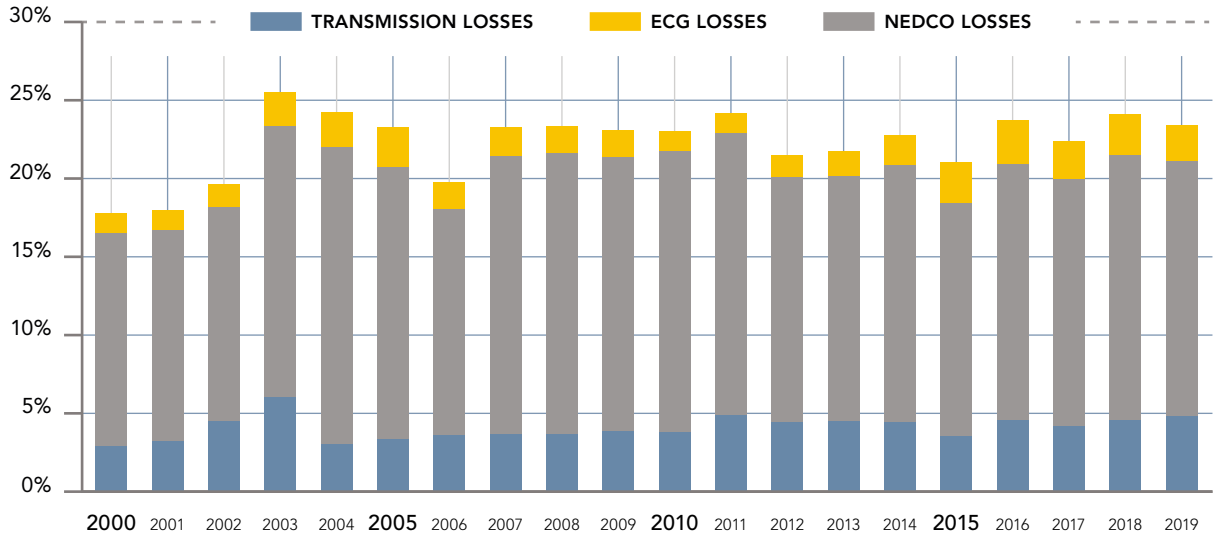


Figure 1: Map of Ghana showing Transmission Grid

As shown in Figure 5, transmission and distribution losses account for a high share of gross electricity transmitted (in GWh) over the past decade. While transmission losses[5] account for around 4 per cent on average, distribution losses[6] recorded by the Electricity Company of Ghana Limited (ECG) have the highest contribution, representing 16 per cent on average of the gross electricity transmitted (EC 2020a). This is because: a) the customer base served by the ECG is higher in comparison to NEDCo and b) the ECG also serves bulk customers, while NEDCo only serves the northern side of the country and not bulk users (Lexology 2019). The system transmission losses recorded in 2019 totalled around 844 GWh (4.7 per cent of the total transmitted energy of 17,887 GWh in 2019).

Figure 5: Transmission and distribution losses as a share of gross electricity transmitted, 2000-2019



Source: EC 2020a

The technical losses are caused by both an inefficient distribution network and obsolete equipment in the transmission network. Commercial losses, on the other hand, result from errors in accounting and power theft through meter tampering and meter bypass. Losses during the collection of revenue occur because of non-payment of bills.

In 2018, ECG lost over $180 million in revenue because of non-payment of bills, of which $150 million (80 per cent) was due to non-payment by public administration bodies (Ministry of Energy 2019). Through the non-payment of electricity bills by ministries, department and agencies to the ECG, the government of Ghana has accumulated over $1,300 million (representing 47 per cent of the total net sector arrears) in arrears to date, making it the single largest debtor to the energy sector (Ministry of Energy 2019). These debts have made it difficult for the power generation and distribution companies in Ghana, including the Volta River Authority, to meet their financial obligations (Kumi 2017).

5.2.2/ NATIONAL ELECTRIFICATION SCHEME

The National Electrification Scheme, set up in 1989, has been the principal framework guiding Ghana's commitment to reaching universal access to electricity by 2020 (Kumi 2017). Nearly 20 per cent of Ghana's population had access to electricity in 1990, and the rate has since improved to 84.3 per cent in 2018, representing an annual increase of 2.6 per cent. Despite its efforts, Ghana is on a trajectory to miss its 2020 target unless measures are implemented to accelerate the annual electrification rate to 4.38 per cent (Kumi 2017). The target for attaining universal access was thus extended to 2025 from 2020, as indicated by the Minister of Energy, Hon. John Peter Amewu, at the 5th Minigrid Action Learning Event held in Ghana on 25 June 2019.

5 *Transmission losses refer to energy losses that arise from the transfer of power across high-voltage transmission lines of 161 kV, 330 kV, 225 kV and 69 kV (in Ghana) from various generation companies directly to some consumers and to the distribution utilities.*

6 *Distribution losses refer to energy losses that arise from the transfer of power across the distribution network at 33 kV, 11 kV and 0.4 kV (in Ghana) to customers. Losses can be from either technical losses or commercial losses. Technical losses refer to energy losses that arise from the flow of power across the power networks due to the inherent properties of these networks. Commercial losses refer to loss of power arising from energy theft, meter bypass, energy accounting error and meter tampering.*

5.2.3/ TRANSMISSION AVAILABILITY

Electricity in Ghana is transmitted at three main high-voltage levels: 69 kV, 161 kV and 330 kV. At present, there are a few 225 kV lines in Ghana for interconnection with neighbouring countries (western neighbour Côte d'Ivoire and northern neighbour Burkina Faso). The Ghana transmission network consists of around 5,966 circuit kilometres of high-voltage transmission lines, which connect generating plants at Aboadze, Akosombo, Bui, Kpong and Tema to some 64 bulk supply points, including electricity distribution companies across the country (EC 2019a).

According to the 2019 Electricity Supply Plan for the Ghana Power Sector (EC 2019a), the transmission system has inadequate available transfer capacity between sub-networks to meet the demand requirements of the major load centres (Accra, Kumasi, Tarkwa, etc.), particularly during peak demand periods. This situation has resulted in low voltages, overloading of lines and increased overall transmission losses.

Critical transmission additions and upgrades have been proposed by the Energy Commission of Ghana to improve transmission reliability. However, Ghana Grid Company (GRIDCo) indicated that the failure of consumers to fulfil their debt obligations has had a strong impact on its effective maintenance of the transmission equipment (Modern Ghana 2019). GRIDCo observed that as of 1 March 2019, ECG's outstanding debt to GRIDCo stood at 701 million Ghanaian cedis, while VALCO owed it 32.6 million Ghanaian cedis. NEDCo's debt stood at 177 million Ghanaian cedis as of 30 September 2019.

A key recommendation of the 2020 Electricity Supply Plan (EC 2020c) is for both GRIDCo and generating companies to ensure a well-coordinated maintenance programme. Given the serious financial burdens that transmission companies face, a relevant question that remains to be seen is how the Energy Commission plans to improve transmission lines when transmission companies have no finances to do this themselves.

5.3/ ELECTRICITY DEMAND AND CONSUMPTION

This section explains the levels of electricity demand and consumption and their evolution among different consumer groups, including residential, non-residential (commercial) and industrial consumers (the largest client group).

As mentioned previously, the total installed electricity generation capacity in Ghana as of December 2019 was 5,084.6 MW, of which 4,592.7 MW (about 90.3 per cent) was dependable capacity. The demand for electricity is lower than the dependable capacity even though Ghana's peak load demand nearly doubled during the period 2009-2019, from 1,423 MW to 2,804 MW (EC 2019a), representing a compound annual growth rate of 7.02 per cent.

In parallel, generation capacity has more than doubled during the same period, from 1,970 MW to 5,172 MW (excluding captive back-up generation), representing an annual increase of 9.71 per cent. A steeper increase is noticeable from 2015 onwards, as a result of the procurement of very costly emergency power plants in response to the 2012-2015 energy crisis (World Bank 2018). Regardless, occasional outages still occur due in part to constraints in the distribution and transmission networks as well as the thermal fuel challenges (EC 2019a), as described in section 5.1.2.

5.3.1/ CUSTOMER CATEGORIES

Box 2 provides details of the broad consumer categories in Ghana, which guide further discussion on the utilisation of electricity.

BOX 2. Categories of electricity consumers

The Public Utilities Regulatory Commission of Ghana categorizes electricity consumers as follows:

1. Residential – Customers who by their request for supply to the utilities indicated that they need the power for purely residential use. The sub-categories are 0-50, 51-300, 301-600 and 600+ kWh units' consumption and Lifeline consumers
2. Non-residential (Commercial) – Customers who by their request for supply to the utilities indicated that they need the power for purely commercial use. The sub-categories are 0-100, 101-300, 301-600 and 600+ units' consumption.
3. Special Load Tariff – Low Voltage (SLT – LV) customers – SLT LV refers to SLT customers who are metered by the distribution utility at the low-voltage side of the transformer of 0.4 kV.
4. Special Load Tariff – Medium Voltage (SLT – MV) customers – SLT MV refers to SLT customers who are metered by the distribution utility at the 11 kV side of the transformer for 11 kV / 0.4 kV transformers. (SLT consumers are mainly from the industrial segment and are sometimes referred to as "industrial" consumers.)
5. Special Load Tariff – High Voltage (SLT – HV) customers – SLT HV refers to SLT customers who are metered by the distribution utility at the 33 kV side of the transformer for 33 kV / 0.4 kV transformers.
6. Special Load Tariff – Mines – SLT Mines refers to SLT customers who are metered by the distribution utility at the 33 kV side of the transformer for 33 kV / 0.4 kV transformers. Tariffs are denominated in U.S. dollars for SLT Mines customers.

Source: PURC 2019a

The non-residential (commercial) customers are small-scale customers whose energy consumption is similar to the residential sector. Commercial and industrial clients targeted in this study are non-residential and are under one of the different special load tariffs.

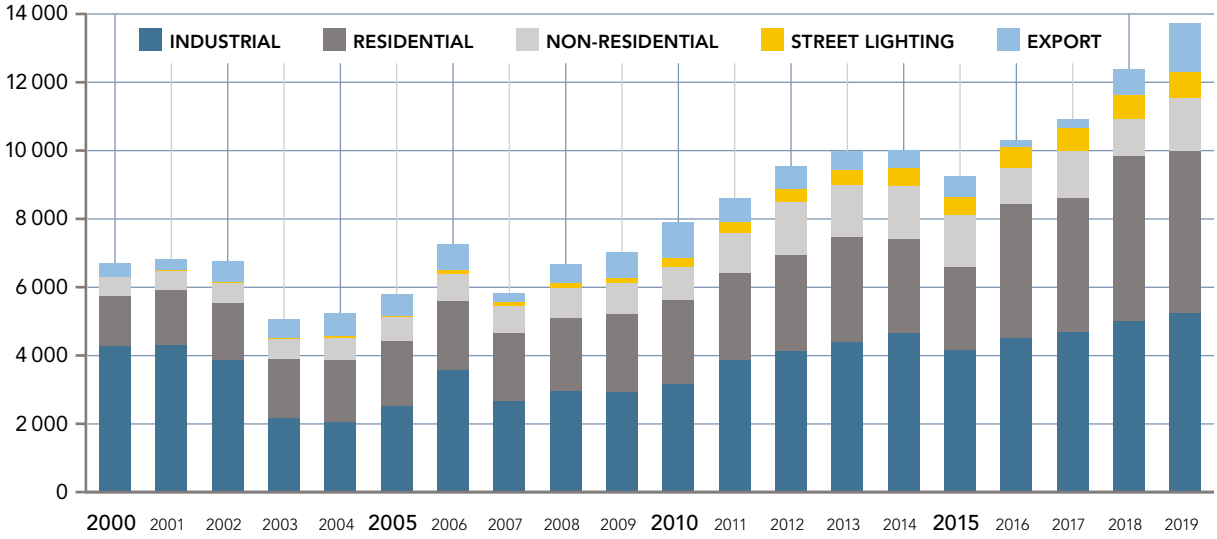
On top of these categories, some customers can also be bulk customers. Bulk customers are categorized as those with a maximum demand of 500 kilovolt-amperes (kVA) or minimum annual energy consumption of 1 million kWh (EC n.d.a). Regarding the tariff based on the Public Utilities Regulatory Commission of Ghana, bulk customers are categorized into two categories: those who purchase electricity directly from an electricity generator and those who procure electricity through a distribution company. Based on that categorization, in addition to paying the total cost of electricity purchased, which falls under one of the special load tariffs, bulk customers have to pay additional charges. For the first category these are the transmission service charges (TSC1 and TSC2) and the distribution service charge (DSC1). For the second category of customers, additional charges include TSC1 and TSC2 and the distribution wheeling charge[7] (DWC) (PURC 2019a).

BOX 3. Bulk customers in Ghana include:

1. Mines (Adamus Gold Resources, Ahafo/Kenyase (Newmont), Akwatia, Akyempem (Wexford), Asanko Gold, Bogosu, Drill Works, Konongo, New Abirim (Newmont), New Obuasi, New Tarkwa, Obuasi, Perseus (Ayanfuri), Prestea);
2. Other bulk customers (Akosombo Textiles, Aluworks, Diamond Cement, Generation Plants Station Service, Ghana Water Company Ltd, Savana Cement (Buipe), Volta Hotel and Volta River Authority Townships);
3. Volta Aluminum Company Limited (VALCO).

7 *The wheeling charge refers to the rate that has to be paid to the respective distribution companies for the use of their networks by the bulk customer, while the distribution charge is the rate that has to be paid to cover the distribution losses; PURC 2019a.*

Figure 6: Utility electricity sales by customer category, including electricity export (GWh), 2000-2019

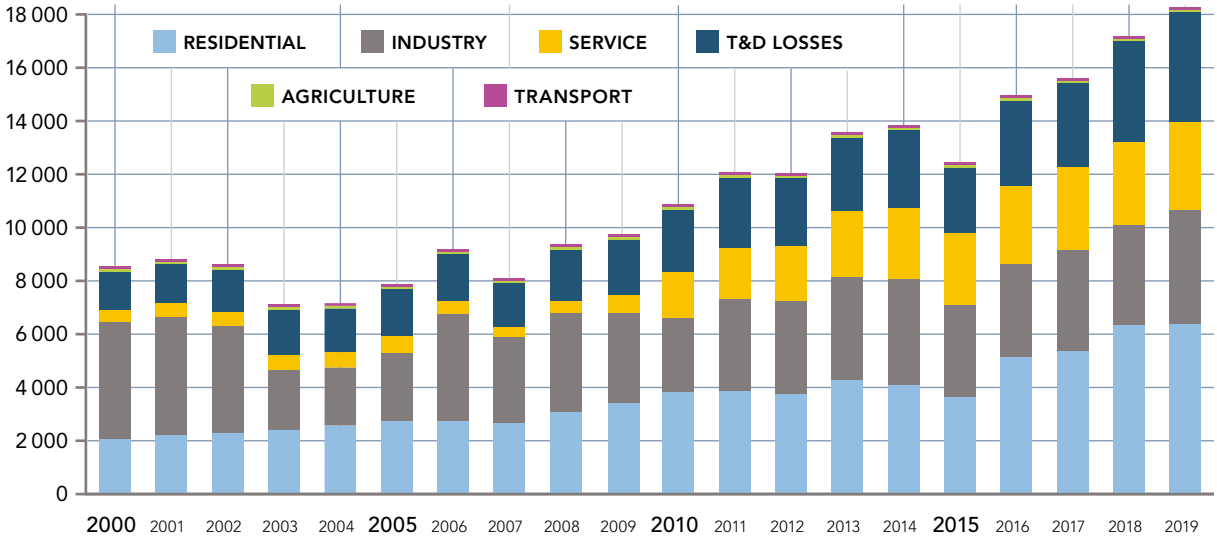


Source: EC 2020a

5.3.2/ ELECTRICITY CONSUMPTION IN THE INDUSTRIAL SECTOR

The industrial sector, made up mainly of the special load tariff categories, is the second-largest client group by consumption, representing around 30 per cent of the electricity consumption in Ghana in 2019, as seen in Figure 7. The vast majority of industries are on the ECG network, which is the focus of the analysis. In 2019, ECG's special load tariff customers constituted 0.036 per cent of the total customer population base of 4.7 million, and this translates to 1,744 customers (EC 2020a). These customers contributed 43 per cent of the total revenue and 30 per cent of Ghana's gross electricity consumption, making it an attractive sector for the different power sector institutions.

Figure 7: Electricity consumption by sector (GWh) in Ghana, including transmission and distribution losses, 2000-2019



Source: EC 2020a

Figure 7 shows the development in energy consumption of the various sectors in Ghana. In recent years, electricity consumption in the industry sector has been declining in comparison to that of the residential sector. One of the reasons, apart from high tariff charges, could be that the industry sector has been forced to rely more on alternative electricity sources that are reliable, such as diesel gen-sets or in some cases renewable captive electricity such as solar, due to the unreliability of grid-supplied electricity (explained further in section 5.4).

Furthermore, transmission and distribution losses (including commercial losses) account for a substantial share of the total electricity consumption in Ghana, representing almost the same amount of electricity as was consumed by the industry sector in 2019. Accordingly, it can be inferred that there is a need for a reliable power supply, which is currently not provided by the grid due to the challenges explained previously. Based on the current status of the grid, with the development of projected consumption especially in the industrial sector, if no alternative is proposed then more challenges will arise that will ultimately result in severe consequences for the overall economy.

BOX 4: Volta Aluminium Company Limited

Volta Aluminium Company Limited has been one of the major electricity consumers in Ghana since its formation. In 2001, VALCO's peak demand represented 27 per cent of Ghana's peak demand, and its energy consumption accounted for 33 per cent of the country's total (PSEC and GRIDCo 2010). The operations of VALCO were reduced considerably due to the electricity crisis, leading to a complete shutdown in 2004. VALCO resumed operations in 2018, accounting for 5.11 per cent of Ghana's total electricity consumption that year (EC 2019a).

5.4/ GRID AVAILABILITY AND ELECTRICITY SUPPLY RELIABILITY

This section focuses on the availability and reliability of grid-supplied electricity in Ghana, which needs to be assessed over its value chain. As explained previously, grid downtime is the result of generation, transmission and distribution issues.

According to the Public Utilities Regulatory Commission's (PURC) benchmark for customer service reliability, a customer is not expected to experience a blackout more than six times in a year, whether in the metropolitan, urban or rural areas of Ghana. However, according to the Energy Commission's 2019 Energy Statistics, ECG customers in these three areas, including industrial and residential users, experienced blackouts 28, 57 and 61 times on average, respectively. NEDCo customers had blackouts 146 times on average. These outages in the distribution network arise due to overloaded transformers and also for other reasons such as vegetation coming into contact with bare overhead lines, third-party contractors excavating underground power cables, loose contacts of overhead line accessories, poor network construction, and lack of redundant lines and cables.

In 2016, the Private Enterprise Foundation conducted a study of the impact of power outages on manufacturing industries in Ghana. The study indicated that all of the surveyed industries considered power supply to be unreliable due to the outages, with the majority reporting outages 6-10 times per month. However, the exact number of surveyed industries is not indicated clearly in the study. The surveyed industries also indicated that this unreliability of the power supply has had negative effects on business, including damage to equipment, loss in material processes, loss in income and loss in production, which ranged between 2 and 24 hours per month (PEF 2016).

Based on a similar World Bank study conducted in 2013 of 720 business establishments across the various manufacturing industries, 89 per cent of the firms reported power outages occurring eight times per month on average, with an average outage duration of seven hours (World Bank 2013). Additionally, 42 per cent of the surveyed firms reported unreliability of electricity as a major obstacle to business operations, while 20 per cent reported unreliability of electricity as a "very severe obstacle." The study further indicated that, as a result of unreliable electricity, 53 per cent of the firms own or share diesel generators.

This illustrates how the unreliability of the power supply represents an obstacle to the daily business operations of firms in Ghana, and this translates to economic losses as experienced by firms. As such, the proper utilization of captive renewable energy installations may present a more reliable alternative to the obstacles currently experienced by firms in Ghana.

5.5/ CONCLUSION

The electricity sector in Ghana is characterised by: a) the total installed generating capacity being higher than peak demand; b) a high level of transmission and distribution losses and c) a high occurrence of grid downtime.

Ghana's generation mix has been undergoing a transformation over the years. It comprised 42.8 per cent hydropower and 57.2 per cent thermal at the end of 2006, then shifted to 77 per cent hydropower and 23 per cent thermal in 2009, before changing drastically in 2018 to only 38 per cent hydropower, 61 per cent thermal and 1 per cent imports (EC 2019a). The country's installed generating capacity increased from 1,730 MW in 2006 to 4,889 MW in 2018 (5,172 MW in 2019), whereas electricity demand increased from 1,393 MW in 2006 to 2,525 MW in 2018. Despite this situation of overcapacity, the country experiences shortages of electricity supply.

