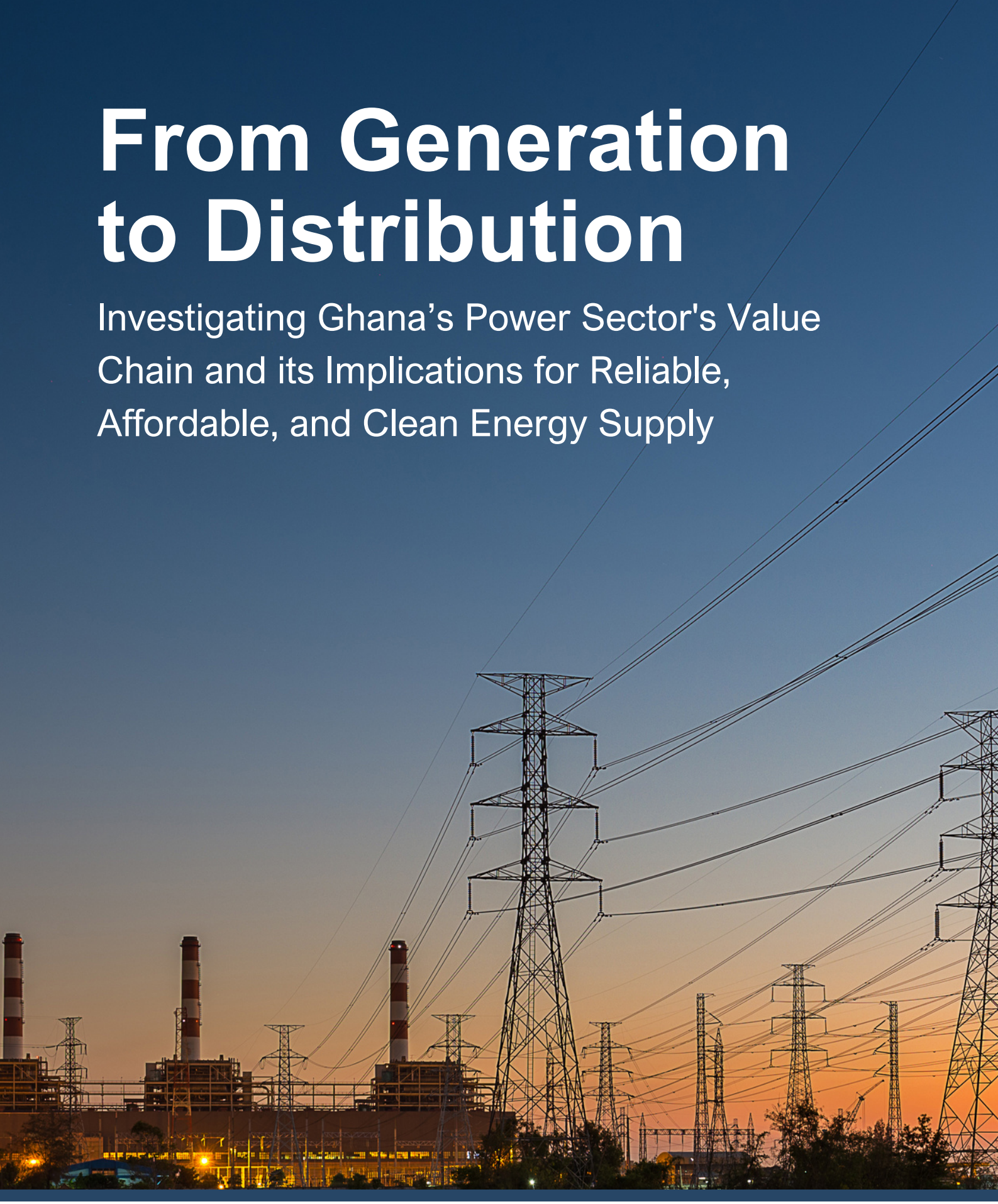
From Generation to Distribution

Investigating Ghana's Power Sector's Value Chain and its Implications for Reliable, Affordable, and Clean Energy Supply



ACEP Africa Centre for Energy Policy

OXFAM

SEPTEMBER 2023

From Generation to Distribution:

Investigating Ghana's Power Sector's Value Chain and its Implications for Reliable, Affordable, and Clean Energy Supply

ACEP Africa Centre for Energy Policy

OXFAM

About ACEP

The Africa Centre for Energy Policy (ACEP) was established in 2010 to contribute to development of alternative and innovative policy interventions through high quality research, analysis and advocacy in the energy and extractives sector in Africa. The focus of the organisation is to create strong connection between research evidence and advocacy which was limited at the time to increase transparency and accountability around energy and extractive sector governance in the region. After over a decade of existence, the organisation has established itself as a thought leader in the sector.

Citation: Africa Centre for Energy Policy (2023), From Generation to Distribution: Investigating Ghana’s power sector's value chain and its Implications for Reliable, affordable, and clean Energy Supply. Accra.

Acknowledgement

ACEP extends its heartfelt appreciation to Oxfam in Ghana for funding this study. We extend our sincere appreciation to the key contributors of the study, Benjamin Boakye, Dr. Charles Gyamfi Ofori, Betty Dufie Owusu, and Eliasu Ali, whose expertise and dedication were instrumental in bringing this report to life.

We earnestly anticipate that the findings presented herein will serve as a valuable contribution toward fostering a sustainable power sector in Ghana.

While this report represents our best efforts, the findings, interpretations, and conclusions do not necessarily align with the perspectives of Oxfam in Ghana, its members, or the governments they represent.

Table of Content

List of Tables

List of figures

Abbreviations

ACEP	Africa Centre for Energy Policy
BPA	Bui Power Authority
BPS	Bulk Supply Points
CAPEX	Capital Expenditure
CWM	Cash Waterfall Mechanism
DSC	Distribution Service Charge
DWC	Distribution Wheeling Charge
ECG	Electricity Company of Ghana
EDRL	Energy Debt Recovery Levy
EDSA	Energy Debt Service Account
EPC	Enclave Power Company
ESLA	Energy Sector Levies Act
ESRP	Energy Sector Recovery Plan
ESTF	Energy Sector Task Force
GNGC	Ghana National Gas Company
GNPC	Ghana National Petroleum Corporation
GPP	Gas Processing Plant
IPSMP	Integrated Power Systems Master Plan
KTPP	Kpone Thermal Power Plant
LC	Letters of Credit
LNG	Liquified Natural Gas
MCC	Millenium Challenge Corporation
MERALCO	Manila Electric Company
MW	Megawatts
NITS 2	National Interconnected Transmission System
PDS	Power Distribution Services
PGISA	Power Generation Infrastructure Support Subaccount
PIA	Project Implementation Agreement
PIAC	Public Interest Accountability Committee
PSP	Private Sector Participation
PURC	Public Utilities Regulatory Commission
SAPP	Sunon Asogli Power Plant
SGN	Sankofa Gye Nyame

TAPCO	Takoradi Power Company
TEN	Tweneboa Enyerra Ntomme
TICO	Takoradi International Company
TOR	Tema Oil Refinery
TSC	Transmission Service Charge
TTIP	Tema Thermal Plant 1
TT2P	Tema Thermal Plant 2
UN	United Nations
VRA	Volta River Authority
WACOG	Weighted Average Cost of Gas
WAGP	West Africa Gas Pipeline

Summary of Issues

- The power sector's role in economic growth is underscored by its function in providing stable electricity. The government manages a significant portion of the sector's interconnected transmission networks and oversees policy direction and regulation. Thus, its actions or inactions can change the trajectory of the power sector due to its multifaceted oversight responsibilities.