Ghana has experienced various challenges in the electricity sector over the past 15 years. Firstly, there is a gap between the total installed electricity generating capacity (5,084 MW at the end of 2019) and dependable electricity generation capacity (4,593 MW), which may be due to several factors such as the efficiency of the power plants with regard to the generation equipment used and its years of operation. The peak electricity demand in 2018 was 2,525 MW, which is almost half of the total installed generating capacity, and still, there are supply reliability issues.

In addition, energy resource supply is challenging. Drought conditions that resulted in lower water levels in dams have led to the non-availability of hydroelectric plants. In parallel, the supply of natural gas from the West African Gas Pipeline has been unreliable, limiting the generation of thermal plants using gas and putting the country's power supply at high risk. Other factors such as a high level of debt burden on electricity companies, accumulated losses in the gas sector and a high level of distribution losses have a direct impact on tariff levels, which are among the highest for comparable developing countries. Moreover, Ghana also faces transmission issues due to inadequate capacity, resulting in low voltages, overloading of lines and higher transmission losses. The low distribution reliability impacts operations of commercial and industrial establishments, mainly in the form of blackouts (power outages).

The unreliability of the power supply has an impact on business performance, as reported by the World Bank and Private Enterprise Foundation studies, and this impact is translated into economic losses from equipment damage, loss in production, etc. This has caused 53 per cent of the firms surveyed by the World Bank to own or share generators. This is in accordance with the declining pattern of electricity consumption by the industry sector, as seen in Figure 7. Accordingly, the use of captive renewable energy installations may be an alternative solution for the industrial sector to address the unreliability of the grid supply.

6/ ELECTRICITY SALES

The discussion of tariffs in this section refers to end-user (consumer) tariffs. Ghana follows generally accepted principles for tariff-setting guidelines. The Public Utilities Regulatory Commission has provided tariff setting guidelines that guide utility companies and other stakeholders as a transparent basis for setting rates for electricity. The PURC takes into account the following:

- Consumer interest;
- Investor interest;
- Cost of production of the service; and
- Assurance of the financial integrity of the public utility.
- The electricity tariff, in general, has two parts: 1) an energy charge (proportional to energy consumed); and 2) a service charge (a fixed amount per month as per the category of consumer), often referred to as a "demand charge."

6.1/ TARIFF STRUCTURE

The Public Utilities Regulatory Commission, an independent body, was set up as a multi-sectoral regulator under the Public Utilities Regulatory Act of 1997 (Act 538) to regulate the provision of utility services in the electricity and water sectors.

The PURC incorporated the Automatic Adjustment Formula with a view to sustaining the real value of the tariffs by adjusting tariffs quarterly, based on variations in factors such as fuel price (light crude oil, natural gas, etc.), foreign exchange, inflation and generation mix. The PURC has also instituted the lifeline tariff for low-income consumers with significantly low consumption levels at tariffs below the cost of electricity provision, in consonance with the government's Ghana Poverty Reduction Strategy. Table 4 illustrates the electricity tariff and structure for each category in 2020.

Table 4: Electricity tariff and structure for different tariff categories, as of 2020

TARIFF CATEGORY	ENERGY THRESHOLD (KWH/MONTH)	TARIFFS		
		Service Charge Charge / month in $ (and Ghanaian pence, GHp)	Energy Charge / kWh in $ (and GHp)	Demand Charge / kVA (in $)
Residential	0 – 50	**Lifeline consumers:** 0.3 (GHp 213) **Other residential consumers:** 1.3 (GHp 745.6)	0.05 (GHp 32.7)	NA
	51 – 300		0.11 (GHp 65.4)	NA
	301 – 600		0.15 (GHp 84.8)	NA
	601+		0.16 (GHp 94.3)	NA
Non-residential (Commercial)	0 – 100	2.2 (GHp 1 242.8)	0.14 (GHp 79.7)	NA
	101 – 300		0.14 (GHp 79.7)	NA
	301 – 600		0.15 (GHp 84.9)	NA
	601+		0.23 (GHp 133.9)	NA
Special load tariff – Low Voltage		8.8 (GHp 4 971.2)	0.15 (GHp 89.1)	**12.4**
Special load tariff – Medium Voltage		12.4 (GHp 6 959.8)	0.12 (GHp 68.9)	**10.6**
Special load tariff – High Voltage		12.4 (GHp 6 959.8)	0.11 (GHp 63.3)	**10.6**
Special load tariff – High Voltage – Mines		12.4 (GHp 6 959.8)	0.21 (GHp 120.8)	**12.4**

Note: Exchange rate for conversion: 5.6 (Central Bank of Ghana exchange rate as of 14/07/2020). NA = not available.Source: PURC 2020a

In 2019, in a major policy shift, the PURC announced the elimination of the demand charge for the special load tariff category users in order to enhance the competitiveness of Ghanaian industries. However, an analysis was planned by the commission to examine the impact of this shift on the special load tariff and the service providers (PURC 2019b). This policy shows the government's intention to support industrial users, given the additional distribution and transmission charges that they have to incur, as illustrated in section 5.3.1. Nevertheless, the tariff published in 2020 re-introduced the demand charge as an alternative for the special load tariff users (PURC 2020a). Further clarity is needed on the initial removal and subsequent re-introduction of demand charges and the reasoning behind these changes.

6.2/ HISTORICAL ELECTRICITY TARIFFS

Table 5 presents the average end-user tariff for all categories in both Ghanaian cedis and U.S. dollars over the past decade (EC 2019b). The average end-user tariff expressed in local currency has been multiplied by five over the decade, an annual average increase of 7 per cent.

Table 5: Average Ghana end-user tariff in Ghanaian cedis and U.S. dollars at year-end, 2009-2018

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GHS/kWh	0.148	0.211	0.245	0.232	0.307	0.464	0.541	0.817	0.798	0.705
Exchange rate	1.43	1.45	1.55	1.88	1.97	3.20	3.68	3.89	4.36	4.59
$/kWh	0.104	0.145	0.158	0.124	0.156	0.145	0.147	0.210	0.183	0.154
Annual change		**39%**	**9%**	**-22%**	**26%**	**-7%**	**1%**	**43%**	**-13%**	**-14%**

Note: Exchange rate is from Bank of Ghana; GHS = Ghanaian cedis.Source: EC 2019c

The PURC carried out a major review of the tariff structure in 2013, considering upward adjustment proposals by the state-owned utility companies, the Volta River Authority, GRIDCo, ECG and NEDCo. Tariffs were increased, but not up to the levels requested by the utility companies. However, in March 2018, the government made a political decision to cut tariffs by between 18 and 30 per cent for residential and non-residential users respectively, while reductions of 10 per cent and 25 per cent were announced for the mining and special load tariff users respectively (Allotey 2018). This decision was driven by the government's 2016 election promises (Business World Ghana 2017).

However, tariffs were increased again in 2019, as shown in Figure 8; the major consumer categories affected were "SLT – HV" and "Commercial 600+". Following the tariff increase in 2019 was a cost review by the PURC, as the initial attempt to reduce the tariff reportedly did not prove to be financially viable for the utilities (Africa Energy Portal 2019). Given the challenges facing Ghana's electricity sector, future tariff reductions seem unlikely as the reduction attempt in 2018 was driven by a political context rather than the current state of the sector.

In 2018, Ghana had the highest electricity tariffs for commercial and industrial facilities in Sub-Saharan Africa at 15-20 U.S. cents per kWh, a rate also well above that of comparable developing countries (Ministry of Energy 2019) (see Table 6).

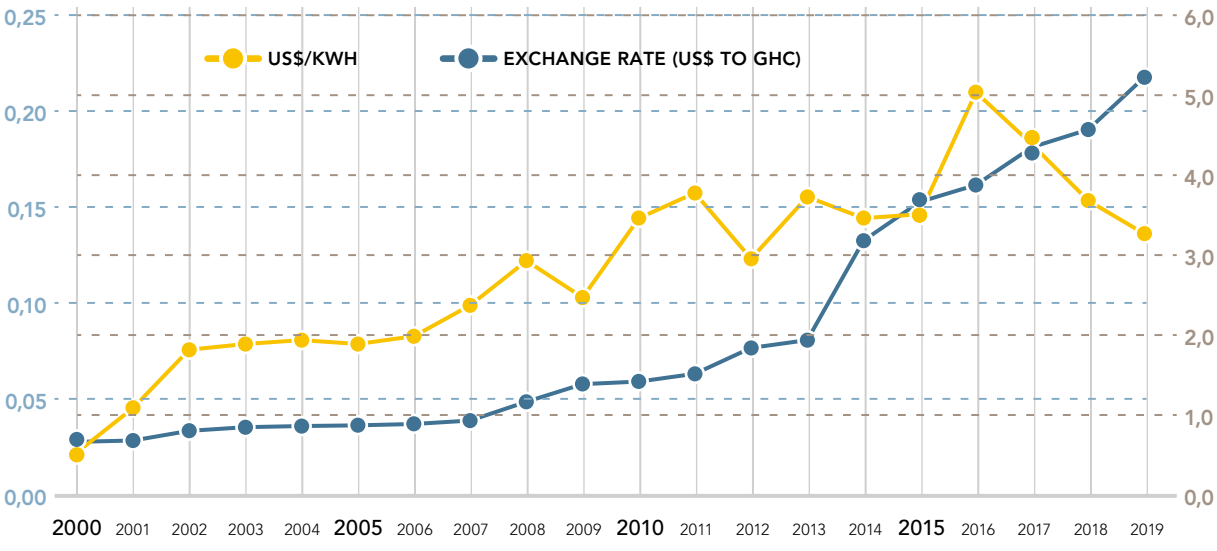
Table 6: Average tariff range for commercial and industrial users for selected developing countries

Country/Region	Ghana	South Africa	India	China	Southeast Asia	Côte d'Ivoire
U.S. cents/kWh	15-19	8-10	8-9	7-8	4-7	15

Source: Ministry of Energy 2019

Figure 8 shows the impact of the exchange rate on the tariff paid by consumers and the influence of the depreciation of the Ghanaian cedi against the U.S. dollar on utility revenues (Kumi 2017).

Figure 8: Evolution of the average end-user tariff for Ghana and of the USD/GHS exchange rate, 2000-2019



Source: EC 2020a

As explained in section 5.3.1, electricity tariffs are grouped into six categories: residential, non-residential and four special load tariff categories: low voltage, medium voltage, high voltage and high voltage – mines. Their evolution between 2011 and 2019 is shown in Table 7.

Table 7: Ghana electricity tariffs shown by their effective dates (2011-2019) in local currency

Tariff Category	Effective Date									
	Dec. 2011	Oct. 2013	Jan. 2014	Jul. 2014	Oct. 2014	Apr. 2015	Jul. 2015	Dec. 2015	Mar. 2018	Jul. 2019
RESIDENTIAL										
0 - 50 (exclusive) (GHp/kWh)	9.5	15.7	17.2	19.3	20.5	21.1	21.1	33.6	27.7	30.8
51 - 300 (GHp/kWh)	17.6	31.4	34.5	38.7	41.2	42.3	42.3	67.3	55.5	61.7
301 - 600 (GHp/kWh)	22.8	40.8	44.9	50.2	53.5	54.9	54.9	87.4	72.1	80.1
600+ (GHp/kWh)	25.3	45.3	49.8	55.8	59.4	61.0	61.0	97.1	80.1	89
Service charge for lifeline consumers (GHp/month)	165.3	295.7	324.5	363.8	387.5	397.7	397.7	633.2	213.0	213
Service charge for other residential consumers (GHp/month)	165.3	295.7	324.5	363.8	387.5	397.7	397.7	633.2	633.2	703.9
NON-RESIDENTIAL (COMMERCIAL)										
0 - 300 (GHp/kWh)	25.3	45.2	49.6	55.6	59.2	60.8	60.8	96.8	67.8	75.3
301 - 600 (GHp/kWh)	26.9	48.1	52.8	59.2	63.0	64.7	64.7	102.1	72.1	80.1
600+ (GHp/kWh)	42.4	75.9	83.3	93.4	99.5	102.1	102.1	162.5	113.8	126.4
Service charge (GHp/month)	275.5	492.9	540.9	606.3	645.9	662.9	662.9	1 055.3	1 055.3	1 173.1
SPECIAL LOAD TARIFF – LOW VOLTAGE										
Energy charge (GHp/kWh)	26.3	47.1	51.7	58.0	61.8	63.4	63.4	100.9	75.7	98.8
Service charge (GHp/month)	1 102.2	1 971.7	2 163.5	2 425.1	2 583.6	2 651.5	2 651.5	4 221.2	4 221.1	4 692.6
SPECIAL LOAD TARIFF – MEDIUM VOLTAGE										
Energy charge (GHp/kWh)	20.4	36.5	40.0	44.9	47.8	49.1	49.1	78.1	58.6	75
Service charge (GHp/month)	1 542.9	2 760.3	3 028.9	3 395.1	3 616.9	3 712.1	3 712.1	5 909.6	5 909.6	6 569.6
SPECIAL LOAD TARIFF – HIGH VOLTAGE										
Energy charge (GHp/kWh)	18.7	33.5	36.8	41.2	43.9	45.1	45.1	71.8	53.8	78.8
Service charge (GHp/month)	1 542.9	2 760.3	3 028.9	3 395.1	3 616.9	3 712.1	3 712.1	5 909.6	5 909.6	6 565.6
SPECIAL LOAD TARIFF – HIGH VOLTAGE – MINES										
Energy charge (GHp/kWh)	29.8	53.2	58.4	65.5	69.8	71.6	71.6	114.0	102.6	249.1
Service charge (GHp/Month)	1 542.9	2 760.3	3 028.9	3 395.1	3 616.9	3 712.1	3 712.1	5 909.6	5 909.6	6 565.6

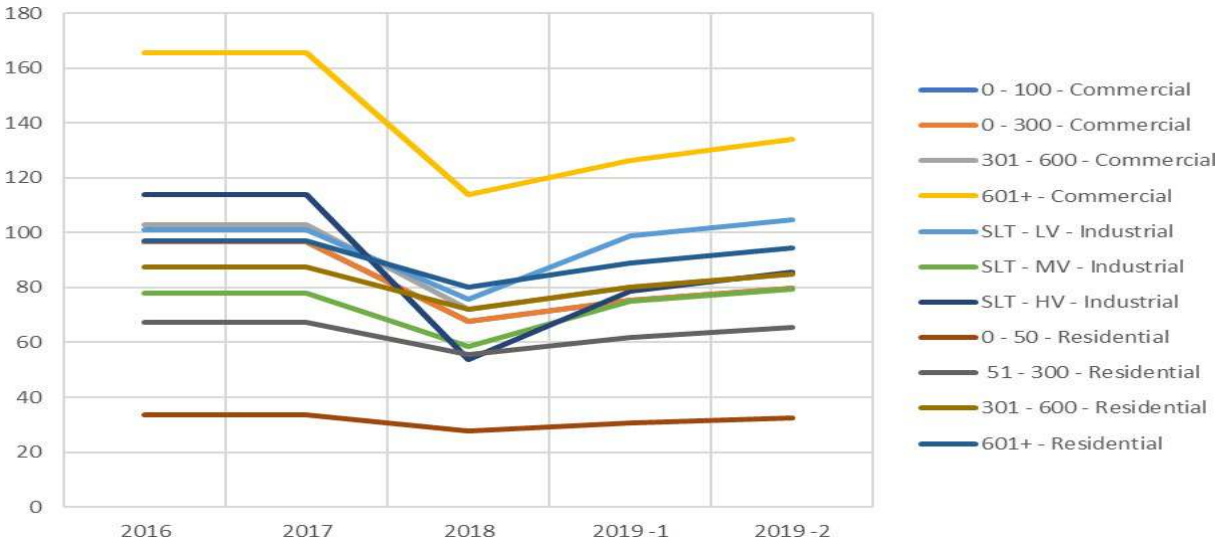
Source: EC 2018b; PURC 2019a

BOX 5: Bulk Customer License

For consumers with an average monthly maximum demand exceeding 500 kVA over three consecutive months or a minimum annual energy consumption of 1 GWh (EC n.d.a), the Energy Commission issues a bulk customer licence. This is solely discretional, as consumers who apply for this licence will pay an annual licence fee to the Energy Commission but will be eligible to contract the power requirements from sources other than the utilities that exercise jurisdiction over their location of operation, thus allowing them to access the deregulated market.

Figure 9 illustrates the different tariffs across customer categories. In 2017, only commercial customers with monthly consumption above 600 kWh paid more than 120 Ghanaian cedis per kWh (22.4 U.S. cents per kWh[8]) for electricity consumption. Commercial (600+) and Industrial customers (SLT – LV) continued to pay more than 100 Ghanaian cedis per kWh (18.7 U.S. cents per kWh). However, the rest of the customer categories paid less than 100 Ghanaian cedis per kWh (18.65 U.S. cents per kWh) in 2018. The figure also illustrates the decrease in tariffs across all categories, which was initiated in 2018. Given that the reduction has proven to be financially unviable for the utilities, the tariffs were increased again the following year.

Figure 9: Tariffs across the different customer categories from 2015 to 2019 in Ghanaian pence



Source: Author compilation based on available data.

It may be observed that the overall levelized cost of electricity of solar PV is expected to be lower than the applicable tariff for commercial and industrial consumers in Ghana (Kemausuor et al. n.d.). Accordingly, the levelized cost of electricity is expected to be between $0.10 per kWh and $0.14 per kWh for grid-connected facilities[9] (BNEF 2019). This would attract commercial and industrial consumers to set up captive solar PV facilities, provided that a supportive regulatory and conducive policy environment exists, since the licensing process is considered lengthy by developers and is limited to 100 kW for on-grid systems (BNEF 2019) and can exceed 1 MW for off-grid systems subjected to self-use or sale to off-takers (EC 2018c). Additionally, the possible implementation of net metering will enhance profitability and result in making the investment in captive installations by the commercial and industrial sectors more attractive, as excess generation from solar may be sold to the grid.

6.3/ CONCLUSION

The electricity tariff in Ghana is derived from the Automatic Adjustment Formula that takes into account variations in fuel prices, inflation, generation mix and foreign exchange. Inefficiencies are built into the tariff levels, making the average tariff in Ghana notably higher compared with other developing countries. An attempt was made in 2018 to reduce the tariff across the different consumer categories; however, the tariff was increased again the following year as the reduction proved financially unviable for the utilities. Given the challenges in the electricity sector, it is unlikely that the tariff would decrease in the near future.

In comparison with the current tariff, the expected levelized cost of electricity for captive solar generation seems to be very cost competitive and attractive for commercial and industrial consumers. Nevertheless, given the lengthy process for obtaining a licence, as expressed by developers, and the limited installation capacity in comparison with Kenya and other Sub-Saharan countries, it may prove to be challenging for deployment of the captive solar solution.

8 *Based on Bank of Ghana foreign exchange rate of 5.3598 as of 8 December 2019.*

9 *Based on the assumptions stated for the levelized cost of energy calculations in BNEF 2019.*

7/ ENERGY POLICY AND REGULATORY FRAMEWORK

This section provides an overview of the policies, laws and regulations governing the energy sector in general and captive installations in particular, including key sector actors. It further analyses the current licensing options available for captive power.

7.1/ ENERGY POLICIES AND LAWS

Many of the general policies and legislation related to the energy sector in Ghana are of relevance to the installation of captive power systems; however, the same cannot be claimed about their adoption. The following sub-sections discuss the most relevant policies and frameworks for captive power.

7.1.1/ STRATEGIC NATIONAL ENERGY PLAN, 2006-2020

Support for electricity generation from renewable sources started in 2006 with the issuance of the Strategic National Energy Plan, 2006-2020, which is considered the first policy instrument showing the government's intentions regarding renewable energy deployment in Ghana. The Plan sets a target for a 10 per cent renewable generation share in the country's electricity mix by 2020 (SEEforALL 2020), excluding hydropower (Asare 2019), with a focus on on-grid connection facilities (Annangfio 2020).

7.1.2/ NATIONAL ENERGY POLICY, 2010

Following the Strategic National Energy Plan, the National Energy Policy was established in 2010 to address the challenges facing the energy sector in general and to reaffirm the government's target for developing the renewable energy sector. The National Energy Policy identified solar, wind, mini-hydropower and waste-to-energy as possible technologies for achieving 10 per cent renewable electricity generation. Among its recommendations was the establishment of fiscal policies and incentives to support renewable development and to improve the production and promotion of efficient uses of biomass (Asare 2019).

7.1.3/ RENEWABLE ENERGY ACT, 2011

To develop the country's renewable energy law and policy, the Renewable Energy Act was introduced in 2011 to provide the legal and regulatory frameworks to achieve the renewable energy targets. The Act also illustrated the licences required for commercial generation. For captive power installations, a licence is required for generation capacities starting from 1 MW or higher, regardless of whether the generating system is for self-use or for sale to an off-taker (EC 2018c). For generation capacities below 1 MW, there are no established regulations (BNEF 2019).

Renewable energy development is a key pillar of Ghana's Nationally Determined Contribution towards reducing greenhouse gas emissions under the Paris Agreement, and Ghana is committed to achieving the objectives of Sustainable Energy for All by 2020.

The Renewable Energy Act, 2011 (Act 832) provides a framework for the development, management and use of renewable energy sources for the production of heat and power in an efficient and environmentally sustainable manner, and to attract investment in renewable energy sources. Act 832 encompasses a feed-in tariff and a net metering scheme, as well as a master plan to boost the sector, as follows:

- **Feed-in tariff scheme:** A guaranteed rate for renewable energy purchased by distribution utilities is offered for 10 years and subsequently reviewed every 2 years. However, with the current feed-in tariffs in place, there is an oversubscription of power that has forced the government to slow any new agreements.
- **Renewable purchase obligation:** Distribution companies, for example, ECG and NEDCo and bulk electricity consumers, are obliged to purchase a certain percentage of their energy from electricity generated from renewable sources.
- **Net metering:** Renewable energy generated by consumers may be delivered to the local utility to offset the cost of electricity provided by the utility. (See Annex 2 for the details of the Licensing for Net Metering Scheme.)
- **Off-grid electrification:** This involves the promotion of mini-grids and stand-alone renewable energy systems for remote off-grid locations.

Act 832 forbids any entity from engaging in any commercial activity without a licence granted by the Energy Commission. Commercial activity includes the production, transport, storage, distribution, sale and marketing of electricity; exportation and re-exportation; and installation and maintenance.

7.1.4/ FEED-IN TARIFF SCHEME, 2013

The feed-in tariff scheme was introduced in 2013 based on the Renewable Energy Act. It was further updated in 2014 and 2016 to support higher capacities for wind and solar and to support new technologies such as tidal and geothermal (PURC 2016). Under the feed-in tariff scheme, distribution system operators are required to purchase electricity from renewable energy sources at a fixed price, which is granted only for 10 years. Additionally, the transmission or distribution system operators are obliged to connect the renewable electricity facility to the transmission or distribution network where the renewable facility is located. This is to be established through a "connection agreement" between the respective transmission or distribution system operator and the renewable electricity facility. However, the renewable electricity producer is liable for the connection costs related to the metering point of the grid (Asare 2019).

7.1.5/ NET METERING SCHEME

According to the Net Metering Sub Code (EC 2015), to benefit from this regime, a customer/generator must undertake the following:

- Enter into a connection agreement with the distribution utility after submitting an application, noting that the total generating capacity of a net-metered facility is limited to 500 kW per installation. The distribution utility provides the application form.
- On receipt of the application form, the distribution utility provides within five working days an estimate of the costs of the materials required and charges for the connection.
- Once the applicant has paid the required cost of materials and charges, the distribution utility installs within five working days a bi-directional meter and other necessary equipment required for the bi-directional flow of electricity.
- The compensation and billing are structured in the following way (EC 2015):
- For every kWh that the customer/generator feeds back to the grid in excess of its consumption, he/she receives a credit determined by the Public Utilities Regulatory Commission.
- For each billing period, the distribution utility carries over any excess kWh credits earned by a customer-generator and applies those credits to subsequent billing periods to offset the customer-generator's consumption in those billing periods until the end of the calendar year.
- All taxes, levies and charges approved by the PURC are paid by the customer-generator based on its total electricity consumption.
- Excess kWh credits do not defray any fixed monthly customer charges, levies or taxes.
- Excess kWh credit accrued to the customer-generator lapses at the end of one calendar year.

After successfully piloting 33 net meters in different residential and commercial facilities, the Energy Commission in collaboration with the Electricity Company of Ghana (ECG) implemented the Net Metering Scheme in October 2016. Since then, however, ECG made a proposal to review the tenets of the scheme out of fear of a reduction in its revenues. ECG recommended revisions of the rate of 1:1 to 1:0.6 for industrial and commercial customers and to 1:0.4 for residential customers, which were submitted to the PURC for approval.

The PURC is yet to revert, thus resulting in the net metering scheme being put on hold. The Energy Commission in collaboration with ECG and PURC are working to resolve this challenge (EC 2018a). According to BloombergNEF (BNEF 2019), the local solar companies are making efforts to lobby for the law, but the timeline and the modalities of the revised scheme are not clear, and the government could set a cap on how much solar can be fed into the grid to protect ECG interests. The Energy Commission is in the process of lowering the existing cap of 500 kilowatts-peak (kWp) for net metering to 100 kWp.

7.1.6/ RENEWABLE ENERGY MASTER PLAN

The Renewable Energy Master Plan[10] (EC 2019d) was developed and submitted to the Cabinet of Ghana in 2019. It has since been accepted and aims to achieve the following by 2030:

- Increase the share of renewable energy[11] in the national energy generation mix from 42.5 MW in 2015 to 1,363.63 MW (with grid-connected systems totalling 1,094.63 MW);
- Reduce the dependence on biomass as the main fuel for thermal energy applications;
- Provide renewable energy-based decentralized electrification options in 1,000 off-grid communities;
- Promote local content and local participation in the renewable energy industry, as non-Ghanaian companies applying for a wholesale licence are required to have at least 15 per cent local ownership, and 60 per cent of the engineering and procurement activities are to go to Ghanaian companies (BNEF 2019).

According to the Renewable Energy Master Plan, targets for specific renewable energy technologies are set as outlined in Table 8.

Table 8:
Renewable energy targets by technology according to the Renewable Energy Master Plan of Ghana

Source: EC 2019d

Renewable energy technology	Target by 2030 (MW)
Solar – utility-scale	447
Distributed solar PV	200
Stand-alone solar PV	20
Solar irrigation	49
Wind – utility-scale	325
Biomass – utility-scale	72
Waste-to-energy – utility-scale	50
Small/Medium hydropower	150
Wave power	50
Mini/Micro-grid	12

Ghana's potential for solar energy generation is high, with solar radiation levels of around 4-6 kWh per square metre, providing great opportunities for exploitation (Kumi 2017).

10 *See Annex 5 for the Renewable Energy Master Plan Implementation Schedule for 2019 until 2030.*

11 *Renewable energy as defined by the Renewable Energy Act 2011 (Act 832). In the Act, hydropower capacity up to 100 MW is considered renewable.*

7.1.7/ RENEWABLE ADOPTION CONSIDERATIONS

From 2012 to 2018, Ghana commissioned three grid-tied solar PV plants interconnected to the distribution network as well as one waste-to-energy plant. The solar PV plants are a 2.5 MWp plant owned by the Volta River Authority, a 20 MWp plant owned by BXC Ghana[12] and a 20 MWp plant owned by Meinergy[13], all located in the Central Region of Ghana. The Safi Sana[14] 0.1 MWe waste-to-energy plant is located in Tema. The Energy Commission, in the energy statistics manual for 2018, reports that solar accounted for 108 GWh of embedded generation in 2017.

Despite the considerable efforts from the government in Ghana to enable the development of the renewable energy sector, the target to achieve 10 per cent renewable electricity generation by 2020 will not be met, as the current electricity generation from renewable sources (excluding hydropower) is only 0.3 per cent. Consequently, the target year of 2020 has been shifted to 2030 (Kaku 2019). The failure to meet the 2020 target is attributed to technical, financial and regulatory factors. The national grid in Ghana is aged and underdeveloped, with the latest enhancement only in the 1990s. This represents a major technical constraint, as ECG has reported that the grid cannot accommodate power from advanced generation resources such as renewable generation (EC 2018a).

Access to finance is considered a main limitation to renewable energy deployment given the capital-intensive nature of renewable facilities. Even though the government established the Renewable Energy Fund in 2011 to subsidize the capital cost of renewable projects (Asare 2019), given the low share of renewable penetration to date, the state support alone may not be sufficient, and the government may need to provide further facilities to attract private investment.

7.1.8/ REGULATORY AGENCIES IN GHANA

Three main agencies are responsible for the regulation of the renewable energy sector in Ghana: the Ministry of Energy and Petroleum, the Energy Commission and the Public Utilities Regulatory Commission. These agencies are in charge of performing certain tasks to facilitate the development of the renewable energy sector. However, the sector lacks the presence of an independent authority that is solely focused on ensuring the implementation of renewable energy policies and regulations. Nevertheless, the government has expressed an intention to establish a "Renewable Energy Authority" to act as the responsible entity for supervising renewable energy project implementation, executing the state-initiated renewable energy projects and managing the renewable energy assets on behalf of the state.

7.2/ OTHER RENEWABLES

As indicated in the Renewable Energy Master Plan for Ghana (published in February 2019), the following clean energy alternatives for electricity are promoted by the government of Ghana: solar, wind, small hydropower and biogas (waste-to-energy). The master plan includes no recorded capacities of clean captive uses of wind, small hydropower and waste-to-energy plants.

In August 2019, the government of Ghana signed a $5.7 million agreement with Germany to build a 400 kW waste-to-energy plant in Kumasi to improve waste management in the country (Njoroge 2019). The demonstration project, which will use a hybrid solar PV, biogas and pyrolysis plant to generate electricity from domestic waste, will help advance Ghana's quest to attain the agenda of the United Nations Sustainable Development Goals. Currently, the country has one waste-to-energy plant: a utility-scale project of 0.1 MWp integrated with the distribution network at 11 kV voltage level in Ashaiman (a town in the Greater Accra region).

12 *BXC Ghana Limited (BXC) is a subsidiary of Xiaocheng Electronic Technology Stock Co. Ltd, a manufacturer of prepayment metering systems and management of power supply around the world. BXC was established in 2010 in Ghana with a group of Chinese investors who have trained and employed Ghanaians to implement major projects in Ghana. BXC operates in the power sector of Ghana and specializes in electricity generation and distribution services.*

13 *Meinergy Technology Ltd.'s 20 MWp solar PV plant is located at the Gomoa Onyadze area in the Gomoa West District of the Central Region of Ghana. The solar PV plant is connected to the 33 kV Ajumako distribution feeder at Kyere Kwanta, around 18 kilometres away.*

14 *Safi Sana Ghana Limited is a waste-to-energy / biofertilizer company located in Ashaiman. The company has an up-scaled faecal and solid waste treatment plant. The biogas generated from the treatment plant is connected to a 100 kW combined heat and power (CHP) co-generation plant and is used as a steady stream of burning fuel to drive a turbine to generate the motive power. The heat from the turbine is recovered and used for the process of heating the bioreactor.*

A 2017 study has identified palm oil as a major constituent in biodiesel that is being used as a fuel in power stations (Asibey 2017). Palm oil industries in Indonesia and Malaysia generate large volumes of waste that are used to generate electricity for operations and even extensions to *in situ* communities. Ghana has similar potential to generate electricity from the palm oil industry, as it has a dominantly agricultural economy that employs around 40 per cent of its population.

A number of palm oil mill companies in Ghana are already generating electricity from palm biomass (Asibey 2017). (Additional examples of companies with biogas investment at their company sites are covered in the United Nations Development Programme's *China – Ghana South-South Cooperation on Renewable Energy Technology Transfer (RETT), Volume 1* (UNDP 2018).) However, with regard to biodiesel and bioenergy in general, proper regulations and frameworks need to be established to govern any adverse effects that the development of this technology may have on increasing deforestation levels, which may arise from the need to expand agriculture activities to produce more crops for bioenergy purposes.

A number of developers have been developing utility-scale wind energy projects for integration at the transmission voltage levels of 161 kV and 330 kV in Ghana (Modern Ghana 2017).

The Bui Power Authority has completed construction of the Tsatsadu Micro Hydropower Plant, the first in Ghana, which has the capacity to generate 45 kW of power with the possibility of adding another 45 kW capacity turbine. Tsatsadu Falls, where the plant is constructed, is located at Alavanyo-Abehenease in the Hohoe District of the Volta Region (BPA n.d.).

7.3/ ENERGY REGULATIONS AND CODES RELEVANT TO CAPTIVE POWER

7.3.1/ ELECTRICITY REGULATIONS, 2008

The Electricity Regulations of 2008 provide guidance for the establishment of a competitive wholesale electricity market to facilitate wholesale electricity trading and the provision of ancillary services in the National Interconnected Transmission System. In the wholesale electricity market in Ghana, the electricity transmission utility ensures the procurement and dispatch of electricity from any facility of a wholesale supplier to a bulk customer and distribution utility in a fair, transparent and non-discriminatory manner. The wholesale electricity market would allow for choice and competition in the wholesale supply of electricity and subsequently create an enabling environment to attract independent power producers into the country as the market evolves and becomes more independent.

7.3.2/ NATIONAL ELECTRICITY GRID CODE OF GHANA, 2009

The purpose and scope of the National Electricity Grid Code is to ensure the coordinated operation of the high-voltage National Interconnected Transmission System within Ghana, for the provision of fair, transparent, non-discriminatory, safe, reliable, secure and cost-efficient delivery of electrical energy. The Grid Code describes the responsibilities and obligations associated with all the functions involved in the supply, transmission, and delivery of bulk electric power and energy over the national transmission system, including the functions of the electricity transmission utility, a transmission system asset owner, a wholesale supplier, a distribution company and a bulk customer.

7.3.3/ OTHER RELEVANT ENERGY SECTOR REGULATIONS AND CODES

The Electricity Supply and Distribution (Technical & Operational) Rules, 2005 (LI 1816) defines the customers' obligations to enable the distribution company to supply safe and reliable power supply to its premises. The regulations apply to a public utility licensed under the Act to distribute and retail electricity to customers.

The Electricity Supply and Distribution (Standards of Performance) Regulations, 2008 (LI 1935) provides performance benchmarks for electricity supply and distribution in conformity with the provisions of Electricity Supply and Distribution (Technical and Operational) Rules, 2005 (LI 1816). These regulations apply to electricity supply and distribution utilities licensed by the commission, and to any person(s) licensed under the Act to distribute and sell electricity without discrimination to consumers in an area or zone designated by the commission. Whereas LI 1816 spells out supply performance and guidelines for only public utilities, LI 1935 spells out supply performance for all person(s) licensed to distribute and sell electricity by the Energy Commission.

The Electricity Transmission (Technical, Operational and Standards of Performance) Rules, 2008 (LI 1934) define the national interconnected transmission system and establish the requirements, procedures, practices and standards that govern the development, operation, maintenance and use of the high-voltage National Interconnected Transmission System.

7.4/ LICENSING FOR RENEWABLE POWER GENERATION

Table 9 shows the renewable energy licences that are applicable for solar PV installations from the Energy Commission of Ghana.

Table 9: Renewable energy licences applicable and relevant for solar PV installations in Ghana

No.	Type of licence	Description	Size of Plant	Incentives	Barriers
1	Rooftop / Small-scale renewable mini-grid electricity sales	This licence authorizes the licensee – an energy services company (ESCO) or an engineering, procurement and construction (EPC) company – to enter into a PPA financing model with licensed bulk customers. The construction permit* fee varies with the size of the plant. An annual renewal licence fee is required.	Small-scale (500 kW to 1 MW) Large-scale (1 MW to 2 MW)	Permitted to have a PPA with clients classified as bulk customers.	Client must hold a bulk customer licence, which must be obtained for every specific project.
2	Wholesale electricity supply	This licence authorizes the licensee to procure, construct and operate an electricity generation facility to produce electricity for sale to distribution companies and bulk customers under a PPA model. The initial licence fee varies with capacity. An annual renewal licence fee is required**.	Small-scale (2 MW to < 10 MW) Medium-scale (10 MW to < 100 MW) Large-scale (> 100 MW)	Permitted to have a PPA with clients classified as bulk customers or with distribution companies.	Client must hold a bulk customer licence, which must be obtained for every specific project.
3	Manufacturing and assembly	This licence authorizes companies to manufacture and assemble renewable energy products in Ghana. No annual renewal licence fee is required.	This applies to all capacities and renewable energy technologies.		A share of local content is required, varying based on the technology.***
4	Importation, installation and maintenance of renewable energy technologies	These licences authorize companies to import or install and/or maintain all types of renewable energy products. The licence fee is different for importation and installation.	This applies to all capacities and renewable energy technologies.	Duty waiver for importation licence for solar PV components.	Duty waiver only applies to balance of components**** if they arrive at the port together, hence only applicable to solar PV panels.
5	Lease-to-own licence***** (under development)	This license will authorize EPCs and ESCOs to offer a lease-to-own payment model to their customers. As part of the requirements for this licence, EPCs and ESCOs would have to secure a permit from the Bank of Ghana.	To be determined.	Permitted to have a lease-to-own agreement with clients. Clients do not need to be bulk customers.	To be determined.

* *The issuance of the construction permit allows the commencement of construction of the power plant, while the licence just ensures the project's registration with the authorities (EC 2018c).*

** *"A licence shall be renewed subject to the equipment or facility having been certified to be in good technical operating condition by the Commission. The procedure for renewal of a licence shall be the same as that applicable to the grant of the initial licence" (EC 2018c, p. 11).*

*** *Source: Felgenhauer (2018).*

**** *Balance of components refers to all components used in a PV plant other than the solar PV panels.*

***** *This is currently in development and has not yet been finalized by the Energy Commission. Source: EC, personal communication with UNEP and Frankfurt School-UNEP Collaborating Centre.*

Source: EC 2018c; Energy Commission, personal communication with UNEP and Frankfurt School-UNEP Collaborating Centre.

Despite the development of regulatory infrastructure for solar PV power generation, some updates in regulation are still required, especially for commercial and industrial PV installations.

A commercial and industrial firm wanting to generate solar energy and use it for self-consumption would require a captive generation licence, provided that it has the internal capacity to do the installations as per the License and Application Manual issued in March 2018 (EC 2018c). There is no mention of the captive generation licence in the updated manual issued in August 2019 (EC 2019e).

In reality, most commercial and industrial firms engage with developers and engineering, procurement and construction (EPC) providers, who will require an importation licence and an installation licence. However, with these licences, the available business models for a commercial and industrial firm are the outright purchase/ownership model for solar PV captive systems, the lease-to-own model and the operating lease model (see section 10.3 for more on financing models for commercial and industrial businesses).

In order for the developer to enter into a power purchase agreement contract with a commercial and industrial client, the developer is required to have a wholesale electricity supply licence, which is required for the generation and sale of electricity. However, a wholesale electricity supply licence may only be issued to those who intend to supply electricity to either a distribution utility or a bulk customer (see section 5.3.1). In this sense, most commercial and industrial PV installations do not qualify for a wholesale licence. Therefore, a power purchase agreement model for a commercial and industrial firm is not possible since they (as off-takers) do not necessarily meet the consumption threshold to be categorized as a bulk customer. Additionally, there is a policy decision to not issue any new wholesale electricity supply licences (EC n.d.b.).