- The government has taken steps to address Ghana's power sector challenges. While these initiatives are promising, their execution has been problematic, highlighting the need for further effort and innovation to ensure a sustainable power sector in Ghana.

- Natural gas is an important fuel source for Ghana's thermal plants. However, the limited capacity of the existing gas processing facility hinders the country's ability to fully commercialise gas supply from the producing fields. Consequently, Ghana has flared large volumes of gas which could have been used for the power sector.

- The notion of excess generation capacity in Ghana's power sector has become a subject of political discourse. To accurately assess excess capacity, it is crucial to consider available generation capacity, peak demand, and reserve margin. Relying solely on the nominal difference may oversimplify the analysis. While there might be a nominal difference between total installed capacity and peak demand, the limitations of certain plants indicate that Ghana's power sector is not burdened by a disproportionate surplus of generation capacity.

- Efficient power transmission relies on a strong transmission network to bolster the reliability of the power supply. Unfortunately, revenue shortfalls exacerbate GRIDCo's challenges in making essential investments in crucial transmission infrastructure.

- The distribution sector generates revenue to meet the financial needs of entities within the power sector value chain. However, inefficiencies in the sector's governance have resulted in substantial under-recoveries, contributing to excessive debts and undermining the sustainability of the power sector.

- Despite substantial investments in power distribution infrastructure, technical and commercial losses in Ghana's power sector have risen from 24% to about 30% between 2014 and 2021. This occurrence underscores the urgent need for comprehensive reforms and improved management practices in power distribution.

- The government continues to make efforts to expand the national energy mix to include renewable energy technologies. The successful introduction and utilisation of renewable energy technologies would require creating an enabling environment for renewable energy companies to thrive.

Introduction

The power sector plays a critical role in promoting economic growth. A stable power supply is vital in supporting social services, powering industries, and boosting productivity. The United Nations (UN) demonstrates the importance of electricity access as it indicates universal access to clean, affordable, and reliable electricity as one of its Sustainable Development Goals. Given the power sector's significance, efficient management is essential to ensure access to affordable and reliable energy by households and businesses.

The government's role in Ghana's power sector spans the generation, transmission, and distribution aspects of the sector's value chain. The government owns about 56% of the installed generation capacity. It also manages the interconnected transmission system, a crucial link between power generation facilities and distribution networks. Again, the government's ownership of the two main distribution utilities allows it to have direct control over the last-mile delivery of electricity to consumers. It also plays a significant oversight role in policy direction and regulation of the power sector.

The Ministry of Energy is responsible for policy formulation, implementation, monitoring and evaluation, and supervision of energy sector agencies. The Ministry collaborates with regulatory bodies responsible for economic and technical regulation of the sector. The Public Utilities and Regulatory Commission (PURC) is responsible for approving rates by public utilities and monitoring performance standards of public utility services. The Energy Commission regulates the utilisation of energy resources in the country.

The diverse roles of the government in management, policy direction, and regulation of power sector activities make it an essential stakeholder in the sector's development. Therefore, its actions or inactions in the sector's governance (e.g., capacity planning, contracting, rate setting, and staff appointments) can shape the sector's trajectory and overall sustainability.[1]

Ghana's power sector has shown significant progress, particularly in energy generation and access. Electricity generation doubled from about 11,000 GWh in 2011 to about 23,000 GWh in 2022.[2] Similarly, households with electricity access increased from 64.2% in 2010 to about 88% in 2022. These achievements place Ghana among the countries

[1] Dye B. (2022). Policy brief and report on political economy of electricity in Ghana. Retrieved from: https://eprints.whiterose.ac.uk/192089/1/Electricity_Ghana_Policy_Brief.pdf
[2] Energy Commission. (2022). 2023 National Energy Statistical Bulletin. Accra.

with the highest electricity access rates in the West African sub-region. Such progress is commendable, as access to electricity is crucial to economic growth and productivity.

Despite these successes, the power sector faces persistent challenges, which include increasing and unsustainable debts, under-recoveries, and the country's inability to meet its clean energy targets. These challenges threaten power sector sustainability and jeopardise access to an affordable and reliable power supply. They also affect investments in other critical social sectors of the economy. For example, the government projects to spend about $97 billion on power sector shortfalls between 2023 and 2026, about twice the projected investments in capital infrastructure in agriculture, fisheries, education, gender, health, and roads. Addressing the governance challenges in the power sector can free up resources to allow investments in the social sectors, which remain grossly underfunded.

Table 1: Power sector shortfalls and investment in critical social sectors (2023-2026)

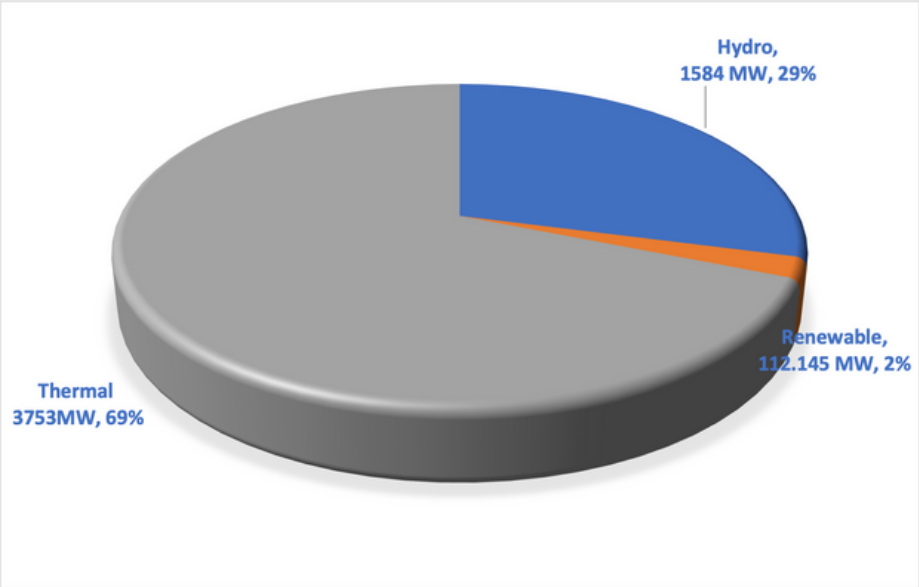
	2023	2024	2025	2026	
Power sector shortfall Social sectors	**23,652.60**	**22,935.17**	**24,942.00**	**26,088.76**	**97,618.53**
Agriculture	532.63	568.50	626.89	697.08	
Fisheries and aquaculture	31.48	33.02	36.54	41.28	
Roads	2,639.47	2,964.67	4,189.94	5,967.12	
Education (incl GETFund)	4,212.22	6,835.68	8,420.72	10,009.01	
Gender and social protection	1.08	0.86	1.02	1.46	
Health	134.50	144.13	158.81	175.94	
Total CAPEX	**7,551.38**	**10,546.87**	**13,433.92**	**16,891.90**	**48,424.06**
Capex % of shortfalls	32%	46%	54%	65%	50%
Multiplier	3.13	2.17	1.86	1.54	2.02

* All amounts are in GHS millions
Source: Extract from the 2023 budget statement of Ghana

Power Generation

Ghana's power generation sources include hydro, thermal, and other renewables. In 2022, the country's total installed capacity was about 5400MW, with a dependable capacity of about 4930MW. Thermal generation forms a significant portion of power generation, representing about 69% of the total installed capacity. Hydro forms about 29%, while renewable generation (solar and biogas) forms about 2% of installed capacity (see Figure 1).

Figure 1: Breakdown of Ghana's generation sources



Source: Energy Commission

Power generation in Ghana is a collaborative effort involving government agencies and Independent Power Producers (IPPs). The Volta River Authority (VRA) operates the Akosombo and Kpong hydro dams and thermal plants like the Takoradi Power Company (TAPCO), Takoradi International Company (TICO), Tema Thermal Plants (TTIP & TT2P), and the Kpone Thermal Power Plant (KTPP). Additionally, the Bui Power Authority (BPA) oversees the management of the Bui hydro dam. Notably, recent amendments to the Bui Power Authority Act have expanded the entity's responsibilities, empowering it to execute renewable energy and other clean energy projects on behalf of the country.[3] Independent power Producers (IPPs) contribute about 44% of the total installed generation capacity, accounting for around 80% of the installed thermal capacity.

[3] Government of Ghana (2020). Bui Power Authority (Amendment) Act, 2020.

Their involvement in power generation underscores their relevance and influence in meeting the country's energy needs.

Two significant issues emerge from Ghana's power generation subsector - critical decisions on fuel supply and issues surrounding excess generation capacity. The assessment of these issues is crucial for efficient power generation planning.

Decisions around natural gas in Ghana's power sector

Ghana's energy mix relies heavily on thermal power, accounting for about 69% of installed capacity. In 2022, about 63% of power was generated from thermal power plants. About 91% of thermal plants rely on natural gas as their fuel source. Ghana's domestic gas sources include associated gas from the Jubilee/TEN fields and non-associated gas from the Sankofa Gye Nyame field. These domestic fields provide about 85% of the country's gas need for power and non-power use. Ghana imports gas from Nigeria through the West African Gas Pipeline (WAGP) to supplement supply from its domestic sources.

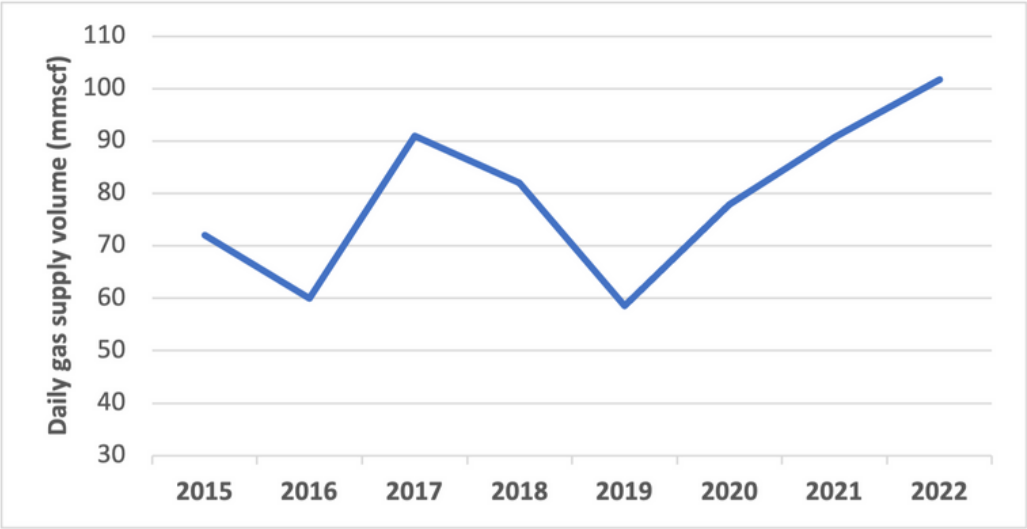
Given its affordability and lower CO_2 emissions potential compared to liquid fuels, natural gas will remain a crucial source of supply to meet Ghana's growing power demand. Consequently, the government's choice to optimise the gas supply becomes pivotal in mitigating the effects of costly fuels on electricity consumers.

Optimising domestic gas

Ghana planned to construct a Gas Processing Plant (GPP) by 2010 to offtake associated gas produced from the Jubilee field. The intention was to synchronise the development of the Jubilee Field with the GPP for gas commercialisation. However, financial constraints delayed the infrastructure and gas supply, a situation worsened by significant breaches in the West African Gas Pipeline (WAGP) which restricted gas supply from Nigeria. Therefore, the government was compelled to procure expensive liquid fuels, which increased the cost of power generation. Additionally, the unavailability of gas contributed to a severe power crisis, impacting productivity levels.

The GPP, with an operating capacity of 120mmscfd, was completed in 2014 and operationalised in 2015. Between 2015 and 2022, it supplied a daily average volume of about 79 mmscf. Within the period, the daily gas supply from the GPP increased from 72mmscf in 2015 to about 102 mmscf in 2022 (see Figure 2).

Figure 2: Average daily gas supply from the Atuabo Gas Processing Plant (2015-2022)