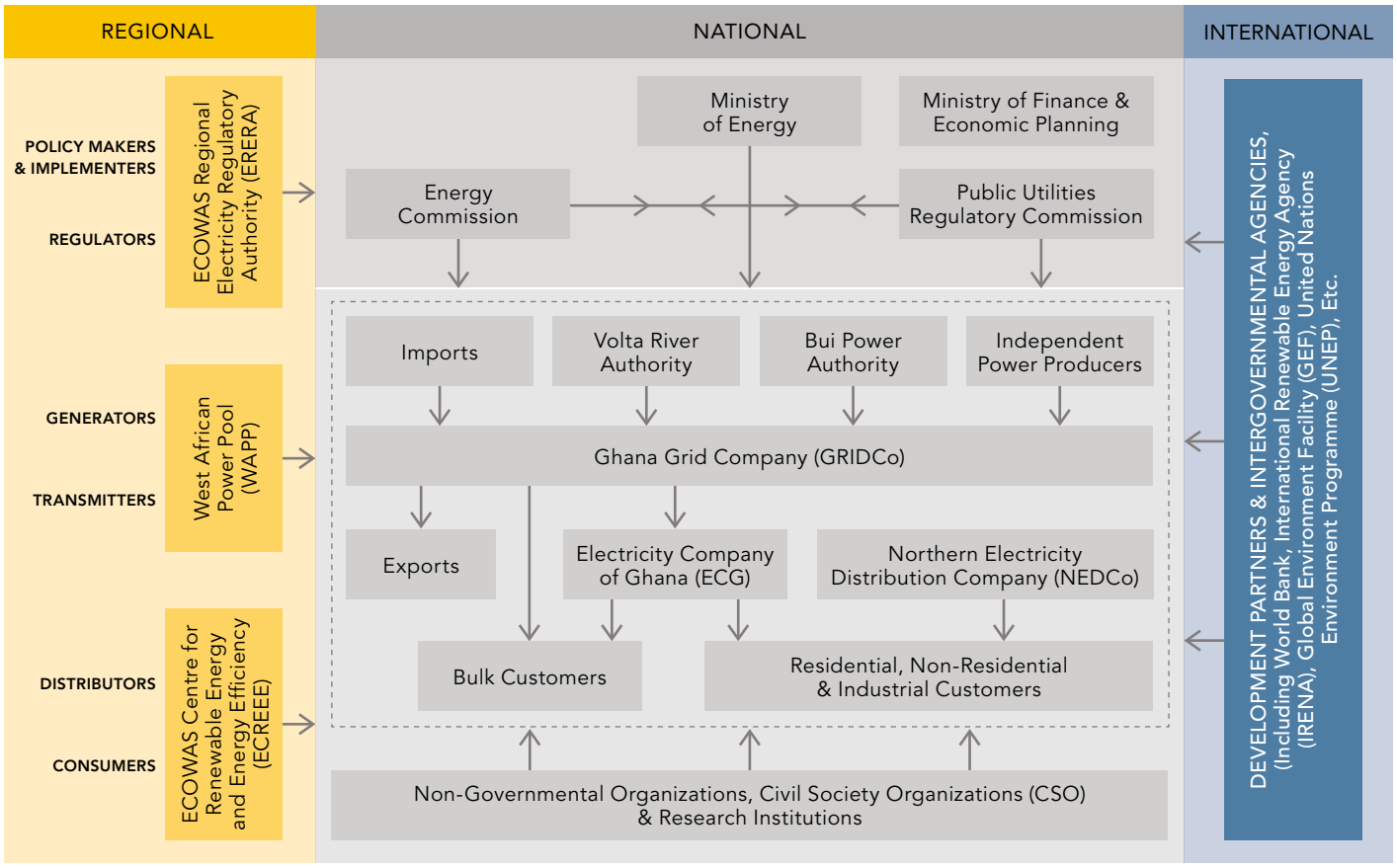
The Energy Commission has issued around 124 provisional wholesale electricity supply licences for utility-scale grid-connected renewable energy projects since the entry into force of the Renewable Energy Act of 2011 (Act 832), out of which only 4 have been developed so far (see Table 1): two 20 MWp utility-scale solar PV projects by BXC Solar and Meinenergy respectively; the 0.1 MWp Safi Sana waste-to-energy project; and a 0.4 MWp commercial solar PV plant installed at Kasapreko.

Commercial and industrial PV solutions that do not qualify for a wholesale electricity supply licence would be in breach of law if they generated, distributed or sold electricity (EC n.d.c).

7.5/ INSTITUTIONAL FRAMEWORK

The government of Ghana rolled out several reforms in the power sector, creating institutions focusing on specific mandates in the sector. Figure 10 illustrates the current institutional framework for the energy sector in Ghana.

Figure 10: Key organisations in Ghana's power sector



Source: Kumi 2017

7.5.1/ MINISTRY OF ENERGY

The Ministry of Energy is responsible for formulating, monitoring and evaluating policies, programmes and projects for the power sector in Ghana. The Ministry is also directly responsible for the implementation of the National Electrification Scheme in various parts of the country.

7.5.2/ ENERGY COMMISSION

The Energy Commission is responsible for the technical regulation of the power sector, including licensing of operators, and also advising the Ministry of Energy on matters relating to energy policy and planning. As mandated by the Energy Commission Act of 1997 (Act 541), the Energy Commission is responsible for the development of regulations and codes for the electricity and natural gas industries in Ghana. The Energy Commission performs these regulatory functions through the elaboration and enforcement of technical rules. It has developed the National Electricity Grid Code and the Electricity Distribution Code.

7.5.3/ PUBLIC UTILITIES REGULATORY COMMISSION

The Public Utilities Regulatory Commission (PURC) is an independent regulatory agency responsible for economic regulation of the power (and water) sector, specifically approving rates for electricity sold by distribution utilities to the public. The PURC is also responsible for monitoring the quality of electricity services delivered to consumers.

7.5.4/ VOLTA RIVER AUTHORITY

The government of Ghana gave the responsibility of generation and transmission of electricity to the Volta River Authority as enshrined in the Volta River Development Act (1961). However, in 2005, this Act was revised in the context of the power sector reforms[15]. The mandate of the Volta River Authority is to focus on electricity generation and to help create an enabling environment to attract independent power producers.

7.5.5/ BUI POWER AUTHORITY

The Bui Power Authority was established in 2007 by an Act of Parliament, BPA Act 740, with a mandate to plan, execute and manage the Bui Hydroelectric Project, now the Bui Generating Station. The Bui Generating Station originally was a peaking plant with the capacity to generate 404 MW of hydropower, which is evacuated from a 161 kV switchyard. Bui is set to add 250 MWp of solar energy to Ghana's national grid. The switchyard has been expanded to evacuate 250 MWp of solar-generated power. Construction of an initial 50 MWp solar PV plant was completed in April 2019 and was expected to be operational in 2020.

7.5.6/ GHANA GRID COMPANY

The amended VRA Act of 2005 revised the mandate of the Volta River Authority to focus on electricity generation and to help create an enabling environment to attract independent power producers. This led to the setting up of an independent Nationally Interconnected Transmission System and the important role of a national transmission operator (Ghana Grid Company Ltd. [GRIDCo]) in planning for the operation and management of this transmission system.

7.5.7/ ELECTRICITY COMPANY OF GHANA

The Electricity Company of Ghana Ltd (ECG) was established on 1 April 1947 as the Electricity Department. ECG was incorporated in 1997 under the Companies Code 1963, and today it is responsible for distributing electricity in the southern part of Ghana: Greater Accra, Volta, Oti, Western, Western North, Central Ashanti and Eastern.

7.5.8/ NORTHERN ELECTRICITY DISTRIBUTION COMPANY

In July 1987, the Volta River Authority set up the Northern Electricity Department, now the Northern Electricity Distribution Company or NEDCo, which took over from the ECG the responsibility of managing electric power distribution in the Ahafo Northern, Bono East, Brong Ahafo, North East Savannah, Upper East and Upper West regions.

15 *In 1994, Ghana's power sector reform programme was initiated aiming to introduce sweeping reforms with the intention of removing perceived policy, regulatory and institutional barriers that were hindering private sector participation and investment in the power sector (Kusi 2005).*

7.6/ CONCLUSION

Ghana's institutional and regulatory framework for the power sector is recent and still evolving.

The government of Ghana implemented a power sector reform programme in 1994, dividing the mandate into generation, transmission and distribution. As part of the reform programme, the government revised the mandate of the Volta River Authority to focus on electricity generation and created an enabling environment to attract independent power producers. It also set up the independent National Interconnected Transmission System, while GRIDCo was given the responsibility of planning and operating the transmission network.

The government endeavoured to provide an institutional and regulatory framework boosting the development of the renewable energy sector. The Renewable Energy Act of 2011 provides the legal framework for the feed-in tariff and net metering schemes and the master plan to boost the renewable energy sector. The net metering scheme, however, is on hold at present with no exact forecast for when those issues will be resolved. There is also provision for a renewable purchase obligation, which requires electricity distribution companies to procure a certain percentage of renewable energy power in their mix. Complementing the Renewable Energy Act of 2011, the Renewable Energy Master Plan approved by the Cabinet of Ghana in 2019 targets 447 MW of utility-scale solar PV, 200 MW of distributed solar PV and 20 MW of stand-alone solar PV by 2030.

A commercial and industrial firm wanting to generate and use solar energy for self-consumption would require a captive generation licence. However, there is no mention of this licence in the updated manual issued in August 2019.

In reality, most commercial and industrial firms engage with developers and EPC providers, which will require an importation licence and an installation licence. Nevertheless, with these licences, the available business models for a commercial and industrial firm are the outright purchase/ownership model for solar PV captive systems, the lease-to-own model and the operating lease model (see section 10.3 for more on financing models for commercial and industrial businesses).

As part of the Renewable Energy Master Plan, a share of local content in the development of renewable energy projects needs to be present and varies depending on the technology and the type of activity. This is also regarded as a barrier given the level of maturity of the renewable energy market in Ghana.

8/ OVERVIEW OF EXISTING CLEAN CAPTIVE POWER FACILITIES

This section explores the variety of captive power technologies across Ghana's various agricultural, industry and service sectors. These captive technologies are primarily from renewable energy sources, specifically solar PV.

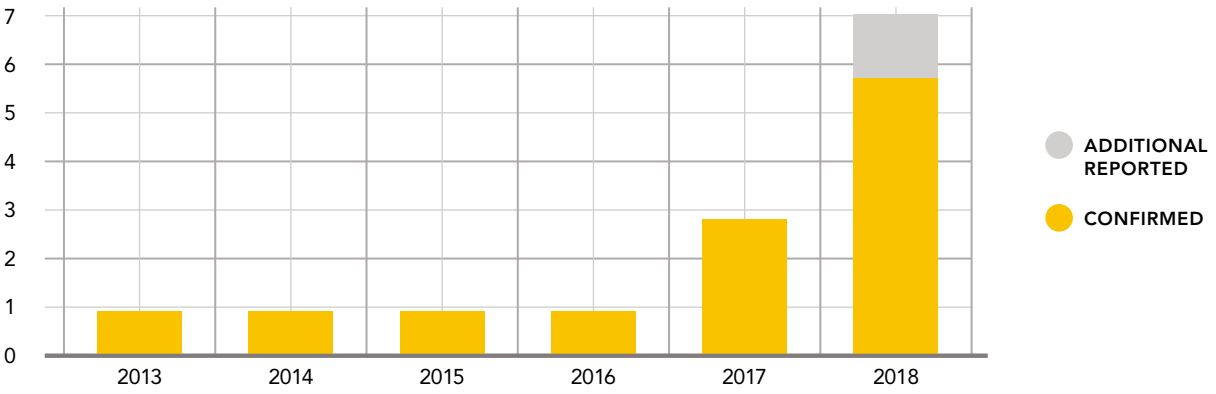
Installation costs for solar and wind energy technologies have decreased rapidly worldwide over the past decade. Among the wide range of technologies available for electricity generation (including thermal coal and natural gas), renewable energy technologies (based on resources such as solar, wind, hydro, etc.) offer lower-cost energy solutions. The International Renewable Energy Agency has observed that the cost of electricity from utility-scale solar PV continued to fall in 2018, with the global weighted-average levelized cost of electricity of solar PV declining 13 per cent in one year to $0.085 per kWh (IRENA 2019). The main factors behind this reduction included lower prices of solar PV modules and balance of system.

Solar PV modules are used in both utility-scale plants and captive solar PV plants. Therefore, the cost of captive solar generation facilities is also expected to be lower, along the lines of utility-scale plants. This has led to the increased adoption of renewable energy technologies around the world, including for commercial and industrial clients. The following section explores existing captive renewable energy power for commercial and industrial clients in Ghana.

8.1/ SOLAR PV

According to BloombergNEF's Solar for Businesses in Sub-Saharan Africa report (BNEF 2019), 7 MW of commercial and industrial solar projects were operational in Ghana as of November 2018, installed mainly in 2017 and 2018 and with individual project capacities of less than 1 MW (see Figure 11). The majority of these projects are used by companies connected to the grid and where grid reliability is also high, which shows that cost saving is the main market driver, not resilience.

Figure 11: Commercial and industrial solar installed capacity (MW) in Ghana, 2013-2018



Source: BNEF 2019

Ghana is home to many multinational companies that have set self-imposed clean energy targets. For instance, the Cargill cocoa factory in Tema has installed a 565 kWp grid-connected solar PV system and targets 18 per cent renewable energy in its power consumption by 2020.

The market is expected to grow in the coming years, as confirmed by developers interviewed by BloombergNEF (2019) who plan to build around 32 MW of captive solar PV capacity, with several multi-megawatt projects already in the development pipeline. According to solar vendors, the market is less competitive than in countries such as Nigeria and Kenya that have larger commercial and industrial solar markets than Ghana, where only a handful of experienced installers is active (BNEF 2019).

Installers of solar PV systems in Ghana claim that customer awareness of solar as a cost-reducing option remains very low but is slowly rising. The market is driven mainly by small-scale commercial projects, although developers consider industrial clients with capacities larger than 500 kW as a promising segment (BNEF 2019) and are targeting a range of commercial and industrial clients such as office buildings, banks, schools, hotels, factories, cold storage facilities and mines. Most projects are on-site and operational, with a good connection to the grid. Geographically, the market is concentrated in the business hubs of Accra and Tema (BNEF 2019).

Economically, solar is already competitive with grid electricity tariffs. It was competitive even after the major tariff reduction in March 2018 and has become even more so after the 2019 electricity tariff increase. In its 2019 study, BloombergNEF projected that the cost of commercial and industrial solar will decline from $0.11 per kWh in 2019 to $0.05 per kWh in 2030, as a result of declines in the costs of PV module and inverter manufacturing, making solar more competitive even if grid tariffs fall further. Installers in Ghana could target equity internal rates of return of 12 per cent to 25 per cent in their projects in local currency (BNEF 2019).

Regarding costs, the capital expenditure for commercial and industrial solar installations as of November 2018 ranged from $0.75 per watt-peak (Wp) to $1.50 per Wp, with the majority paying around $1 per Wp (BNEF 2019). Developers and EPC companies generally use "tier 1" solar modules, which they said were bought for $0.34 to $0.59 per Wp in November 2018 (BNEF 2019). Solar modules and components are exempted from duties and value-added tax provided that the components reach customs together with solar modules to benefit from the tax incentive; otherwise, a 5 per cent import duty is applied to inverters (BNEF 2019). Additionally, importers need to pay 17.5 per cent value-added tax.

Transport of equipment is not challenging since Ghana has relatively good road infrastructure, and most PV systems are installed in Accra. Battery storage may generally result in making the project not economically and financially viable given the global prices of this technology. However, the need for battery storage for commercial and industrial projects in Ghana should be assessed on the basis of each project's conditions and needs.

8.2/ EXISTING CAPTIVE POWER INSTALLATIONS

Solar PV installations shown in Table 10 demonstrate what was achieved by year-end 2019 across a variety of industries.

Table 10: Selected solar PV captive installations across a variety of industries in Ghana, as of end-2019

SOLAR CAPTIVE POWER INSTALLER	LOCATION	TECHNOLOGY	DEVELOPER	CAPACITY	DATE
Cargill*	Tema	Solar PV	DSE Group	565 kWp	November 2017
Kasapreko Company Ltd.**	Accra	Solar PV	CrossBoundary Energy Ghana Ltd	400 kWp	February 2019
Wegdam Foodlink B.V.	-	Solar PV	DSE Group***	350 kWp	December 2016
Red Sea Housing Services	Tema	Solar PV	REDAVIA Solar****	336 kWp	October 2018
East Cantonments Pharmacy Limited	-	Solar PV	DSE Group	106 kWp	-
Stanbic Bank	Kasoa, Tema and Dansoman	Solar PV	Ecoligo GmBH	40 kWp	2018

*Source: * Cargill 2017, ** Kasapreko 2019, *** DSE Group Africa n.d., * REDAVIA n.d.*

In addition to captive solar PV installations, a variety of captive small bioenergy installations exist in the country. Most of these existing systems are located at sugar factories (particularly oil palm plantation mills). Additional enterprises that have installed bioenergy captive plants include a research institute, a dried fruit company and a fertilizer company. Selected biogas and biomass installations in Ghana are shown in Table 11.

Table 11: Selected biogas / biomass projects in Ghana

COMPANY NAME	INSTALLED BIOGAS / BIOMASS CAPACITY	COMPANY LOCATION	INDUSTRY TYPE	SOURCE
Ghana Oil Palm Development Company	4.0 MW	Kwahu, Eastern Region	Oil palm	UNIDO 2018
Twifo Oil Palm Plantation Mill	610 kW	Central Region	Oil palm	Asibey 2017
Benso Oil Palm Plantation Mill	500 kW	Greater Accra Region	Oil palm	Asibey 2017
Juaben Oil Mills Ltd.	424 kW	Ashanti Region	Oil palm	Asibey 2017
Kwai Oil Palm Plantation Mill	420 kW	Eastern Region	Oil palm	Asibey 2017
HPW Fresh and Dry	200 kW	Adeiso, Eastern Region	Dried fruits	UNIDO 2018
Safi Sana Ghana Ltd.	100 kVA	Ashaiman, Greater Accra Region	Biofertilizer	UNIDO 2018
Kumasi Abattoir	30 kVA	Kumasi, Ashanti Region	Abattoir	UNIDO 2018
Kumasi Institute of Tropical Agriculture	15 kVA	Kumasi, Ashanti Region	Research institute	UNIDO 2018

Source: Author compilation based on available data.

8.3/ CONCLUSION

While Ghana reportedly had just 7 MW of commercial and industrial solar installed capacity as of October 2018, the country could become one of the fastest growing markets with its strong pipeline of captive installations, high electricity prices and large mining sector. There is a solid economic case for commercial and industrial customers to turn to solar PV captive power generation installations. Many of these customers have already opted for captive electricity generation. Most of these plants are solar PV-based, while others are biogas-based electricity generation plants.

As indicated by BloombergNEF, six installers in Ghana have been working on a pipeline of 32 MW of commercial and industrial solar capacity for delivery in the next two years, with several megawatt-scale projects in advanced stages. With new transmission lines planned to distribute electricity further, captive power is being encouraged as a means to meet any supply gap at the national level. This is also addressed in the Ghana Renewable Energy Master Plan of 2019, which targets the integration of solar PV and solar water heaters in existing and new buildings, as well as captive power due to the increasing cost of conventional power. Other forms of clean captive power generation such as wind power, bioenergy and waste-to-energy are also targeted and encouraged for industrial use.

9/ GHANA MARKET POTENTIAL FOR CAPTIVE POWER

This section reviews the relative importance of the industry sector in Ghana's economy, providing an overview of the primary sectors and then identifying the main target areas for potential clean captive power installations.

The overview consists of screening the various sectors in Ghana, namely the service, industrial and agricultural sectors, and each of its respective sub-sectors, to identify those that might have the highest potential for the adoption of clean captive installations. Information on company numbers, company size and electricity demand is provided based on the limited data available.

This section draws heavily on the *Integrated Business Establishment Survey* reports from 2015 (Phase I) and 2018 (Phase II), which provide the most relevant and recent publicly available national statistical data on the number and size of enterprises and establishments (facilities, factories, workshops, etc.).

The scope of the present study is on clean captive power potential for private industrial clients. Therefore, special attention was given to the industry and service sectors and their sub-sectors, which are more energy-driven in comparison to agriculture. Further details are elaborated in the following sub-sections.

9.1/ GHANA SECTOR OVERVIEW

Ghana's gross domestic product (GDP) grew at an average annual rate of 5 per cent between 1990 and 2010, increasing in a moderate but consistent way (Addo 2017). The country's economy is the second biggest in West Africa, supported by strong exports of cocoa, gold and oil. Ghana is the continent's second largest gold producer after South Africa (Economies Africaines 2017).

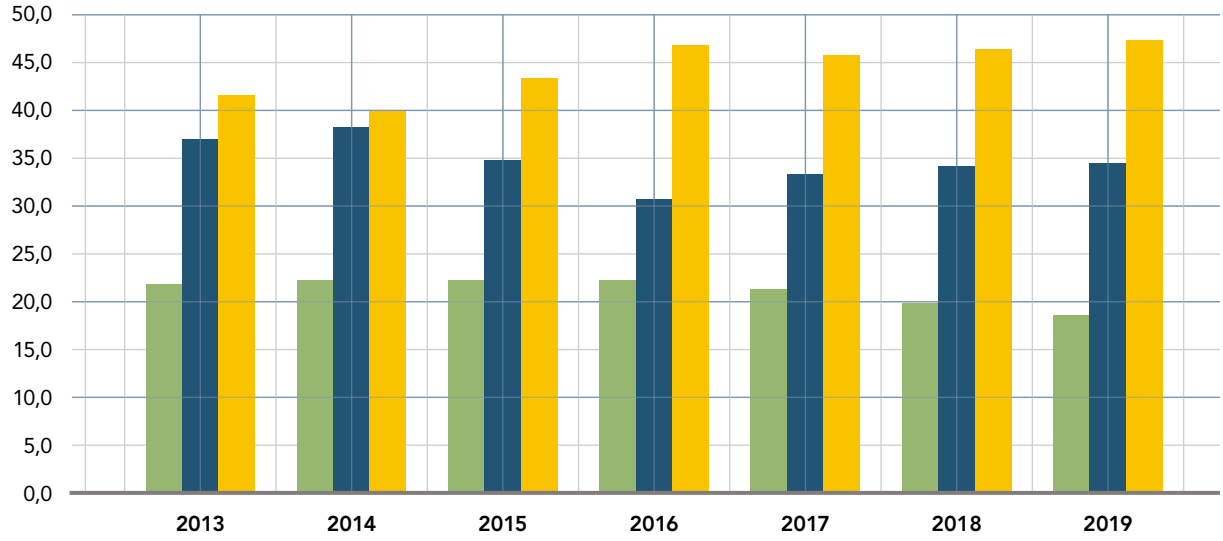
Since 2017, Ghana has featured consistently among Africa's 10 fastest growing economies, and following national industrialization policies it was classified as the world's 26th fastest growing industrial producer (U.S. CIA n.d.) with a growth rate of 7.8 per cent (Addo 2017).