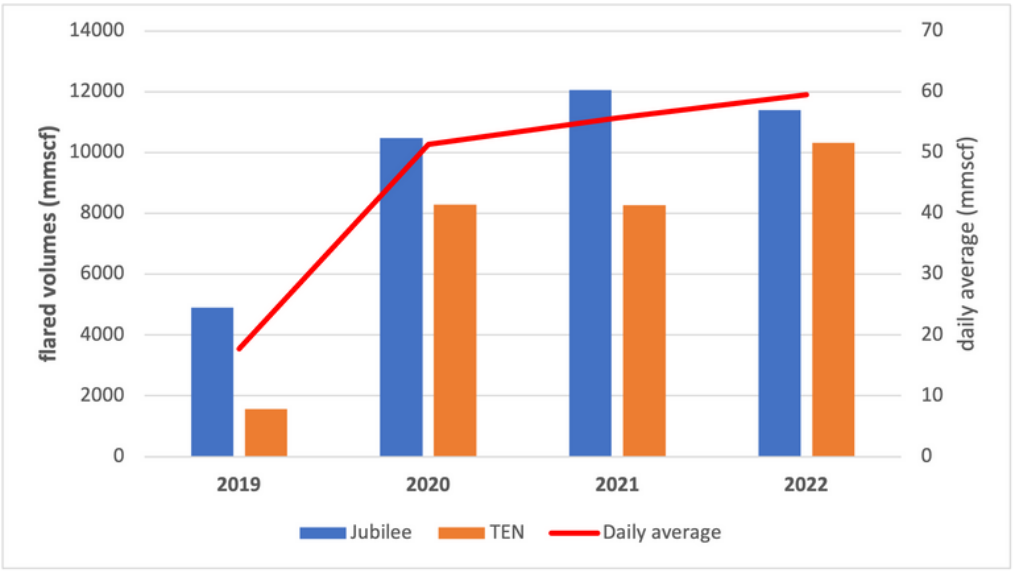


Source: Energy Commission

The government also planned a second phase of the processing infrastructure in anticipation of first oil from the TEN fields in 2016. However, the construction of the second phase has witnessed significant delays, resulting in gas from TEN fields being used to smoothen gas supply from the Jubilee fields.

The limited capacity of the GPP hinders the country's ability to fully commercialise gas from the Jubilee/TEN fields. As a result, the operators have flared large volumes of gas that could have been used to meet the country's power demand. Between 2019 and 2022, approximately 66.4 billion cubic feet (bcf) of gas were flared from the Jubilee and TEN fields. These flared volumes could have provided an average daily supply of about 51mmscf in 2019, increasing to 60mmscf by 2022 (see Figure 3).

Figure 3: Volumes of flared gas from Jubilee/TEN fields between 2019-2022



Source: Ministry of Finance; Public Interest Accountability Committee (PIAC)

According to recent news reports, the Ghana National Gas Company (GNGC) has entered into a Project Implementation Agreement (PIA) with its joint venture partners, including Integrated Logistics Bureau, Jonmorre International, Phoenix Park Limited, and African Finance Corporation, to construct the second phase of the processing facility, with an initial capacity of 150mmscfd, expandable to 300 mmscfd.[4] While these developments have the potential to enhance Ghana's efforts to commercialise its gas resources, it is evident that Ghana has missed opportunities for gas commercialisation through excessive gas flaring.

Ghana's plan on Liquified Natural Gas (LNG)

There was no domestic gas source to meet power demand prior to the construction of the GPP. The Energy Commission had forecasted that by 2015, the gas demand for thermal plants in the Western Region would range from 180mmscfd to 200mmscfd. The Commission, therefore, suggested that this demand could be met by constructing a 200-250 mmscfd LNG facility. Consequently, the Commission consistently advised the government to encourage investment in a regasification facility to supplement the gas supply from Nigeria.

> "*In this respect, Government should proactively create incentives to encourage investment in LNG regas facility built in the shortest possible time. An investment workshop for stakeholders where the government entities including Ghana Investment Promotion Centre and the Ministries of Energy and Finance can table the economic and investment incentives that the government could offer would be very essential.*" [5]

Unfortunately, the government did not heed the recommendations outlined by the Energy Commission. The government's indecision contributed to the country's long spell of power outages, resulting in productivity losses for households and businesses.

Ghana reaffirmed its dedication to acquiring LNG imports to enhance its short- to medium-term gas supply. Consequently, a long-term agreement was established with Shell to provide approximately 200 mmscfd of LNG. The government pointed to rising electricity demand and the inconsistent gas supply from Nigeria as the primary factors driving the decision to import LNG.

However, thorough assessments of the need for LNG, even by government agencies, have contradicted the government's position. For example, the Integrated Power Systems Master Plan (IPSMP) [6] strongly advises against long-term fixation on LNG supply. The master plan recommends that the government should focus on domestic

[4] Arthur-Mensah, G. (2023). Ghana Gas signed an agreement for a US$700 million second gas processing plant. Ghana News Agency. Available at https://gna.org.gh/2023/02/ghana-gas-signs-agreement-for-us700-million-second-gas-processing-plant/

[5] Energy Outlook for Ghana. (2011, 2012, and 2013)

[6] The IPSMP is a long term, least-regrets power sector resource plan which meets the future demand for power and fuel requirements.

gas resources and use LNG only to smoothen the domestic gas supply.

> *"…it is critical to recognise that LNG is simply a proxy for the need for additional gas supply beyond what has been assumed. In other words, additional gas supply from domestic resources can replace the LNG supply."*[7]

Price risks of LNG

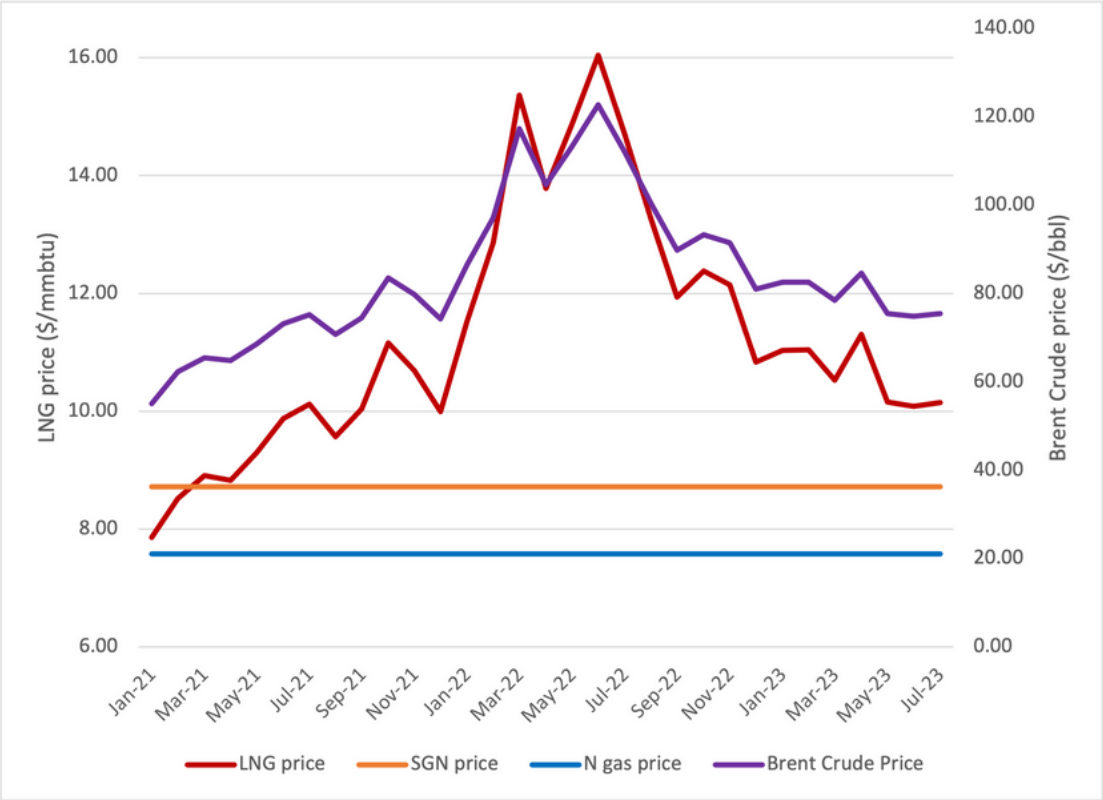
The power sector is the main off-taker for natural gas, highlighting gas's crucial role in electricity tariffs. Ghana's Weighted Average Cost of Gas (WACOG) includes various components such as commodity, gathering, processing, transmission, and service charges.

The commodity price accounts for about 75% of WACOG. Consequently, any changes in commodity costs substantially impact electricity tariffs. Therefore, Ghana needs a lower and more consistent gas price to maintain stable and affordable electricity tariffs.

The commodity prices of Ghana's existing gas suppliers are fixed and ensure certainty in electricity tariff estimation. However, the commodity price of LNG under the gas sales agreement between Ghana and Shell is linked to the price of Brent crude oil. This introduces significant uncertainties in the final price of LNG as it oscillates with changes in the price of crude oil. Figure 4 illustrates that LNG prices increase with rising crude oil prices, while imports from Nigeria and gas from Sankofa remain unaffected by changes in oil prices. Moreover, the figure also shows that the current crude oil prices will result in higher LNG prices compared to Ghana's existing gas supply sources.

[7] Government of Ghana. (2019). Integrated Power System Master Plan. Volume 2.

Figure 4: LNG prices compared with Sankofa and imports from Nigeria



Source: Author's construct

The government identified the aluminium, steel, and fertiliser industries as potential off-takers of LNG. However, its own prior assessment of these markets identified several challenges, such as the sensitivity of these investments to commodity prices, high capital expenditure requirements, and the relatively lower scale of demand in the Ghanaian market.[8] These factors introduce significant investment risks for these industries.

Additionally, ACEP's economic assessment of the integrated aluminium industry showed that the growing efforts of recyclable aluminium and the cost of retrofitting Ghana's existing smelter provide additional risks to the development of the aluminium industry.[9] Therefore, committing to a long-term gas supply, which carries significant price risks, for these investments that already face volatility in commodity prices would further expose Ghana to substantial costs.

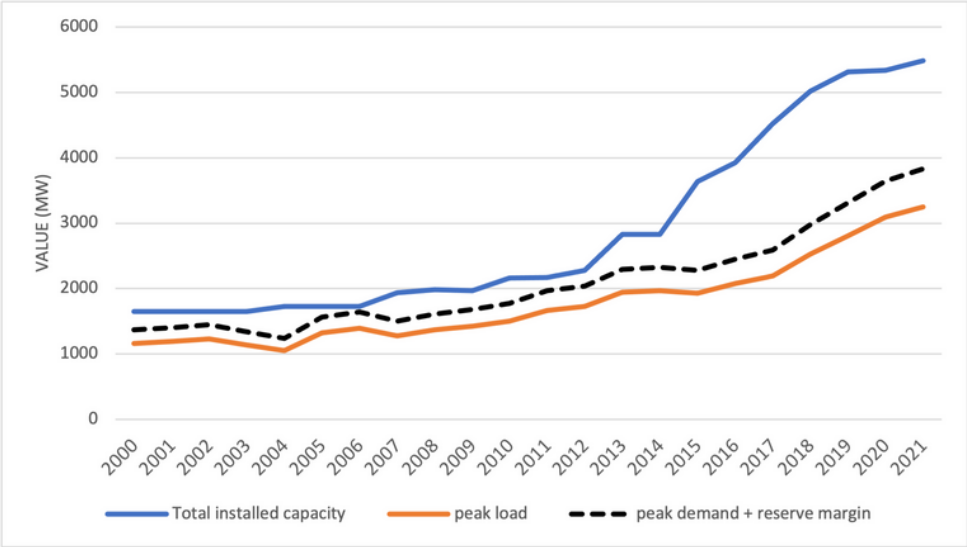
Fortunately, Ghana has been spared from the liability due to ongoing project delays and, more recently, a shift in the supplier's focus towards the high gas demand from Europe. Subsequently, the Energy Commission's 2023 energy outlook highlights that the government has postponed LNG supplies in 2023. Ghana needs to focus on optimising its domestic sources of natural gas while utilising LNG to smoothen the domestic gas supply.

[8] Government of Ghana. (2016). Gas Master Plan.
[9] Boakye, B., Ofori, C. G. (2019). Evaluation of the proposed Integrated Aluminium Industry and the $2 billion Chinese barter deal. Africa Centre for Energy Policy.

Excess generation capacity in Ghana

Ghana's installed capacity has risen from 2170MW to about 5400MW between 2011 and 2022, with an annual growth rate of about 15%. However, the peak demand growth rate did not follow a similar pattern over time as it grew at an annual rate of 9%. This has widened the gap between installed capacity and peak demand (see Figure 5).

Figure 5: Gaps between generation capacity and peak load in Ghana



Source: Authors' construct with data from Energy Commission

The widening gap between installed capacity and peak demand suggests the presence of excess generation capacity, which has become a subject of political contention. In 2021, the Ministry of Finance informed the Parliament of Ghana that the government had paid about $937.5 million to three IPPs for excess capacity charges over four years.[10] The Vice President also disclosed that between 2018 and 2021, excess capacity payments totalled around GHS 17 billion.[11] The government has even separated Ghana's debt into categories with and without energy sector debts, arguing that the excess capacity liabilities primarily contribute to the overall debt.[12] However, the government has not been able to provide details to explain whether payments under the power purchase agreements are for capital recovery or power generation. While these debates continue, assessing whether Ghana has excess capacity is crucial.

[10] Agyeman N. K. (2021). Govt pays $937.5m to 3 IPPs for 4 years' excess capacity charge. Graphic online. Available at https://www.graphic.com.gh/news/general-news/govt-pays-937-5m-to-3-ipps-for-4-years-excess-capacity-charge.html

[11] Bawumia, M. (2020). The state of the economy. Speech delivered at the National Tescon Conference. Ghana. Available at https://citinewsroom.com/wp-content/uploads/2022/04/here.pdf