Ghana's GDP grew 6.5 per cent in 2019, driven mainly by the non-oil sector; its three main sectors are services (47.2 per cent in 2019), industry (34.3 per cent) and agriculture (18.5 per cent), as shown in Figure 12.

The country received more than a third of West Africa's foreign direct investment[16] in 2018. The new Business Regulatory Reform programme is expected to further foster a vivid business environment (AfDB 2020). The economy is also expected to benefit from the African Continental Free Trade Agreement and continued foreign direct investment, which is expected to double over the next 10 years.

16 *A foreign direct investment is an investment made by a firm or individual in one country into business interests located in another country. Generally, foreign direct investment takes place when an investor establishes foreign business operations or acquires foreign business assets in a foreign company (Investopedia).*

Figure 12: Share of GDP by sector (per cent), 2013-2019



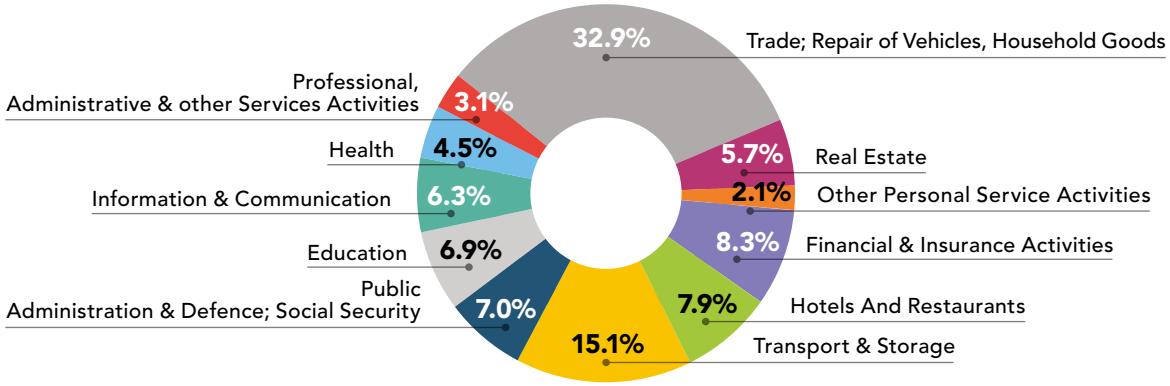
	2013	2014	2015	2016	2017	2018	2019
AGRICULTURE	21.7	22.1	22.1	22.1	21.2	19.7	18.5
INDUSTRY	36.9	38.1	34.6	30.6	33.2	34.0	34.3
SERVICE	41.4	39.8	43.2	46.7	45.6	46.3	47.2

Source: GSS 2019

9.2/ SERVICE SECTOR OVERVIEW

The service sector contributed 47.2 per cent of GDP in 2019, with the most important sub-sectors being the trade and repair of vehicles and household goods; transport and storage; financial and insurance activities; hotels and restaurants; public administration, defence and social security; education; and information and communication (see Figure 13).

Figure 13: Service sector by value-added activities



Source: GSS 2020

9.2.1/ NUMBER OF ESTABLISHMENTS AND DISTRIBUTION BY SIZE

Table 12 provides an overview of the main service sectors in Ghana based on the size of establishments according to the *Integrated Business Establishment Comprehensive Sectoral Report* from 2018 (GSS 2018). The majority of total workforce establishments in the service sector are small and medium enterprises, accounting for 75.1 per cent, whereas large-sized firms represented only 13.4 per cent.

Table 12: Overview of the service sector in Ghana, 2018

ECONOMIC SECTOR	SIZE OF BUSINESSES (NO. AND %)							
	Large		Medium		Small		Micro	
Trade and repair of vehicles and household goods	79	(0.03%)	854	(0.4%)	26 124	(11%)	209 651	(88.6%)
Transport and storage	45	(2%)	215	(9.3%)	1 197	(52%)	843	(36.7%)
Hotels and restaurants	29	(0.1%)	747	(1.7%)	7 599	(17%)	36 307	(81.3%)
Public administration and defence; social security	86	(1.7%)	137	(2.7%)	788	(15.4%)	4 109	(80.3%)
Financial and insurance activities	300	(4.9%)	629	(10.3%)	3 207	(52.6%)	1 957	(32.1%)
Education	97	(0.6%)	1 681	(9.9%)	12 922	(75.7%)	2 364	(13.9%)
Information and communication	34	(1.1%)	131	(4.2%)	694	(22.1%)	2 286	(72.7%)

Source: GSS 2018

The table indicates that the sub-sector on the trade and repair of vehicles and household goods accounts for the highest number of establishments, particularly micro-sized enterprises, similar to the food and restaurants sub-sector. The education sub-sector focuses the most on small-sized establishments, followed by financial and insurance activities. Large-sized establishments account for only a small fraction of the total, mostly in the financial and insurance activities sub-sector.

9.2.2/ GEOGRAPHICAL DISTRIBUTION OF FIRMS IN THE SERVICE SECTOR

Of the 535,471 total establishments in the service sector, the majority are concentrated in Greater Accra (135,318 or 25.3 per cent) and in the Ashanti region (98,959 or 18.5 per cent), followed by the Western and Eastern regions (see Table 13).

Table 13: Distribution of employees across regions, by size

	SERVICE SECTOR OF ALL SIZES		DISTRIBUTION BY SIZE			
RANKING	Region	No. of establishments	Micro	Small	Medium	Large
1	Greater Accra	135 318	120 606	24 187	3 833	887
2	Ashanti	98 959	84 162	16 622	1 183	252
3	Western	59 138	41 981	10 469	703	169
4	Eastern	49 294	39 392	8 828	453	146
5	Central	46 156	35 673	8 294	446	106
6	Brong Ahafo	44 527	32 232	8 059	466	116
7	Volta	39 263	26 262	6 220	304	93
8	Northern	36 017	23 181	7 589	266	72
9	Upper East	14 238	9 595	3 464	165	55
10	Upper West	12 561	8 194	2 292	115	29

Source: GSS 2018

Overall, the top four regions could be expected to have the highest number of service establishments that may be interested in clean captive power.

9.2.3/ ENERGY CONSUMPTION IN SERVICE SECTOR

The following data were collected from the Energy Commission's analysis of Ghana's National Energy Statistics (2008-2017) (EC 2018b). Although data limitations impede the full applicability of the study, it provides an indicative understanding of energy use and energy balance across the three sectors. Table 14 shows the production, transformation and final consumption (demand) of all forms of energy:

Table 14: Ghana's energy balance in 2017 (ktoe)

SUPPLY AND CONSUMPTION	Crude Oil	Natural Gas	Petroleum Products	Biomass	Hydro	Solar	Electricity	Total
Production	8 547.30	850.50	123.00	3 903.30	482.90	2.40	-	13 909.40
Imports	237.90	295.20	4 221.30	-	-	-	21.20	4 775.60
Exports	-8 304.20	-	-471.20	-1.80	-	-	-23.00	-8 800.30
International Marine Bunkers	-	-	-90.70	-	-	-	-	-90.70
International Aviation Bunkers	-	-	-154.50	-	-	-	-	-154.50
Stock Changes	-311.70	-	43.90	-	-	-	-	-267.90
Total energy supply	**169.20**	**1 145.60**	**3 917.00**	**3 901.50**	**482.90**	**2.40**	**-1.80**	**9 616.90**
Statistical differences	-27.80	1.40	220.00	-		-	0.10	193.60
Electricity plants	-168.50	-1 039.40	-627.40	-	-482.90	-2.40	1 209.80	-1 110.90
Petroleum refinery	-24.50	-	16.50	-	-	-	-	-8
Other transformation	-	-	-	-	-	-	-	-
Energy industry own use	-4.10	-76.0	-	-	-	-	-6.10	-86.20
Losses	-	-	-	-1 072.10	-	-	-162.00	-1 234.10
Final energy consumption	**-**	**28.80**	**3 086.20**	**2 829.40**	**-**	**-**	**1 039.80**	**6 984.20**
Residential	-	-	176.30	2 481.40	-	-	532.50	3 190.20
Industry	-	28.80	291.10	223.50	-	-	264.10	807.50
Commerce & Service	-	-	16.50	124.50	-	-	242.50	384
Agriculture & Fisheries	-	-	75.10	-	-	-	0.30	75.40
Transport	-	-	2 526.20	-	-	-	0.50	2 526.60
Non Energy Use	-	-	0.90	-	-	-	-	0.90

Source: EC 2018b

Final energy consumption in transport (as part of the service sector) and in commerce and services account for the largest portion of the energy utilised, followed by the industry sector. Although changes to the table have occurred since 2013, these sub-sectors have always been the largest consumers of total energy consumption in Ghana.

9.2.4/ POTENTIAL FOR CLEAN CAPTIVE POWER IN THE SERVICE SECTOR

Within the service sector, the following four sub-sectors are among those with the largest numbers of establishments that could have clean captive potential, and also have the highest expenses in energy/electricity consumption:

- Trade and repair of vehicles and household goods,
- Transport and storage,
- Hotels and restaurants,
- Financial and insurance.

Overall, the breakdown by size and operating costs of businesses in each service sub-sector helps identify the indicators for the market potential of clean captive power. The study assumes that these four sub-sectors have the most potential to be clean captive power users, due to the nature of these industries, overall interest in reducing costs as well as the distribution of establishments by size. Also supporting this assumption is the operating cost incurred from financial and insurance activities establishments, with this sub-sector recording the highest expense on electricity (70.9 per cent). Trade and repair of vehicles and household goods also incurred the highest expenses on purchasing fuel (77.3 per cent) and materials and supplies (88.4 per cent) compared to other service sub-sectors.

Table 15: Operating cost of businesses in the service sector, by expenditure category (percentage)

	TOTAL GHS	MATERIAL AND SUPPLIES GHS	GOODS PURCHASED FOR RESALE GHS	FUEL PURCHASED GHS	ELECTRICITY PURCHASED GHS	WATER PURCHASED GHS	OTHER PURCHASES GHS	OTHER OPERATING COSTS GHS
ALL SUBSECTORS	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Wholesale and retail trade and repair of motor vehicles and motorcycles	63.9	88.4	83.2	77.3	10.1	28.8	32.2	10.0
Transportation and storage	1.8	0.8	1.0	9.5	0.9	2.8	0.1	2.7
Accommodation and food service activities	2.5	3.2	2.3	2.7	4.9	20.5	3.6	1.0
Information and communication	2.9	0.5	10.4	2.8	6.0	7.2	2.9	5.0
Financial and insurance activities	24.5	2.7	0.2	3.6	70.9	14.8	53.0	76.5
Real estate activities	0.5	0.5	0.0	0.1	0.2	0.3	0.1	0.8
Professional, scientific and technical activities	0.6	0.4	0.1	0.4	0.7	2.5	2.6	1.0
Administrative and support service activities	0.3	0.2	0.2	0.5	0.4	0.7	0.1	0.4
Education	0.6	0.3	0.7	1.1	1.4	8.2	2.5	0.9
Human health and social work activities	0.8	0.9	0.8	0.4	1.9	3.2	2.4	0.6
Arts entertainment and recreation	0.1	0.1	0.0	0.1	0.2	0.5	0.0	0.1
Other service activities	1.6	2.0	1.1	1.5	2.4	10.5	0.6	0.8

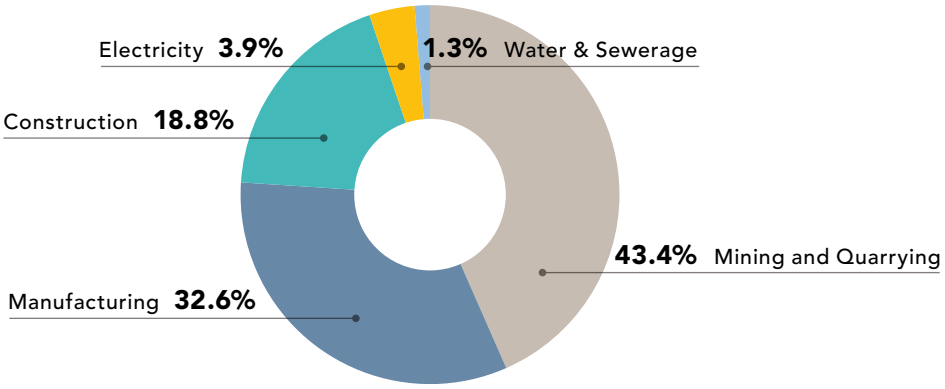
Source: GSS 2018

9.3/ INDUSTRY SECTOR OVERVIEW

Within the industry sector, which contributed 34.2 per cent of GDP in 2019, the most important sub-sectors are mining and quarrying, manufacturing, construction, electricity, and water and sewerage (see Figure 14).

According to a 2013 census conducted by Ghana Statistical Services, published in 2018 (GSS 2018), the largest number of companies in the industry sector are in the manufacturing (92 per cent) sub-sector, followed by the construction (6 per cent) sub-sector.

Figure 14: Industry sector by value-added activities

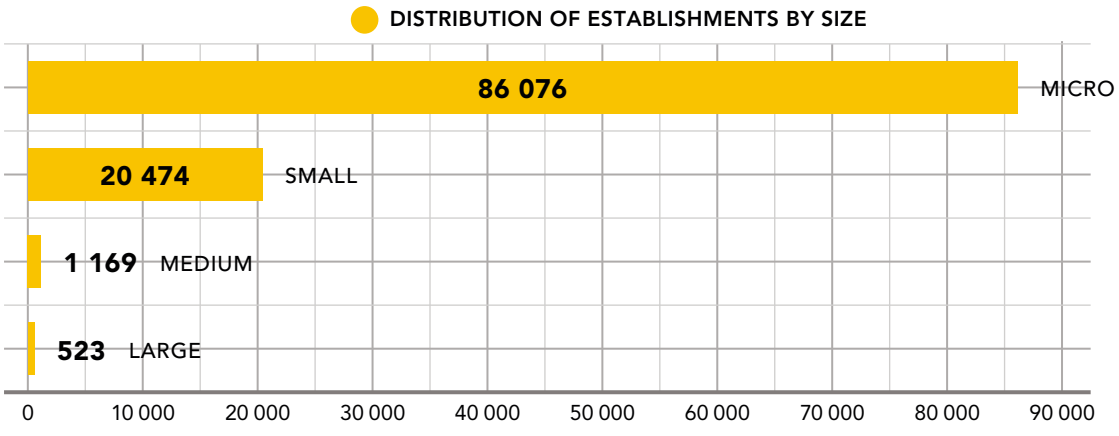


Source: GSS 2020

9.3.1/ NUMBER OF EMPLOYEES AND DISTRIBUTION BY SIZE

The predominant size of establishments in the industry sector is micro. As seen in Figure 15, micro-sized establishments account for 79.5 per cent of total establishments in the industry sector, followed by small-sized establishments at 18.9 per cent. There are only 523 large-sized establishments in the sector.

Figure 15: Distribution of establishments in the industry sector (No.), by size



Source: GSS 2015a

Within the industry sector, almost all establishments are in the manufacturing sub-sector, which also has the highest proportion of persons employed (around 65.1 per cent). However, the manufacturing sub-sector accounts for only 1.2 billion Ghanaian cedis of all wages and salaries paid. Meanwhile, only 293 establishments are in the mining and quarrying sub-sector, which employs 9.6 per cent of people in the industry sector but has the largest share of paid wages and salaries for employees. This could be attributed to the fact that the mining and quarrying sub-sector is fuel-driven (the extraction of crude petroleum and natural gas activities). The water supply, sewerage and waste management sub-sector contributes the least to wages and salaries and has the fewest enterprises within the industry sector.

Table 16: Compensation of employees across regions, by size

Economic sector	No. of establishments	No. of employees	Wages and salaries (Ghanaian cedis)
Mining and quarrying	293	40 121	8 855 455 213
Manufacturing	101 789	271 862	1 188 588 784
Electricity and related	327	17 280	807 455 034
Water and waste	507	24 242	127 834 115
Construction	3 414	64 023	531 121 095

Source: GSS 2018

Similarly, large establishments also incurred the most expenditure of the total Industry sector, being the dominant size of businesses across all sub-sectors (except for construction, where small-sized businesses accounted for 25.7 per cent of the total industry sector expenditure). Thus, the focus of this analysis is on large and small businesses, as well as on three key sub-sectors: mining and quarrying, manufacturing and construction.

Table 17: Type and value of purchases and other operating costs in the industry sub-sectors (GHS), by size

SUB-SECTOR/SIZE	Material and supplies	Goods purchased for resale	Fuel purchased
INDUSTRY	**47 089 141 948**	**2 182 130 610**	**4 155 028 052**
Large-Sized	18 345 439 830	1 195 486 991	1 995 441 537
Medium-Sized	7 848 135 978	20 986 758	1 990 062 739
Small-Sized	19 822 047 902	899 925 064	148 604 923
Micro-Size	1 073 518 238	65 731 797	20 918 854
MINING AND QUARRYING	**2 943 976 208**	**60 013 437**	**2 739 307 644**
Large-Sized	2 005 530 334	49 961 546	888 388 002
Medium-Sized	691 708 869	9 677 085	1 829 136 844
Small-Sized	245 786 699	297 805	21 626 855
Micro-Sized	950 306	77 000	155 943
MANUFACTURING	**16 539 757 596**	**991 107 497**	**402 025 489**
Large-Sized	9 246 836 727	40 119 470	257 479 220
Medium-Sized	2 389 070 393	6 911 104	77 547 978
Small-Sized	4 017 370 271	879 718 890	48 915 444
Micro-Sized	886 480 206	64 358 034	18 082 847
ELECTRICITY, GAS, STEAM, AND AIR CONDITIONING SUPPLY	**1 830 332 687**	**1 105 762 051**	**773 911 091**
Large-Sized	1 656 126 439	1 105 351 500	762 706 896
Medium-Sized	78 703 501	357 551	1 383 184
Small-Sized	80 701 390	0	9 815 211
Micro-Sized	14 801 356	53 000	5 800
WATER SUPPLY; SEWERAGE WASTE MANAGEMENT	**125 801 435**	**270 409**	**24 252 252**
Large-Sized	112 271 755	54 476	19 927 448
Medium-Sized	6 208 716	83 993	1 900 963
Small-Sized	6 172 186	52 750	2 341 272
Micro-Sized	1 148 779	79 191	82 569
CONSTRUCTION	**25 649 274 023**	**24 977 217**	**215 531 577**
Large-Sized	5 324 674 576	0	66 939 971
Medium-Sized	4 682 444 500	3 957 025	80 093 769
Small-Sized	15 472 017 356	19 855 619	65 906 142
Micro-Sized	170 137 591	1 164 573	2 591 695

Source: GSS 2018

Electricity purchased	Water purchased	Other purchases	Other operating costs	TOTAL
866 738 473	**80 826 914**	**206 714 198**	**6 595 259 337**	**61 175 839 532**
663 881 663	50 309 214	200 998 643	4 137 122 671	26 588 680 549
71 443 221	12 088 262	5 550 436	1 744 573 078	11 692 840 472
89 627 231	11 707 096	142 884	591 715 146	21 563 770 246
41 786 358	6 722 341	22 235	121 848 442	1 330 548 265
449 875 187	**2 921 959**	**190 266 192**	**3 038 068 002**	**9 424 428 629**
416 690 727	2 284 064	189 432 784	2 243 336 979	5 795 624 436
6 072 064	319 435	810 692	598 595 488	3 136 320 477
27 006 275	310 185	17 100	194 855 111	489 900 030
106 120	8 275	5 616	1 280 425	2 583 685
306 174 093	**63 134 215**	**14 965 862**	**1 704 598 816**	**20 021 763 568**
159 426 844	44 317 152	10 911 987	1 216 681 706	10 975 773 106
56 303 181	5 511 822	3 997 094	202 249 555	2 741 591 127
49 777 100	7 064 403	40 162	179 567 607	5 182 453 877
40 666 969	6 240 837	16 619	106 099 949	1 121 945 461
13 585 501	**1 829 398**	**0**	**380 304 940**	**4 105 725 668**
12 862 283	1 748 017	0	345 384 520	3 884 179 655
222 818	4 980	0	2 610 022	83 282 056
495 331	75 939	0	32 282 335	123 370 206
5 070	461	0	28 062	14 893 749
74 101 944	**470 207**	**8 976**	**86 098 673**	**311 003 896**
69 434 475	331 634	8 922	57 469 940	259 498 650
267 651	35 372	0	17 984 924	26 481 619
4 008 304	59 015	54	10 280 083	22 913 664
391 514	44 186	0	363 726	2 109 965
23 001 749	**12 471 135**	**1 473 168**	**1 386 188 906**	**27 312 917 775**
5 467 334	1 628 347	644 950	274 249 526	5 673 604 704
8 577 507	6 216 652	742 650	923 133 090	5 705 165 193
8 340 222	4 197 554	85 568	174 730 010	15 745 132 471
616 685	428 581	0	14 076 280	189 015 405

9.3.2/ GEOGRAPHICAL DISTRIBUTION OF FIRMS IN THE INDUSTRIAL SECTOR

By location, the Greater Accra region has the highest number of manufacturing companies (23.4 per cent), followed by the Ashanti region (19.6 per cent); meanwhile, the Upper West region (2.8 per cent) has the lowest number (see Table 18). Companies in the industry sector are predominantly of micro (80 per cent) or small size, although large multinationals such as Coca-Cola and Unilever are also established in the country.