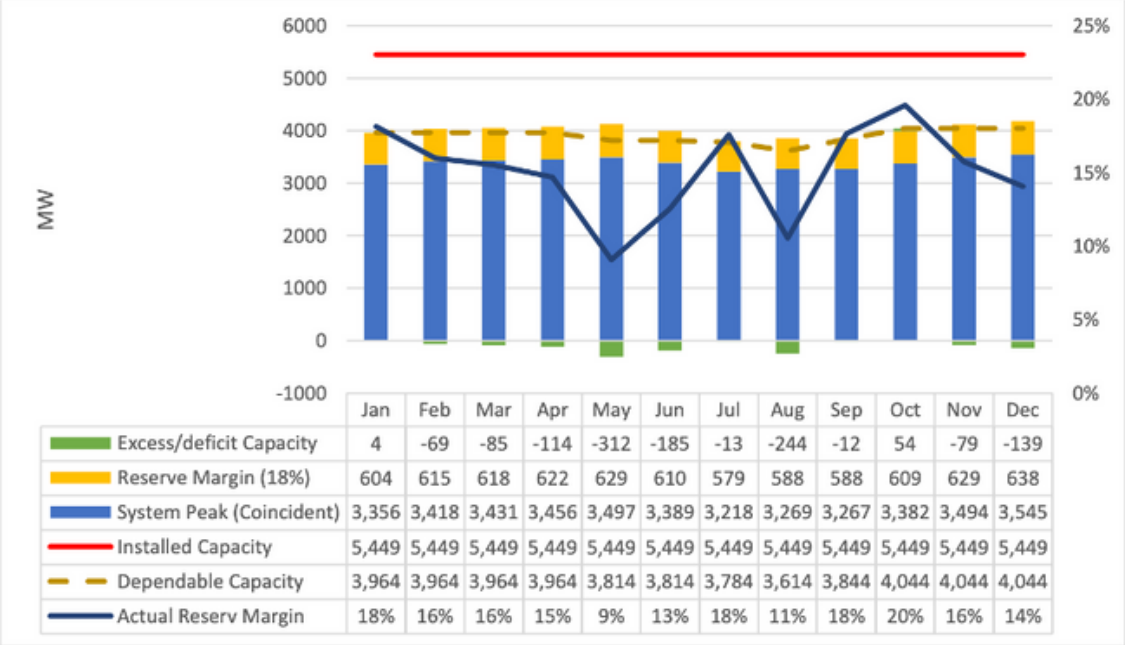
[12] Annual debt reports (2018-2021) by the Ministry of Finance

Does Ghana have excess capacity

Assessing the differences between installed capacity and peak load (including reserve margin) gives a sense of substantial excess generation capacities. However, the excess capacity cannot be viewed only in understanding these nominal differences. The difference between available capacity and peak demand with reserve margin is more appropriate in determining excess capacity. Available capacity is a function of the plant's dependable capacity, availability, and fuel supply.

Considering these factors, the Energy Commission's estimates contradict the prevailing opinion regarding excess capacity (see Figure 6). The Commission's projections for 2022 show that excess capacity occurs only in January (4MW) and October (54MW). The Commission foresees a deficit capacity ranging from 12MW to 312MW for the remaining ten months.

Figure 6: Energy Commission's projected monthly available capacity and system peak load for 2022



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Excess/deficit Capacity	4	-69	-85	-114	-312	-185	-13	-244	-12	54	-79	-139
Reserve Margin (18%)	604	615	618	622	629	610	579	588	588	609	629	638
System Peak (Coincident)	3,356	3,418	3,431	3,456	3,497	3,389	3,218	3,269	3,267	3,382	3,494	3,545
Installed Capacity	5,449	5,449	5,449	5,449	5,449	5,449	5,449	5,449	5,449	5,449	5,449	5,449
Dependable Capacity	3,964	3,964	3,964	3,964	3,814	3,814	3,784	3,614	3,844	4,044	4,044	4,044
Actual Reserv Margin	18%	16%	16%	15%	9%	13%	18%	11%	18%	20%	16%	14%

Source: 2022 Energy Outlook (Energy Commission)

Power plants undergo regular maintenance to address occasional wear and tear and prolong their operational lifespan. During these maintenance periods, the plants are temporarily shut down, rendering them unable to generate electricity even when there is a power demand. While newer and more efficient power plants tend to be more reliable, older and less efficient plants experience more frequent shutdowns, making them less dependable. Additionally, the available capacities of power plants vary due to factors such as fuel supply and operational efficiency.

Table 1 below shows the list of plants and their peak loads between 2021 and 2022. Plants like Ameri, Aksa, KTPP, TTIP, and TT2P have lower available capacities.[13] Generally, these plants may have outdated equipment or less advanced technologies, making them less efficient in power generation. Moreover, certain power plants like Aksa rely on liquid fuels, which are more expensive than natural gas. The combination of inefficiencies and reliance on liquid fuels contributes to the reduced available capacities observed in these power plants.

The nominal difference between installed capacity and peak load oversimplifies the determination of excess capacity. The lower available capacities for some power plants demonstrate that Ghana's power sector operates within its limitations and does not exhibit a disproportionate excess generation capacity.

Table 2: Available capacities of some power plants (2021 and 2022)

Plant	Installed capacity (MW)	2021		2022		Available capacity(2021 & 2022)
		Peak load (MW)	Available capacity	Peak load (MW)	Available capacity	
Akosombo	1020	833.24	82%	855.89	84%	83%
Aksa	370	133.85	33%	102.87	28%	31%
Ameri	250	97.70	7%	0.00	0%	4%
Bui	404	188.76	47%	278.22	69%	56%
Cenit	110	107.43	57%	108.00	76%	65%
Cenpower	360	229.58	58%	321.49	89%	72%
Karpower	470	379.74	81%	251.16	48%	67%
Kpong	160	134.47	84%	130.68	82%	83%
KTPP	220	101.40	19%	116.86	41%	29%
SAPP	560	389.81	70%	352.92	63%	67%
TAPCO	330	267.20	74%	330.96	100%	85%
Tico	340	261.17	77%	279.20	82%	79%
TT2PP	87	17.48	13%	20.78	13%	13%
TTIPP	110	106.83	49%	107.67	33%	42%
Twin City	203	182.22	67%	199.83	98%	81%

Source: Authors' calculations with data from the Energy Commission (Wholesale Electricity Market)

[13] Available capacity was determined by the taking the ratio of the plant's peak load to the installed capacity and expressed as a percentage $\left(Available\ capacity = \frac{Peak\ load}{Installed\ capacity} \times 100\%\right)$

Power Transmission

Ghana Grid Company (GridCo) operates the National Interconnected Transmission System (NITS), which comprises a network of transmission lines with various voltage levels, including 161kV, 69kV, 335kV, and 330kV. The total transmission circuit length as of 2022 was 7,200.5km. Additionally, the NITS consists of Bulk Supply Points (BPS), load transformers, capacitive compensation devices, and reactors. The NITS enables electricity transmission from generation sources to load centres nationwide for subsequent distribution to end users.

The transmission component of Ghana's power value chain is the crucial link between power generation and power distribution. Hence, disruptions in transmission networks substantially impact power distribution and access to electricity, irrespective of the amount of power generated. Transmission system failures have significantly contributed to nationwide power outages (Table 3). The relevance of the transmission subsector to power supply reliability demonstrates the need for substantial investment in strengthening transmission infrastructure.

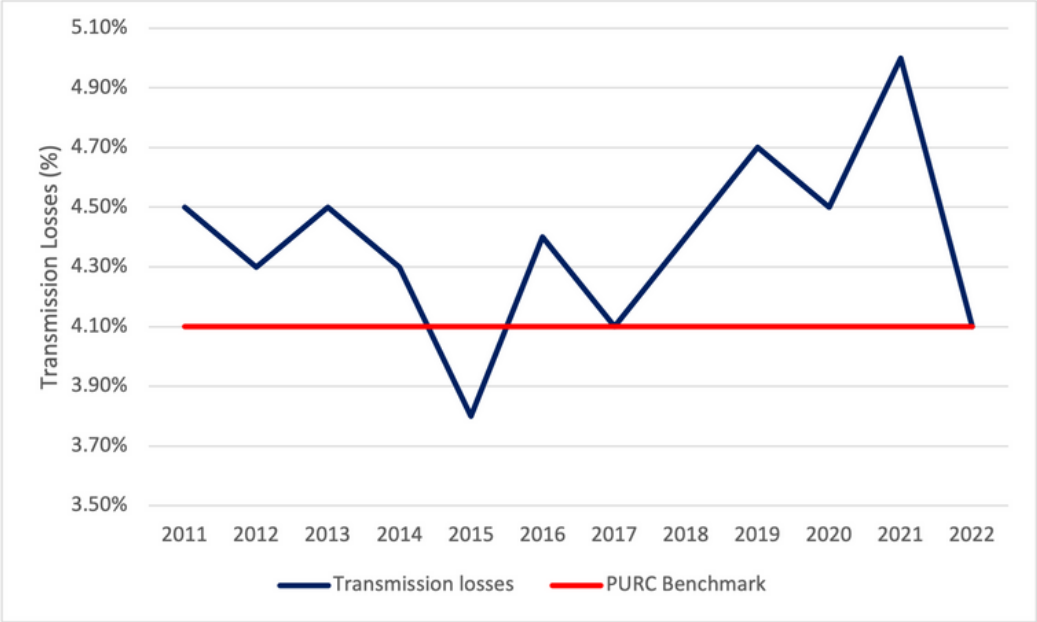
Table 3: Causes of major power outages in Ghana (2021-2023)

Date	Extent of outage	Cause
Feb 2021	Accra, Tema & Kumasi	Gas supply challenges
Mar 2021	Total power outage	Transmission system failure
Mar 2021	Accra East, Winneba, Techiman & Sunyani	Gas supply challenges
Apr 2021	Parts of Accra	Transmission system failure
Apr 2021	Parts of Ghana	Transmission system failure
Nov 2021	Parts of Ghana	Transmission system failure
May 2022	Parts of Ghana	Transmission system failure
Mar 2023	Parts of Ghana	GPP shutdown for maintenance
Jul 2023	Parts of Ghana	Gas supply challenges

Source: Gridco's press releases (2021-2023)

Congestion on critical transmission lines, transformer overloads, and lower network capacities in some areas constrain the performance of the NITS. These challenges affect system reliability and eventual power service delivery. They also contribute to transmission losses, increasing over the years. Between 2011 and 2022, GRIDCo's transmission losses exceeded the PURC benchmark of 4.1%. In 2022, transmission losses decreased to reflect PURC's 4.1% benchmark.

Figure 7: Trend of transmission losses (2011-2022)



Source: Authors' construct with data from Energy Commission

Revenue shortfalls also worsen GRIDCo's inability to invest in crucial transmission infrastructure that can reduce losses and enhance reliability. GRIDCo's primary revenue source is the Transmission Service Charge (TSC), which end users pay as part of electricity tariffs. The TSC is approved by PURC and is designed to meet the transmission company's annual revenue requirement. However, under-recoveries in the power sector contribute to gaps between programmed and actual revenues. For example, GRDICo received about 12% of its revenue requirement under the Cash Waterfall Mechanism (CWM)[14] for March and April 2023. Out of a total invoice of about GHS 186 million for the period, the transmission company was paid only GHS 23 million.

A robust transmission network is necessary for efficient power transmission to strengthen reliability in the power supply. Therefore, the government must invest in transmission infrastructure to strengthen the grid's capacity to recover quickly during major system disturbances.

[14] The CWM was implemented to allow for an equitable distribution of revenues to all players in the power sector value chain. More details of the mechanism are provided in Section 4.

Power Distribution in Ghana

Power distribution utilities interface directly with most of the electricity consumers. The Electricity Company of Ghana (ECG) and the Northern Energy Distribution Company (NEDCo) are responsible for power distribution within the southern and northern sectors. The Enclave Power Company is a private entity that also distributes power it purchases from VRA to some manufacturing companies in Accra.

The distribution sector plays a crucial role in generating revenue to meet the financial needs of various entities in the power sector, including the transmission company, power generators, and fuel suppliers. Consequently, any inefficiencies in power distribution and revenue collection can harm the sustainability of other entities upstream in the power sector.

ECG has the largest customer base and distributes a significant portion of Ghana's power generation to its customers in the southern belt. It is also the biggest purchaser of energy generated in the country. Between 2015 and 2021, ECG purchased about 90% of the average power generated during the period (see Table 4).

Table 4: Total energy purchases by distribution utilities in GWh (2015-2021)

Year	ECG	NEDCo	EPC	Total
2015	7,544	1,013	102	8,659
2016	9,316	1123	108	10,547
2017	9,783	1224	157	11,164
2018	10,901	1,318	161	12,380
2019	1,535	1,413	235	3,183
2020	12,706	1576	242	14,524
2021	14,222	1,764	232	16,218
2022	14,811	1,824	228	16,863

Source: 2022 Energy Statistics (Energy Commission)

ECG purchases enough volume of electricity, making them accountable for the financial sustainability of the power sector and other components of the value chain. Inefficiencies in the sector's governance have resulted in substantial under-recoveries, contributing to excessive debts in the power sector. For example, IPPs were owed about $ 1.7 billion as of May 2023. Similarly, gas supply payments from the Sankofa Gye Nyame (SGN) field are also in arrears of nearly $600 million – about $380 million for LC drawdowns and additional invoices of about $207 million as of May 2023. The government has undertaken several initiatives to address the critical sustainability challenges in power distribution. However, these interventions have not ensured the financial sustainability of the distribution sector. Without addressing the governance inefficiencies to facilitate the power distribution subsector's operations, attaining financial sustainability in the power sector would remain arduous.

The Cash Waterfall Mechanism

The Cash Waterfall Mechanism (CWM) was implemented to allow for the equitable distribution of revenues and to avert the practice of unfair distribution among players in the power sector. The government of Ghana established the Cash Waterfall Mechanism (CWM) to meet two key objectives:

- To ensure fairness in the distribution of tariff revenue among all parties along the power sector value chain – generation companies, fuel suppliers, ECG, transmission companies, and the Regulator.
- To ensure equitable allocation of gas revenue collected from all sources to all parties under the Natural Gas Clearinghouse, which includes GNPC, GNGC, VRA, and NGAS.

While the CWM can ensure fairness in revenue distribution, its success depends on the distribution sector's ability to generate sufficient revenue from power purchases. In 2021, the total cost of electricity generation billed to ECG was about GHS 6.4 billion. Additionally, gas consumed for the ECG market was about $523 million (about GHS 3.03 billion),[15] yielding a total bill of about GHS 9.43 billion. However, ECG's net revenues were GHS 5.26 billion, which is about 56% of the total invoices. Again, reports on the performance of the CWM showed that ECG could meet about 11.2% of its revenue requirements in March and April 2023.