Table 18: Regional distribution of companies by Industry sub-sector (No.)

	INDUSTRY SECTOR OF ALL SIZES		DISTRIBUTION BY SIZE			
Ranking	Region	No. of establishments	Micro	Small	Medium	Large
1	Greater Accra	27 302	21 457	4 929	597	319
2	Ashanti	20 752	16 430	4 101	167	54
3	Western	9 899	7 824	1 910	103	62
4	Eastern	9 558	8 078	1 383	72	25
5	Volta	9 115	7 790	1 289	25	11
6	Northern	8 662	6 435	2 165	53	9
7	Central	8 250	6 837	1 340	62	11
8	Brong Ahafo	7 899	6 049	1 769	63	18
9	Upper East	3 752	2 767	953	20	12
10	Upper West	3 053	2 409	635	7	2

Source: GSS 2015a

In terms of distribution by size, Greater Accra also records the most establishments across all sizes in comparison with other regions. The four regions of Greater Accra and of Western, Ashanti and Eastern (the other top three regions) could be expected to have the highest number of industrial establishments interested in clean captive power. This is in line with the study's analysis in section 9.3.1.

9.3.3/ ENERGY CONSUMPTION IN THE INDUSTRY SECTOR

Of the five main industrial sub-sectors in Ghana, three are most likely to have the greatest potential for clean captive power uptake: mining and quarrying, manufacturing, and construction. The 2013 census (GSS 2018) indicates that the mining and quarrying sub-sector consumed 51.9 per cent of operating costs spent on electricity, while the manufacturing sector consumed 35 per cent. These two sub-sectors also dominate in the share of expenditure on water and fuel purchased across the Industry sector. Table 19 details the electricity consumption by mining and quarrying and manufacturing sub-activities.

Table 19: Operating costs of the mining and quarrying and manufacturing sub-sectors (percentage)

GROUPS	Material and Supplies	Goods Purchased for Resale	Fuel purchased	Electricity purchased	Water purchased	Other Purchases	Other Operating Costs	TOTAL
MINING AND QUARRYING	**6.3**	**2.8**	**65.9**	**51.9**	**3.6**	**92.0**	**46.1**	**15.4**
Extraction of crude petroleum and natural gas	2.1	-	2.6	0.4	0.8	-	7.9	2.7
Mining of metal ores	3.2	0.0	12.4	47.7	2.1	91.7	32.8	7.8
Other mining and quarrying	0.2	0.4	6.8	2.0	0.4	0.4	1.0	0.7
Mining support service activities	0.8	2.3	44.1	1.8	0.3	0.0	4.3	4.2
MANUFACTURING	**35.1**	**45.4**	**9.7**	**35.3**	**78.1**	**7.2**	**25.8**	**32.7**
Food products	10.5	2.0	1.5	5.5	10.1	1.5	7.0	9.1
Beverages	1.3	0.7	2.0	6.2	30.1	0.0	3.9	1.7
Textiles	0.4	0.2	0.5	0.5	0.6	-	0.7	0.5
Wearing apparel	0.8	3.2	0.1	2.4	4.8	0.0	0.8	0.8
Leather and related products	0.3	0.1	0.0	0.2	0.2	-	0.1	0.2
Wood and products of wood and cork, except furniture	1.0	2.1	1.7	3.3	1.3	0.0	1.3	1.1
Paper and paper products	0.4	0.7	0.1	0.3	0.6	-	0.5	0.4
Printing and reproduction of recorded media	0.3	0.1	0.1	0.6	0.7	0.0	0.5	0.3
Coke and refined petroleum products	1.9	-	0.0	0.1	7.8	-	3.5	1.9
Chemicals and chemical products	1.8	0.1	0.3	1.0	1.2	1.8	0.6	1.5
Pharmaceuticals, medicinal chemical and botanical products	0.3	0.0	0.2	0.8	1.0	2.7	0.5	0.3
Rubber and plastics products	1.6	0.2	0.5	2.9	3.4	1.0	1.1	1.4
Other non-metallic mineral products	1.7	0.3	1.8	2.6	1.8	0.2	1.8	1.7
Basic metals	4.2	0.0	0.3	5.8	1.9	-	1	3.5
Fabricated metal products, except machinery and equipment	2.2	0.5	0.3	1.9	2.4	0.0	1.2	1.9
Computer, electronic and optical products	0.2	0.5	0.0	0.0	0.2	-	0.0	0.1
Electrical equipment	2.2	0.0	0.0	0.1	0.1	-	0.1	1.7
Machinery and equipment n.e.c.	0.1	0.0	0.0	0.1	0.1	-	0.1	0.1
Furniture	0.6	0.4	0.1	0.6	1.4	-	0.8	0.6
Other manufacturing	3.4	34.1	0.0	0.1	7.9	-	0.1	3.8
Repair and installation of machinery and equipment	0.1	0.1	0.0	0.2	0.4	0.0	0.1	0.1

Source: GSS 2018

Meanwhile, the construction sub-sector – while having the second highest number of establishments – is the biggest spender on materials and supplies, with 54.5 per cent. Based on Table 17 from section 9.3.1, this sub-activity incurred the highest expenditure (over 47 billion Ghanaian cedis), thus making construction the sub-activity that accounts for 46.1 per cent of total operating costs in the industry sector.

Table 20: Operating costs of the construction sub-sector (percentage)

GROUPS	Material and Supplies	Goods Purchased for Resale	Fuel purchased	Electricity purchased	Water purchased	Other Purchases	Other Operating Costs	TOTAL
CONSTRUCTION	**54.5**	**1.1**	**5.2**	**2.7**	**15.4**	**0.7**	**21.0**	**44.6**
Construction of buildings	39.8	0.5	2.5	1.2	5.7	0.3	7.3	31.6
Civil engineering	12.2	0.0	2.4	1.1	8.5	0.3	12.8	11.0
Specialized construction activities	2.5	0.7	0.3	0.3	1.2	0.0	0.9	2.1

Source: GSS 2018

According to the BloombergNEF report (BNEF 2019), interviewed solar developers expect activities in the industrial sector (mainly metal processing, cement manufacturing, and food and beverages manufacturing) to become the main target for commercial and industrial solar in Ghana. This is because of their important and growing power demand (which increased 5.3 per cent annually on average between 2008 and 2017) and the high costs related to grid electricity tariffs[17]. These industries also face challenges with the reliability of the power supply, as indicated in section 5.

The heaviest power consumers in Ghana are the 51 companies registered as bulk customers, which form part of the industrial segment (as of July 2019) (EC n.d.d). Most of these are in the cement, steel and mining sub-sectors, followed by food processing and beverages in the manufacturing segment. Many of these customers are concentrated in the Tema Export Processing Zones, which are authorized by the government to promote industrial activities.

Electricity in the Tema export zone is provided by Enclave Distribution Company, which is 100 per cent privately owned, unlike ECG and NEDCo. Enclave mainly purchases electricity from the Volta River Authority, and in return, it supplies it to the special load tariff customers in Tema (EPC n.d.) This arrangement may add to the electricity tariff incurred by the special load tariff customers, because in this case, in addition to the cost of electricity paid to the distribution company, a transmission charge (TSC1 and TSC2) and a distribution wheeling charge (DWC) have to be levied (PURC 2020b).

9.3.4/ POTENTIAL FOR CLEAN CAPTIVE POWER IN THE INDUSTRY SECTOR

Based on the market analysis of industrial sectors above, it can be inferred that the three sub-sectors of mining and quarrying, manufacturing and construction may have the most prospective users with potential interest in adopting captive power, as well as be able to replicate the model. Identified manufacturing sub-sectors with the biggest potential for clean captive power installations include cement, steel manufacturing, mining, metal processing, pulp and paper, chemicals, food products and beverages, which could benefit from having solar PV electricity available.

In addition, the Ghana Government's One District, One Factory initiative, which aims to build 50-65 factories per year from 2017 to 2020, is expected to create potential commercial and industrial clients. The extractive industry (mainly gold mining) is another potential target, accounting for around 10 per cent of the country's total power demand (BNEF 2019). According to the World Bank (2015), 11 gold mines are grid-connected, of which 6 also use diesel generators. The stakeholders' consultative mission conducted in Ghana for the Clean Captive Installations for Industrial Clients in Sub-Sahara Africa project has helped identify a number of other possible sub-sectors within the service sector (apart from mining and manufacturing segments), such as retail stores, private universities and hospitality, where captive solar PV installations could be beneficial for the profitability of firms. This statement is based on discussions with a variety of stakeholder organizations including the Chamber of Commerce and several industry associations.

17 *The government of Ghana, in an electricity tariff review that took effect from 1 July 2019, scraped off demand charges for industries as a means of bringing relief in the cost of electricity for Industrial consumers. Demand charges could represent up to 50 per cent of the monthly electricity bill for industrial customers.*

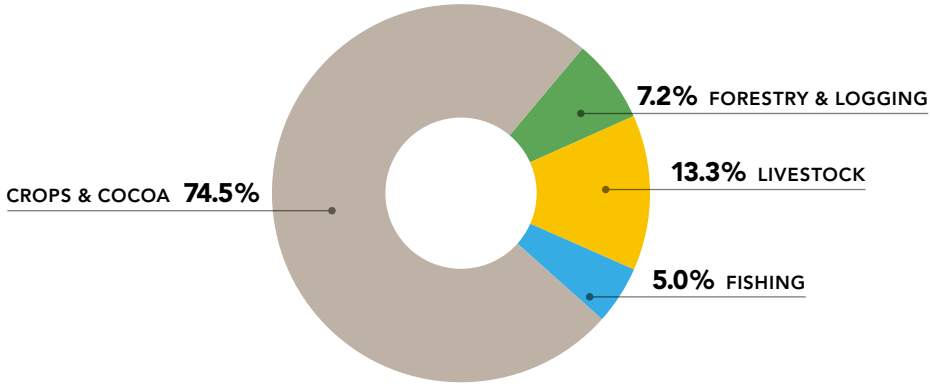
9.4/ AGRICULTURE SECTOR EXCLUDED FROM FURTHER SCREENING

Of the three main economic sectors in Ghana, the industry and service sectors are considered to have a higher potential for clean captive power installations than agriculture. The following sub-sections provide a brief overview of the agriculture sector and explain why it is excluded from further screening.

9.4.1/ NUMBER OF EMPLOYEES AND COMPENSATION OF WAGES BY SIZE

Within agriculture, the most important sub-sectors are crops and cocoa, livestock, forestry and logging, and fishing (see Figure 16).

Figure 16: Agriculture sector by value-added activities



Source: GSS 2020

Table 21 presents information on the number of employees by size of establishment category: large, medium, small and micro. Notably, large establishments engaged more employees (64.4 per cent) than all other agriculture establishment size categories. Consequently, in terms of wages and salaries paid in the agriculture sector, large establishments contributed 40.3 per cent, compared to medium and small-sized establishments with 31 per cent and 26 per cent respectively. This may be because large establishments are financially sound and are able to employ and retain skilled labourers who receive high wages and salaries.

Large-sized agriculture establishments involved in the sub-sector on crop and animal production, hunting and related service activities had the largest share of employees (62.3 per cent). Meanwhile, both the forestry and logging sub-sector and the fishing sub-sector are dominated by small-sized establishments in the number of employees and wages and salaries paid.

Table 21: Compensation of employees by size of business

Economic sector	Size of businesses (No. employees)				Wages and salaries (Ghanaian cedis and %)			
	Large	Medium	Small	Micro	Large	Medium	Small	Micro
Crops and livestock production, hunting and related service activities	25 935	4 445	8 980	2 275	44 501 860	14 514 788	33 272 125	4 791 547
					(45.6%)	**(15%)**	**(34.3%)**	**(4.9%)**
Forestry and logging	252	21	361	5	81 891	30 180	1 990 600	9 129
					(3.9%)	**(1.4%)**	**(94.3%)**	**(0.4%)**
Fishing and aquaculture	574	515	851	120	13 611 022	29 775 450	1 639 736	166 302
					(30.1%)	**(65.9%)**	**(3.6%)**	**(0.37%)**

Source: GSS 2018

9.4.2/ GEOGRAPHICAL DISTRIBUTION OF FIRMS IN THE AGRICULTURE SECTOR

There are 3,033 total establishments in the agriculture sector, significantly fewer than in the other two primary economic sectors. The Western, Brong Ahafo and Ashanti regions have the highest number of establishments, followed by the Greater Accra and Eastern regions. According to the *Integrated Business Establishment Survey Phase II Report* (GSS 2018), the Western region has the highest number of establishments (708 or 23.3 per cent) and has more employees (16,683 or 37.6 per cent) relative to the other regions. However, in terms of wages and salaries, employees in the Greater Accra and Ashanti regions receive more than those in the Western region.

Table 22: Compensation of employees across regions by size

	Agriculture sector of all sizes			Distribution by size*			
Ranking	Region	No. of employees	No. of establishments*	Micro	Small	Medium	Large
1	Western	708	218	78	50	69	21
2	Brong Ahafo	575	574	398	152	21	3
3	Ashanti	549	673	449	178	37	9
4	Eastern	325	389	217	140	21	11
5	Greater Accra	241	338	158	118	35	27
6	Volta	232	160	86	52	14	8
7	Northern	202	205	137	57	8	3
8	Central	153	206	134	45	18	9
9	Upper West	30	45	17	25	3	0
10	Upper East	20	23	5	14	4	0

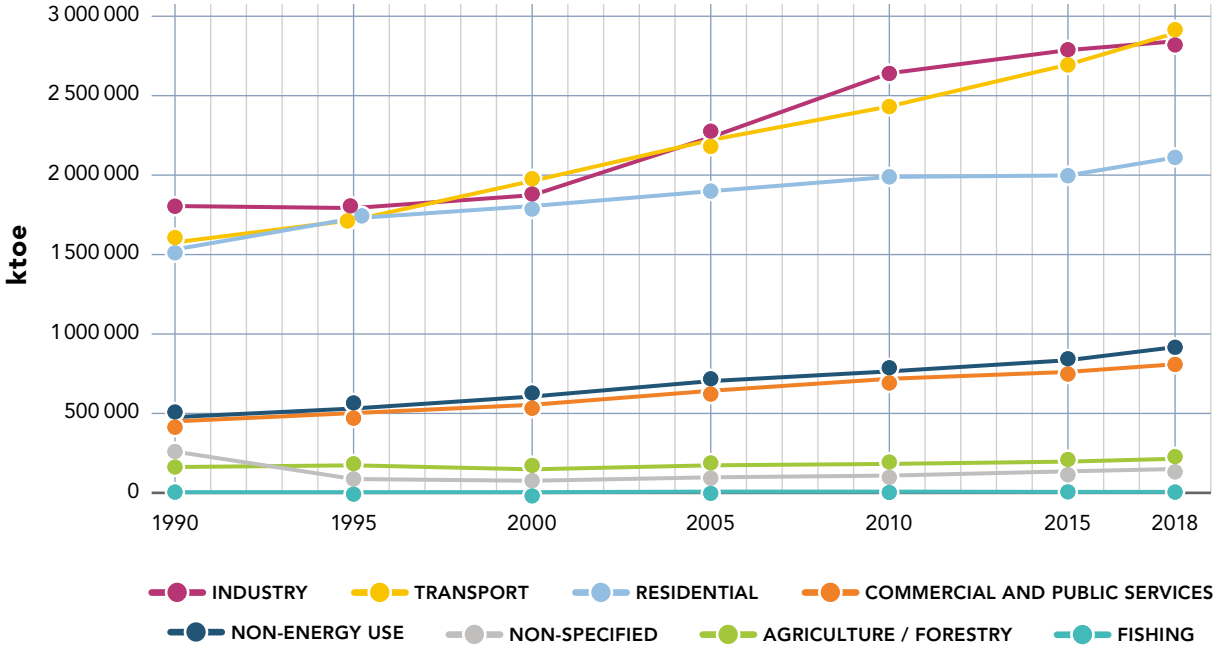
Source: GSS 2018; data with (*) from GSS 2015a

9.4.3/ SECTOR EXCLUDED FROM FURTHER SCREENING

As discussed in section 9.2.3, energy consumption is rather low in the agriculture sector compared to the industry and service sectors. Data from the International Energy Agency (2020) on total final energy consumption across sectors show the significant difference in energy consumption between the agriculture and other sectors in the past 30 years. This implies that the industry and service sectors are more energy intensive, using more advanced technologies and engaging more people, whereas agriculture is less energy intensive, and its sectoral share of total GDP has been decreasing in recent years.

The majority of the establishments in agriculture – while dominated by micro-sized firms – incurred only 23 per cent of the total purchases and operating costs of the sector. The overall potential for replicability of clean captive power is thus expected to be low. However, the data available in the sector are limited, making it difficult to conduct a better and proper analysis for captive power potential. Therefore, while the agricultural sub-sectors are not deemed to have good prospects for clean captive installations, more findings on the local energy resources available, the specific cost of electricity in agriculture, operating characteristics, etc. are required to clarify the true potential of this sector.

Figure 17: Total final energy consumption by sector, 1990-2016



Source: IEA 2020

9.5/ CONCLUSION

The competitiveness of many economic sub-sectors is directly dependent on their operational expenses and energy costs, especially for sub-sectors where the energy cost per ton of output / production is high. Any cost reduction through lower electricity bills would help reduce expenses and improve competitiveness. Geographically, the markets with the greatest total potential for clean captive installations in the industrial sector in Ghana are expected to be the Greater Accra, Western, Ashanti and Eastern regions, due to the number and size of business establishments across all three sectors (service, industry and agriculture) and to the (relatively higher) share of energy expenditure used by those establishments in these regions.

10/ FINANCING CLEAN CAPTIVE POWER

This section provides a brief discussion of the banking sector in Ghana along with prevailing interest rates and the distribution of loan assets among the prominent market segments. The discussion also focuses on renewable energy financing along with bilateral institutions (such as the Agence Française de Development (AFD) and the U.S. Agency for International Development (USAID)) and multilateral institutions (such as the International Finance Corporation) and how various financing products need to be introduced in the market to suit renewable energy technology financing. The report briefly discusses the role of the engineering, procurement and construction (EPC) contractors and energy service companies (ESCOs) in providing solar PV electricity installations, and the types of financing they avail. The section also describes available financing models for solar PV installations for commercial and industrial customers.

10.1/ BANKING SECTOR OVERVIEW

The Ghanaian banking sector is regulated by the Bank of Ghana under the Bank of Ghana Act. In 2019, the Bank of Ghana completed a consolidation and strengthening exercise that led to a reduction in the number of commercial banks – some banks merged, while others became insolvent or lost their licences because they could not meet the new minimum capital requirements. On 31 December 2018, the minimum capital requirement for a commercial banking license was raised to 400 million Ghanaian cedis (around $75 million). The commercial banking sector is now considered robust and increasingly competitive. However, it remains cautious as a result of past experiences with high loan losses, due largely to inadequate risk management.

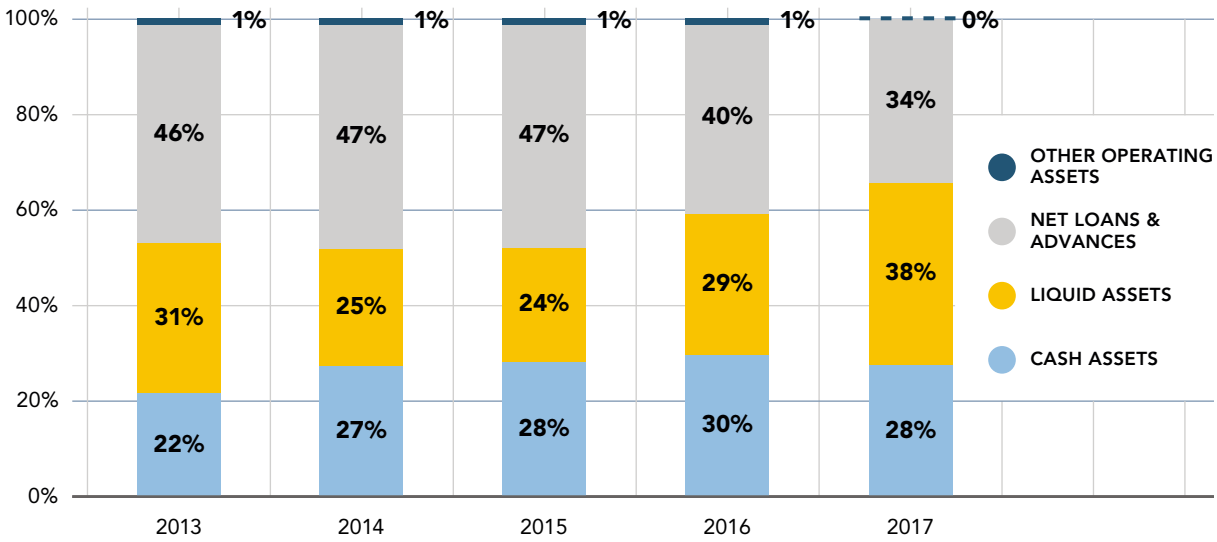
Ghana was home to 23 licensed commercial banks (universal banks) as of 30 September 2019 (reduced from 34 prior to the recapitalisation exercise), comprising 9 local banks and 14 foreign banks (i.e., banks with a non-Ghanaian majority control). Total assets amounted to 112 billion Ghanaian cedis ($2.2 billion) as of 30 June 2019.

Access to credit by private sector companies remains limited and costly, with a bank average annual interest rate of almost 30 per cent (in Ghanaian cedis) at the beginning of 2018 (European Commission 2018). Lending rates as of September 2019 ranged between 23 per cent and 27 per cent (in Ghanaian cedis). The rates are largely dependent on the Bank of Ghana reserve rate, which remained at 16 per cent for most of 2019, and the Treasury Bill rates, which ranged between 14.75 per cent and 17.2 per cent during the first nine months of 2019.

The difficulty for private companies to access commercial finance in Ghana is explained by the significant weight of non-performing loans as well as the new rules imposed on universal banks. Following the more stringent loan-loss write-off criteria introduced in June 2018, the Bank of Ghana demanded that each bank provide a plan to discharge non-performing loans and clean up the bank's portfolio. The non-performing loan rate was reduced to 18.2 per cent at the end of December 2018, from 21.6 per cent in December 2017.

Figure 18 shows the historical trend for assets held by the banking industry in Ghana, showing a crunch in lending as the impaired assets of banks increased.

Figure 18: Share of industry operating assets in Ghana by composition, 2013-2017

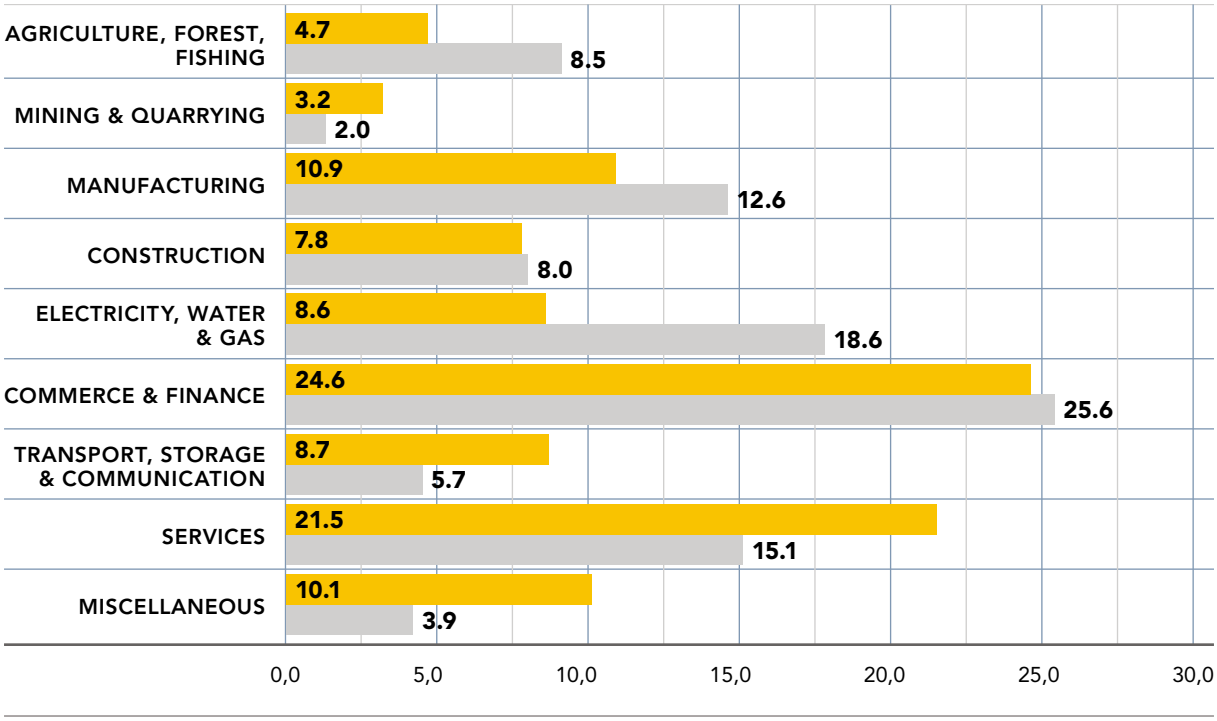


Source: PwC 2018

A breakdown by economic sector of credit and non-performing loans (see Figure 19) for Ghana universal banks as of December 2018 shows that the commerce and finance sector is the largest recipient of credit and also accounts for the largest share of non-performing loans at 25.6 per cent. While the mining and quarrying sector is the smallest recipient of credit at 3.2 per cent, it registered the lowest share of non-performing loans at 2.0 per cent. The electricity, gas and water sector, with 8.6 per cent of outstanding credit balances, accounted for the second largest share of industry non-performing loans, at 18.6 per cent (Bank of Ghana 2019).

The impact of the above on the credit market for clean captive renewable energy installations in general and solar PV facilities in particular for the commercial and industrial segment is that banks are reluctant to lend because of reservations caused by historical sector losses (in the conventional electricity sector, not the renewable energy sector). Hence, post the recapitalisation exercise, banks have more stringent lending criteria. Where they do not have the market expertise in a new field, they shy away from lending or impose conditions that act as market barriers, including higher interest rates, shorter tenors, higher collateral requirements and historical performance criteria.

Figure 19: Sector distribution of total credit and non-performing loans (per cent) as of December 2018



Source: Bank of Ghana 2019

10.2/ CAPTIVE POWER FINANCING LANDSCAPE

10.2.1/ COMMERCIAL BANKS

Only very few commercial banks in Ghana are active in financing commercial and industrial renewable energy captive power installations, as most of these projects are not well understood by the banks and are perceived as high-risk projects to finance. The banks that have done the most in this area have either developed in-house expert teams such as "green teams" or "renewable energy finance teams" or have an in-house renewable energy champion who guides commercial lending teams in the structuring and analysis of opportunities.

Commercial and industrial borrowers for solar PV are offered annual interest rates of between 23 per cent and 27 per cent (in Ghanaian cedis) and very short tenors of between two and five years. Tenors of more than five years usually require executive management support, which is exceptional. Even so, seven-year tenors are the longest that were communicated "could" be possible.

However, in a few instances where lines of credit are in place to support renewable energy lending, there has been very low usage due to banks' assessment of the risks of such lending. Foreign exchange risks are not hedged by the banks and are expected to be covered by the borrowers. Banks usually have lien over the adequate proportion of a client's liquidity.

Moreover, the banks that have internal competence have not yet had direct exposure to renewable energy projects, usually preferring to extend facilities to EPC contractors by use of letters of credit[18] to finance imports of system components such as solar panels and inverters.

18 *Different renewable energy business models are illustrated in Tool 1.*

In the few cases approved to date, lending operations for solar PV projects have used standard commercial terms and existing bank products. There are, however, recent examples of banks approaching development finance institutions for concessional lines of credit to support lending to the sector at annual rates of between 18 per cent and 22 per cent (in Ghanaian cedis) and tenors of over seven years. Several commercial banks that are currently finalizing lines of credit suitable for lending to clean captive projects have received technical training from the U.S. Agency for International Development, Agence Française de Development (AFD), KfW, and the Belgian Investment Organisation, among others.

Ghanaian banks are increasingly seeking concessionary lines of credit in support of their lending to specific sectors such as renewable energy and energy efficiency. Rates typically desired in the market for such concessionary lines are in the region of 10 per cent (in U.S. dollars). Loans from the Green Climate Fund and other intervention funds specific to renewable energy and energy efficiency, such as AFD's SUNREF, KfW, etc., are expected to reduce interest rate levels to as low as 3 per cent (for the Green Climate Fund).

Other concessional loans provided via the commercial banks, and with tenors of a minimum of 5 years and up to 15 years, are being discussed between the banks and third-party providers of credit lines. With several banks going through the process of applying for these lines of credit or recently having had lines approved over the last 12 months, most of the approved concessional lines for renewable energy and energy efficiency have yet to be used.

Table 23: Bank "green lending" facilities from bilateral agreements, 2019

BANK NAME	TYPE	PARTNER INSTITUTION	FACILITY AMOUNT	DENOMINATION / EXPECTED INTEREST RATE / TENOR	STATUS
CalBank	Renewable energy	**Agence Française de Développement (AFD)**	$20 million	U.S. dollars / 10% Minimum 5 years	Approved July 2019
	Renewable energy	**International Finance Corporation**	$12.5 million	U.S. dollars / 10% Ghanaian cedis / 22-25% Minimum 5 years	Approved May 2018
Ecobank	Renewable energy	**Green Climate Fund – Accredited Entity**	Not disclosed	U.S. dollars / unknown For projects approved for Green Climate Fund funding 3% Tenors unknown	NA
Fidelity*	Blended, water sanitation and health care	**SNV (Netherlands Development Organisation)**	Not disclosed	Ghanaian cedis / 10% for water and sanitation projects 22% for healthcare projects 36 months tenor	Approved
Stanbic	Renewable energy	**AFD**	€10 million	Ghanaian cedis / 13-19% 15 years	Approval in final stages

** Fidelity bank's facility has been in place for two years. While it is for Water, Sanitation and Health (WASH) projects, as indicated in the table, the bank has stated that it would be able to utilize the same structure and likely the same source of funding for a ring-fenced line for renewable energy lending. Discussions are ongoing in this respect.*

Note: NA = not available

Source: Author's own compilation based on available data.

10.2.2/ FINANCING PROGRAMMES

SUNREF

In 2016, the AFD approved the SUNREF West Africa Programme, with a component in Nigeria and a component in Ghana (EC n.d.e). The programme comprises three pillars in Ghana: credit lines financed by AFD of up to 30 million euros with local banks, a technical assistance facility of 2 million euros, with support from the European Union Africa Infrastructure Trust Funds (EU-AITF) and an investment grant scheme also funded by the EU-AITF of 2.4 million euros to provide additional incentives to green investments.

CalBank is the first bank in Ghana to participate in this SUNREF programme, and the first agreement with CalBank is a credit line facility of 17 million euros that will allow the bank to provide green credit loans to finance small and medium enterprises in Ghana for renewable energy and energy efficiency projects. The second agreement is a grant of 1.4 million euros to the beneficiaries of the clients of the bank who are eligible under the programme.

BILATERAL GREEN LENDING FACILITIES

Other bilateral facilities have recently been approved for some of the banks that have demonstrated progress in the area of internal capacity for lending to "green" projects including renewable energy and energy efficiency projects in the commercial and industrial sector. Those include credit lines from the International Finance Corporation and from other crowdfunding platforms, including Ecoligo, a German initiative.

Of the various banks that have shown some degree of capacity and interest in the area of renewable energy and energy efficiency lending to the commercial and industrial sector, four stand out that are likely to be actively lending to market participants in the short term. These are CalBank, Ecobank, Fidelity Bank and Stanbic Bank. Three of these banks have lines of credit that are being finalized or are in place for green financing, as shown in section 13.1.1.

These banks are open to undertaking lending via the use of an actual example transaction that provides them with hands-on experience in lending to the renewable energy sector, and in this respect, these banks would welcome a model to standardize their approach for assessing the risks and developing standardized lending criteria for the financing of renewable energy projects.

OTHER RENEWABLE ENERGY FINANCING PROGRAMMES AND INITIATIVES

A number of banks have had varying degrees of training in the area of renewable energy finance (mostly from USAID's Climate Economic Analysis for Development, Investment and Resilience (CEADIR) project). CEADIR helps governments, the private sector and civil society make the business and economic case for investing in climate change mitigation and adaptation. CEADIR supports analysis and planning to mobilize financing from private and public sources and has undertaken training with several of the banks visited.

Ghana joined the Scaling-up Renewable Energy Programme (SREP) for Low-income Countries of the Climate Investment Funds in 2013. The programme targets the implementation of four projects funded by lines of credit, concessional financing and subsidies. These projects are: 1) installation of 55 renewable energy mini-grids and 35-50 stand-alone solar PV systems in 500 rural communities; 2) installation of 15,000 solar PV net metering systems with battery storage; 3) financing of utility-scale solar PV and wind projects; and 4) technical assistance and capacity building to improve the regulatory and institutional framework (European Commission 2018). SREP will also develop business models for mini-grids and the financing model of stand-alone systems. However, the programme is still in the early implementation stages (European Commission 2018).

The EU Technical Assistance Facility of Sustainable Energy for All has been active since 2014 in renewable energy finance, rural electrification, and the feasibility and installation of solar PV pumping systems (European Commission 2018). The technical assistance, especially for the renewable energy finance component, may help in raising awareness and interest among the financial institutions or parties subjected to that component on financing renewable energy projects.

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is implementing the Energising Development (EnDev) programme in partnership with other partners. Under the project, GIZ has provided farmers with subsidies of up to 40 per cent to own PV grid-connected irrigation systems in Ghana. GIZ also trained the farmers to acquire skills in agri-business development and management (European Commission 2018).

Power Africa is a continent-wide U.S. initiative to promote energy access. Power Africa, via USAID, works with the Private Finance Advisory Network (PFAN), funded by the United Nations Industrial Development Organization (UNIDO) and other donor agencies, to help provide financing to businesses engaged from a competition phase to financial close and project commissioning. Captive users are eligible for PFAN financing support. PFAN currently has a pipeline of transactions, both off-grid and grid-connected, supported through the West Africa Forum for Clean Energy Financing, where businesses make presentations to various financiers for support.

Other USAID programmes include the Clean Energy Finance Expert Capacity Building (CEFECAB) initiative being implemented by USAID West Africa and the Economic Community of West African States (ECOWAS) Centre for Renewable Energy and Energy Efficiency (ECREEE), which targets regional off-grid electrification projects by giving funding to banks for on-lending. ECOWAS and USAID are expected to work mainly with both Republic Bank and Stanbic Bank.

In June 2017, as part of the G20 Compact with Africa Programme, Ghana signed a 100 million euro bilateral Investment and Reform Partnership agreement to promote private investment in renewable energy. The programme has seen success in growing investor interest in locations where the business climate has improved (IFC 2018).

10.2.3/ PRIVATE FINANCING

Given the good potential for clean captive power in commercial and industrial facilities in Ghana and the relative lack of accessible bank financing, specialized captive solar PV financing firms have recently entered the market. Most of the companies have a base or strong presence in other parts of Africa (see Table 24).

Table 24:
Selected captive PV financing firms / energy service companies active in Ghana

Source: Author's own compilation based on available data

NAME	LOCATION
BERKELEY ENERGY	Headquartered in Singapore. An international business with operations in Kenya, London, India and Ghana.
CROSSBOUNDARY ENERGY	Based in the United States, with an office in Ghana (and in other countries).
DSE GROUP	Established in 2009. Started with solar PV installations in 2010 out of a solar company called Arends Techniek, long active in the Netherlands.
DUTCH & CO	A Ghanaian company (with a Dutch Holding Co.) incorporated in 1994. Has had a focus on renewable energy technology since 2010, beginning with LED lights, before moving into solar PV installations as a development company in 2017.
REDAVIA SOLAR POWER	Headquartered in Munich, Germany. Currently operating in Kenya, Tanzania, Ghana and Germany. Has been in operation for 10 years but in Ghana for 2 years as of 2019.
TRANSLIGHT	A wholly-owned Ghanaian company established in 2014.
YINGLI	Yingli Namene is a Ghana Ltd Company established in 2015. It has a parent company based in the U.K. (Yingli Namene), the result of a U.K. investor buyout of the former Chinese-held U.K. arm of the company Yingli Co.

OVERVIEW

- The company develops utility-scale renewable energy projects in these countries and acts as a project developer and EPC. It also provides upfront financing for its clients.
- Focused on only 300 kWp solar PV grid-connected and hybrid solutions in Ghana, it acquired Azimuth Power's operations and business in Ghana in 2019. Customers in Ghana served include: Ashesi University, Best Western Premier Hotel in Takoradi, Holiday Inn Hotel and Shop n Save.
- Berkeley Energy provides project financing to its customers through the lease-to-own model for 10-20 years on a rolling basis for systems below 500 kWp, and a PPA model for systems above 500 kWp. Available funding as of 2019 was $50 million.
- Funding to date is sourced internationally from finance partners: Overseas Private Investment Corporation, World Bank, Asian Renewable Fund.
- Total funding raised for deployment to Ghanaian projects is $50 million.

- Part of the CrossBoundary Group.
- $8 million in equity was raised for the CrossBoundary Energy Fund 1 in 2015.
- $6 million debt facility with Overseas Private Investment Corporation since 2018.
- The company has operations in Ghana and Nigeria, with Nairobi acting as the main office.
- CrossBoundary Energy has installed a 400 kWp solar PV system on the rooftop of Kasapreko Company Limited in Accra and is constructing a 999 kW rooftop solar PV system for a multinational in Tema.

- DSE Group specializes in energy efficiency through LED (light-emitting diode) lighting and solar PV installations, ranging from small residential to large-scale industrial systems. It has commissioned over 2,800 solar installations globally.
- In 2016, DSE began operations in West Africa as AB Solar Africa, deploying many installations in Ghana, Togo, Benin and Côte d'Ivoire. In 2019, DSE merged with DENG limited.
- In Ghana, the group has installed a 350 kWp solar plant for a meat company, a 106 kWp solar facility for a pharmacy and 565 kWp on a cocoa factory.
- DSE provides project financing to its clients through a lease-to-own model.

- The company works with solar PV installations that are grid-connected, captive and with or without battery storage.
- It functions as an EPC company and developer, but also offers operations and maintenance services for its clients.
- Its ideal client base operates in the commercial and industrial space and includes hospitality, airports, mining and retail.
- Dutch & Co funds projects mainly from the point of view of supplying and installing equipment against milestone (payments being made by the client with final payments being made on project completion).
- The company has undertaken a number of projects across banks, retail, mining and hospitality. It has an installed capacity of 1,400 kWp, completing about nine projects in a number of sectors with project sizes from 16.5 kWp to 565 kWp.

- REDAVIA is an industry leader in solar power that provides solar farms to businesses and communities in West and East Africa.
- As of 2019, it had installed more than 10 systems in Ghana, ranging from 40 kWp to 800 kWp for manufacturing companies, universities, etc., for a total installed capacity of 3-4 MW.
- REDAVIA provides project financing to its customers using the lease-to-own model over 10-12 years or a rental option through outright purchase. It is currently evaluating the PPA model for bulk customers.
- In January 2019, REDAVIA and ElectriFI signed a $2 million financing agreement to support REDAVIA's expansion in Ghana's industrial and commercial sector, offering affordable, reliable and clean power generated through modular solar farms. This occurred in conjunction with the recently signed $4 million innovative debt financing deal from responsAbility Investments AG.

- Translight initially focused only on the supply of back-up systems during Ghana's energy crisis period (2013-2015).
- From 2016, the company added the development of solar PV modules for both off-grid and grid-connected solutions for its clients. The largest project installed to date had 300 kWp capacity.
- The company currently receives finance for commercial and industrial consumers from Wilkins Engineering, which finances the importation of equipment that Translight installs.
- Translight has plans to finance projects itself and is looking for financing partners to support this. Potential partners include Wangara Green Ventures, currently going through due diligence.
- Translight is also in discussions with Ernst & Young.
- The company's product offerings include solar panels, batteries and inverters, with a focus on ensuring that the best-quality equipment is supplied.
- The company offers two finance models: lease-to-own (5-6 years) and full lease (rental) – a shared service approach for systems of more than 500 kWp.

- The company delivers projects with both equity and debt financing. The financiers are drawn from a pool of investors in the U.K. using a crowdfunding platform and energy investors who choose which projects they will invest in. These investors execute PPA agreements with the off-takers, as the ESCO for each project. Yingli acts as the operations and maintenance for the projects and works with Ghana Power Scientific as its installation partner.
- Tenors for the company's lease-to-own projects are between 3 and 20 years, and projects are targeted to provide 30-50% solar PV energy supply as part of the total energy mix of the off-taker.
- Clients typically pay a monthly fixed fee, based on a rate of $0.12 per kWh.
- The company has completed 5-6 projects to date including Kasapreko and 3 branches for Stanbic Bank.

10.3/ FINANCING MODELS FOR COMMERCIAL AND INDUSTRIAL SOLAR PV INSTALLATIONS DEPLOYED IN GHANA

In Ghana, only certain financing models can be implemented for the commercial and industrial sector, due mostly to regulatory restrictions.

OUTRIGHT PURCHASE / ASSET FINANCE

Under this model, the owner purchases the solar PV system upfront, financed with either company capital or debt. Once purchased, the user can either take on the responsibility of operations and maintenance or enter into an operations and maintenance contract with the EPC contractor or system supplier. In Ghana, in some cases, the EPC contractor will include in the offer price 2-3 years of operations and maintenance and training for the company's staff. Because of the high upfront costs involved, many businesses in Ghana prefer other financing models, rather than purchasing the asset outright[19].

LEASE-TO-OWN (FINANCING LEASE)

With lease-to-own, a third-party finances the captive plant either fully or partially. Depending on the contract, the client may make a small upfront capital investment (not necessary in some cases) and thereafter a monthly lease payment for the duration of the contract. The client effectively pays off the value of the solar plant through the monthly payments, and ownership is transferred to the client at the end of the contract. The contract may have a long duration (for example, up to 15-25 years). Under this model, system operations and maintenance are usually the responsibility of the developer for the duration of the lease contract. Some lease-to-own contracts have an early buy-out option where the client can purchase the system at an agreed residual value. In Ghana, many projects may be financed under a lease-to-own arrangement (for instance by REDAVIA, DSE Group, etc.).

OPERATING LEASE

With this model, an end-user makes little or no upfront payment and the lease period spans several years, the term of which is largely dependent on the financing institution. The developer is responsible for plant operations and maintenance during the lease period. In some contracts, the developer/financier provides performance guarantees to the end-user in terms of energy production. At the end of the lease period, the end-user may be given the option to purchase the system at residual value or to extend the lease, or the developer removes the plant from its premises. The operating lease model is being used in Ghana for captive projects by companies such as Translight Solar and SunPower Innovations. In many instances, what is publicly announced as a "PPA" is in fact an operating or financing lease arrangement. Solar leasing (financing and operating leases) appears to have a high potential for growth based on interviews with private sector players.

POWER PURCHASE AGREEMENT (PPA)

This model differs from the lease-to-own and operating lease arrangements in that monthly payments are not fixed but based on the energy consumed (X amount / kWh consumed) over a long-term contract (for example, 15 years or more) by an end-user from a third-party-owned captive plant on either the end-user's premises or a nearby premises. The plant owner is responsible for developing, financing, building and operating the plant.

In Ghana, however, any entity that intends to engage in commercial activity under renewable energy generation cannot do so without a wholesale electricity supply licence (see section 7.4). Commercial activities include the production, transport, storage, distribution, sale and marketing, importation, exportation and re-exportation of renewable energy as well as the installation and maintenance thereof. A wholesale licence permits the holder to manufacture and assemble renewable energy products. It also permits the holder to install, generate and supply electrical energy.

19 *Based on private sector stakeholder interviews (September 2019)*

Wholesale supply licences are mainly intended for generators who wish to make use of the national grid to supply electricity to licenced distribution utilities or bulk customers. In this sense, most commercial and industrial PV installations do not qualify for a wholesale electricity supply licence. Therefore, a PPA model for a commercial and industrial firm is not possible since they (as off-takers) do not meet the consumption threshold to be categorized as a bulk customer. Additionally, there is a policy decision to not issue any new wholesale electricity supply licences. Commercial and industrial solar PV solutions that do not qualify for a wholesale licence would be in breach of the law if they generated, distributed or sold electricity (EC n.d.c).

10.4/ CONCLUSION

The banking sector has stabilised after confidence-building and strengthening (among other measures, including through consolidation and recapitalization) initiated by the Bank of Ghana. The commerce and finance sector is the largest recipient of industrial credit. The electricity and gas sectors have among the largest share of non-performing loans (the second largest, at 37.8 per cent).

Ghana's financial sector is diverse and competitive but has not yet taken a step into financing renewable energy and solar PV systems, mostly because of historical losses in the conventional electricity sector. However, other factors such as high-interest rates and foreign exchange volatility, as well as the 2018 increased capital adequacy requirements for banks, have not permitted local banks to provide long-term financing of more than 3-5 years' maturity. The limited involvement of these banks is also due to the limited in-house practical lending experience in most banks. Banks are clearly taking a cautious approach to exposure in the area of renewable energy financing.

Despite financing difficulties, the solar PV market in Ghana is on the rise. This can be attributed to the following:

1. The government pushed through the National Energy Policy, supplemented by the investment-focused Renewable Energy Master Plan, which aims to increase Ghana's renewable energy installed capacity to around 2,500 MW by 2030. Leading by example, the government has begun switching government buildings and public institutions to solar power under the Solar Rooftop Programme.
2. The reduced cost of solar technologies, low maintenance requirements and the ability to produce power without fuel have led to the decision to invest in a solar system that reduces energy uncertainty and pays for itself in a short amount of time.
3. The availability of development agency support and credit lines from development finance institutions offered to Ghana banks has helped to reduce lending rates and increase tenors; other sources of offshore funding have also contributed.
4. The increasing presence of established private financiers and ESCO firms that provide PV financing (such as those mentioned in Table 24) has resulted in increased interest in solar system installations.

Additionally, despite the development of regulatory infrastructure for solar PV power generation, some updates in regulation are still required, especially for commercial and industrial PV installations. This is mainly because a wholesale electricity supply licence is required for the sale of electricity. However, a wholesale licence may only be issued to those who intend to supply electricity to either a distribution utility or a bulk customer (see section 5.3.1). In this sense, most commercial and industrial PV installations do not qualify for a wholesale electricity supply licence. Therefore, a PPA model for a commercial and industrial firm is not possible since the firm (as an off-taker) does not meet the consumption threshold to be categorized as a bulk customer. Additionally, there is a policy decision to not issue any new wholesale licences.

Hence the only business models available to commercial and industrial businesses are the outright asset purchase (ownership model), lease-to-own and lease (rental) models.

11/ CONCLUSION

The Ghana country report for Clean Captive Installations for Industrial Clients in sub-Saharan Africa has presented and analysed information on the electricity sector of the country, regulatory considerations, electricity tariffs, market potential, the financing landscape and stakeholders relevant to captive power in industry. The study was based on reports and data available at the time of writing and on interviews with key stakeholders.

While data limitations did not allow for in-depth analysis of specific industrial sub-sectors, the study has highlighted important findings and areas for consideration and, in some cases, further investigation. This will inform the design of interventions for the scale-up of clean captive installations in the service and industrial sectors in Ghana, including the preparation of case studies, business models and financing structures, awareness raising, and identification and implementation of a pilot project. The current energy situation of Ghana offers a good potential for clean captive installations.

Although the country has and will continue to have higher installed generating capacity than the peak demand, supply reliability is rather low due to high levels of transmission and distribution losses. In addition, the frequent grid downtimes negatively impact the operations and revenues of commercial and industrial clients. It is for these reasons that captive power, although not being encouraged as a means to address any shortfall of supply, is seen as an alternative private sector solution to address the challenges of the unreliability of power supply.

In 2018, Ghana had the highest electricity tariffs for commercial and industrial facilities in Sub-Saharan Africa, at 15-20 U.S. cents per kWh. In comparison, the expected levelized cost of electricity for captive solar generation seems to be very cost competitive and attractive for commercial and industrial consumers.

The government has endeavoured to provide an institutional and regulatory framework boosting the development of the renewable energy sector. The Renewable Energy Act of 2011 provides the legal framework for the feed-in tariff and net metering schemes and the master plan to boost the renewable energy sector. The net metering scheme, however, is on hold at present with no exact forecast regarding when those issues will be resolved. There is also provision for a renewable purchase obligation, which requires electricity distribution companies to procure a certain percentage of renewable energy power in their mix. Complementing the Renewable Energy Act of 2011, the Renewable Energy Master Plan approved by the Cabinet of Ghana in 2019 targets 447 MW of utility-scale solar PV, 200 MW of distributed solar PV and 20 MW of stand-alone solar PV by 2030.

The competitiveness of many economic sub-sectors is directly dependent on operational expenses and energy costs, especially for sub-sectors where the energy cost per ton of output/production is high. Any cost reduction through lower electricity bills would help reduce expenses and improve competitiveness. Geographically, the markets with the greatest total potential for clean captive installations in the industrial sector in Ghana are expected to be the Greater Accra, Western, Ashanti and Eastern regions, due to the number and size of business establishments across all three sectors (service, industry and agriculture) and the (relatively higher) share of energy expenditure used by those establishments in these regions. The sub-sectors in the service and industry sectors in Ghana have been identified as strong potential sectors for clean captive power, based on criteria such as the nature of such industries, overall interest in reducing costs as well as the geographical distribution of establishments by size.

A key barrier to the uptake of clean captive installations in Ghana is the uncertainty surrounding the country's energy regulatory framework, especially around obtaining licences. Given the lengthy process for obtaining a licence, as expressed by many developers, and the limited installation capacity in comparison with Kenya and other Sub-Saharan countries, this may prove challenging for the deployment of the captive energy solution. Additionally, as part of the Renewable Energy Master Plan, a share of local content in the development of renewable energy projects needs to be present and varies depending on the technology and on the type of activity. This is also regarded as a barrier given the level of maturity of the renewable energy market in Ghana.

Financing of clean captive installations in Ghana has proven to be another obstacle in the uptake of clean captive installations. Concessionary lines of credit are increasingly being sought by Ghanaian banks in support of their lending to specific sectors such as renewable energy and energy efficiency. Specific intervention funds such as the Green Climate Fund, AFD and SUNREF aim to reduce interest rate levels and increase tenors. Despite this, only very few commercial banks in Ghana (CalBank, Ecobank, Fidelity Bank and Stanbic Bank) are active in financing commercial and industrial renewable energy captive power installations, as most of these projects are not well understood by the banks and are perceived as high-risk projects to finance.

Hence, private financiers have entered the market to satisfy the growing demand for capital for clean technologies. Many captive power developers, ESCOs, EPC companies and equipment suppliers and installers have begun working with private financiers to provide dedicated solutions for captive power users. Some captive projects are implemented solely with capital from facility owners, but other business models such as financing, operating and financing leases are being offered and adopted in the market.

Overall, Ghana has enormous potential for clean captive power within the service and industry sector, and better transparency in the regulatory environment and the presence of an active financing ecosystem will be conducive for higher uptake of clean captive installations.

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13/ ANNEXES

13.1/ STAKEHOLDER MAPPING

13.1.1/ KEY STAKEHOLDERS FOR CAPTIVE SOLAR PV

With a focus on solar PV captive power, key stakeholders in Ghana include a number of government entities, banks and related institutions, industry associations, financiers/ESCOs, EPCs/ESCOs, equipment suppliers and current industrial captive renewable energy users.

GOVERNMENT ENTITIES

Table 25: Key government entities

INSTITUTION	FUNCTION
Ministry of Energy	The Ministry of Energy is the government ministry responsible for energy policy formulation, implementation, monitoring and evaluation as well as the supervision and coordination of the energy sector public agencies.
Public Utilities Regulatory Commission – PURC (regulator)	PURC is responsible for approving the rates for electricity sold by distribution utilities to the public and for monitoring the quality of services delivered to consumers.
Energy Commission (regulator)	The Energy Commission is responsible for the technical regulation of the power sector, mainly the licensing of operators, and for advising the Minister of Energy on energy policy and planning,

GENERATION, TRANSMISSION AND DISTRIBUTION COMPANIES

Table 26: List of key generation, transmission and distribution institutions

INSTITUTION	FUNCTION
The Volta River Authority – VRA (generation company)	The Volta River Authority (VRA) was established in 1961 with the mandate to generate, transmit and distribute electricity under the Volta River Development Act. In 2005, following the promulgation of a major amendment to the Act in the context of the Ghana Government Power Sector Reforms, the VRA's mandate was largely restricted to the generation of electricity. The VRA is the largest generation company.
BUI Power Authority (generation company)	The Bui Power Authority manages the Bui Hydro Power Plant, whose installed capacity is 404 MW.
Electricity Company of Ghana – ECG (distribution company)	ECG is responsible for the distribution of electricity in the southern sector, which accounts for around 71% of the total electricity consumed annually in Ghana.
NEDCo (distribution company)	NEDCo, an affiliation of the VRA, is responsible for the distribution of electricity in the northern sector, accounting for around 9% of electricity consumed annually.
Enclave Power Limited (distribution company)	Enclave Power Limited is a private distribution company that distributes electricity for industries in the Free Zones Enclave of Ghana in Tema.
Ghana Grid Company – GRIDCo (transmission)	GRIDCo, a state-owned entity, performs the transmission function, with the exclusive mandate to act as the independent system operator, to operate the National Interconnected Transmission System and to be the market administrator.

COMMERCIAL BANKS AND RELATED

There are three key commercial banks for captive power in Ghana and two to three that are known to potentially be interested (see Table 27).

Table 27: Key commercial banks and related institutions

INSTITUTION	RELEVANCE
Access Bank (Ghana) Plc	No significant experience to date. Has interest in captive power.
CalBank Ghana Limited	Has previously undertaken the funding of a few renewable energy projects, such as SunPower Solar and the Ghana University Biogas project, Currently reviews renewable energy projects for lending. Has a $20 million renewable energy facility approved by AFD and $12.5 million from the International Finance Corporation.
Ecobank Bank Ghana Limited	Has a history of activity in the climate change and renewable energy space and was also recently approved as a Direct Access Entity of the Green Climate Fund, which will enhance the bank's efforts for funding projects in the renewable energy space.
Fidelity Bank Ghana Limited	Active bank in supporting renewable energy financing to be implemented in 2020. Fidelity Bank has a multi-banking sector team assessing renewable energy opportunities, including personnel from credit risk, environmental and sustainability risk, relationship management (commercial lending) and product development.
Ghana Home Loans	No significant experience to date. Has interest in captive power.
Republic Bank Limited	No significant experience to date. Has interest in captive power.
Stanbic Bank Ghana Limited	Active bank in solar PV lending. Three branches have had solar PV installed, and there is a rollout plan for more branches to receive solar PV systems.

FINANCIERS

Financiers of relevance include Berkeley Energy, CrossBoundary Energy, DSE Group, Dutch & Co, REDAVIA, Translight and Yingli (see Table 24 in section 10.2.3).

CAPTIVE PV PROJECT DEVELOPERS, ESCOS AND EPCS

There are a number of captive PV power project developers, ESCOs and EPCs. Some companies provide both ESCO and EPC / operations and maintenance services for outright purchase, while others are focused purely on EPC (see Table 28).

Table 28: Key solar PV captive power developers, ESCOs and EPCs

NAME	RELEVANCE
AB Solar Africa	A joint venture that has references from both partners, including DSE Group's experience in many installations ranging from small residential to large-scale industrial systems (over 2,800 solar installations), and Ibort System Engineering Services' huge experience in electrical installations in Ghana.
Association of Ghana Solar Industries (AGSI)	Is open for membership to solar industrial companies, other renewable businesses and individuals with the goal to seek a common front and to provide representation on the development of alternative energy sources in Ghana. Seeks to achieve this through consultations with the appropriate state agencies, donors and the private sector involved in policy formation and regulation.
CrossBoundary Energy	Apart from providing financing, CrossBoundary also acts as a project developer and ESCO.
Dutch & Co	Function as an EPC company and developer and also offers operations and maintenance services for its clients.
SunPower Innovations	Provides grid-connected, off-grid and hybrid PV solutions to residential, commercial and industrial customers in Ghana. Has installed a cumulative total capacity of 10 MWp PV systems in Ghana. Offers project financing to its clients through the lease-to-own model and has also registered a subsidiary to provide rental services. Has developed the largest hybrid solar PV installation at A&C mall in Ghana with a solar PV capacity of 1.3 MWp and a battery capacity of 1 MWh (A&C n.d.).
Tino Solutions	A leading renewable energy EPC and project management company specialized in the provision of turnkey and tailored solar PV power solutions. Known in the sale and distribution of renewable solar components such as inverters, panels, charge controllers, battery monitors, solar batteries, etc.
Wilkins Engineering	Offers qualitative turnkey services covering financial planning and coordination, overseeing permitting and government approvals and handling the design, materials and construction of the plant. Developed the financial model for grid-connected and stand-alone solar power projects, which help investors and interested businesses understand the financial risks and returns of the opportunity.

13.2/ GENDER BALANCE IN THE CLEAN CAPTIVE POWER SECTOR

The service sector engaged the largest number of persons, with over 80 per cent (2.7 million persons), followed by the industry sector with 18.2 per cent (614,517 persons) (GSS 2015b). There are mixed variations between both genders across sub-sectors in Ghana. For example, the trade and repair of vehicles and household goods sub-sector recorded the largest number of persons, with males accounting for a higher proportion than females (although the difference is insignificant). However, the hotels and restaurants sub-sector has more female employees, accounting for nearly two-thirds of the total number of persons engaged in this sub-sector. Table 29 presents the distribution of persons engaged in the sub-sectors with high clean captive power potential by sexes.

Table 29: Number of male and female employees per sub-sector

ORGANIZATION	Male		Female	
	Number	% of total male persons	Number	% of total female persons
Trade and repair of vehicles and household goods	479 816	23.5	338 032	25.1
Transportation and storage	57 493	2.8	17 777	1.3
Hotel and restaurant	76 139	3.7	114 426	8.5
Financial and insurance	74 993	3.7	46 666	3.5
Manufacturing	262 489	12.9	174 827	13
Mining and quarrying	32 310	1.6	10 266	0.8
Construction	69 430	3.4	18 442	1.4

Source: GSS 2015b

Furthermore, online research on potential captive solar PV financing firms was conducted to reveal indicative information on male and female representation at high-level positions, as presented in Table 30. A number of solar PV companies that are specialized in solar services, equipment and engineering are also included.

Table 30: Estimated number of male and female employees in selected captive power entities

ORGANIZATION	High-level staff (Managerial positions and up)	
	Male	Female
Africano Electro	2	2
Azuri Group	6	1
Berkeley Energy	6	1
Black Star Energy (subsidiary of Energicity Corp)	6	0
Blue Power Energy	2	1
CalBank	>20	9
CrossBoundary Energy	18	15
DSE Group	-	-
Dutch & Co	-	-
Eco Bank	9	3
Fidelity Bank	8	3
NorthLite Solar	1	1
REDAVIA Solar Power	6	2
Solar Light	3	2
Tino Solutions	5	0
Translight	3	1
Volta Power Co	4	2
Wilkins Engineering	3	3
Yingli	7	0

Source: Author compilation

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CLEAN CAPTIVE INSTALLATIONS FOR INDUSTRIAL CLIENTS IN SUB-SAHARA AFRICA

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visit the project website
www.captiverenewables-africa.org

ABOUT UN ENVIRONMENT PROGRAMME

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