Furthermore, ECG's willingness to adhere to the CWM comes into question if it allocated a disproportionate amount of revenue generated to itself while significantly underpaying other entities within the value chain. The company disbursed about GHS 256 million (about 59% of revenue) to itself when it was entitled to GHS 135 million (26.37% of revenues) under the CWM for March and April 2023.Whereas ECG met about 78% of its

[15] Average exchange rate of GHS 5.81 to the US dollar. Source: Bank of Ghana

revenue requirement, the other entities earned a maximum of 12% of their requirements. This disproportionate allocation undermines the objectives of the CWM and affects the revenue-generating potential and sustainability of other entities of the electricity value chain.

Table 5: Actual invoices and revenues disbursed under CWM (March and April 2023)

Stakeholders	Actual invoices	ECG's Payment under CWM	% of paid invoice
Generation	2,046.72	111.70	5.50%
Fuel supply	1,280.78	40.00	3.10%
Transmission	186.22	23.00	12.40%
Distribution	326.24	255.91	78.40%
Total	3,839.96	430.61	11.20%

Source: CWM mechanism

The establishment of the CWM was part of carrying out the Energy Sector Recovery Program (ESRP),[16] overseen by the Energy Sector Task Force (ESTF). However, it is interesting to observe that despite the presence of a highly influential task force, there was weak compliance with the terms of the CWM. The government has expressed its dedication to revising the CWM in the second phase of ESRP. The revamped CWM will operate with two tiers: handling direct payments to IPPs and managing payments to SOEs and fuel suppliers.

However, the effectiveness of the CWM's implementation doesn't significantly hinge on the number of tiers the government decides to incorporate. Instead, its success is contingent upon ECG's ability to minimise its under-recoveries and generate revenues that align with the energy procurement from power generators. Additionally, the Task Force must guarantee ECG's compliance with the disbursement criteria outlined in the mechanism. Any deviation from these conditions would undermine the fundamental purpose of the CWM, which is to ensure equitable revenue distribution among entities within the power sector.

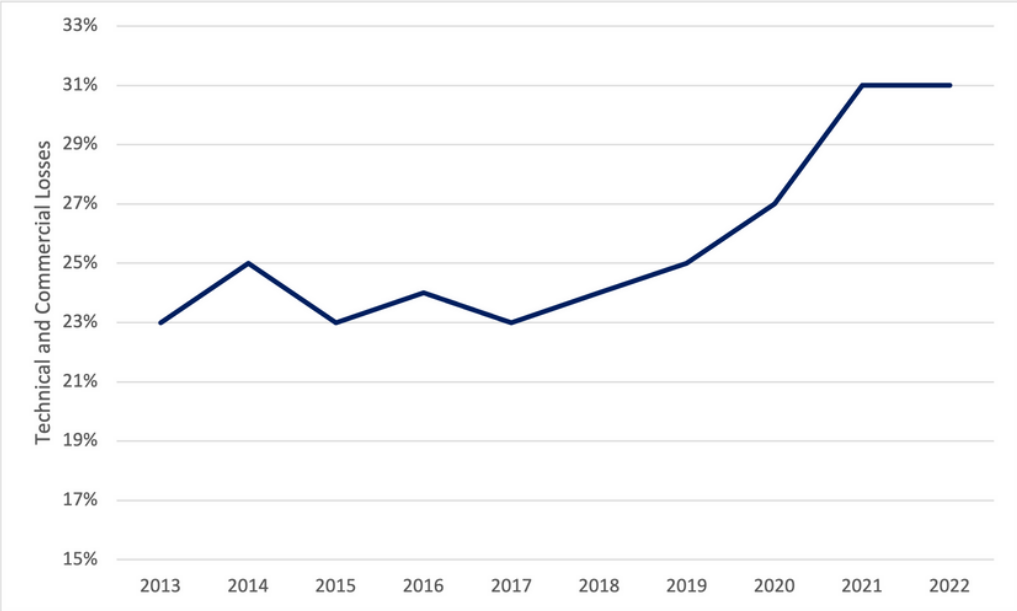
[16] The Energy Sector Recovery Program (ESRP) was rolled out in 2019 to provide a clear and comprehensive roadmap to restore the financial viability of the energy sector outlines its plan of implementation to generate and recover more revenues from end users for disbursement.

The trend of distribution losses

Distribution losses, made of technical and commercial losses, have been increasing despite the investments in power distribution. A comprehensive assessment of the power sector in 2014 recommended that an annual investment of about GHS 192 million over five years in ECG was enough to reduce its aggregate technical, commercial, and collection losses by 15 percentage points.[17] However, in the case of ECG, investments seem to correlate with the extent of losses. The company indicates it has invested about $690 million in distribution infrastructure between 2017 and 2021 (about $422 million in completed projects and $274 million in ongoing projects).[18]

Over the period from 2014 to 2022, technical and commercial losses in power distribution have increased from 24% to approximately 31%, as indicated in Figure 7. These losses do not include collection losses, which occur when the distribution utility cannot collect the full amount of tariffs owed by electricity consumers. The increasing trend in technical, commercial, and collection losses, despite significant investments, shed light on the existing managerial challenges within ECG. These issues also underscore the pressing need for comprehensive reforms and improved management practices within the power distribution sector.

Figure 8: Technical and commercial losses by ECG from (2013-2022)



Source: Authors' construct with data from Energy Commission

[17] International Finance Corporation (2014). Due Diligence and Private Sector Participation Options Study in Ghana's Distribution Sector.
[18] Electricity Company of Ghana (2022). Proposal for electricity distribution and supply: Aggregate revenue requirement and tariff.

The Public Utilities Regulatory Commission (PURC) has incorporated provisions for distribution losses through the Distribution Service Charge (DSC2). The DSC2 is a component of the Distribution Wheeling Charge (DWC), the rate paid by embedded bulk customers who procure electricity through distribution companies. The PURC has set an approved distributional loss rate of 21.4% for the Electricity Company of Ghana (ECG), which is factored into the tariff.

While electricity tariffs generally include a component that covers distributional losses, these losses must be within reasonable limits. Generally, price regulators in the power sector must ensure that utilities effectively address and mitigate losses. A possible approach to keeping utilities accountable is to lower the allowable losses, which can result in relatively lower tariffs.

ESLA, a silver bullet to power sector challenges?

The government of Ghana implemented the Energy Sector Levies Act (ESLA) to address the existing debts in the energy sector. One of the components of this act is the Energy Debt Recovery Levy (EDRL), which was intended to support debt recoveries and promote infrastructure development in the power sector. The EDRL receipts were directly allocated to the Energy Debt Service Account (EDSA) and the Power Generation Infrastructure Support Subaccount (PGISA). The EDSA was specifically established to address debts owed by the Tema Oil Refinery (TOR) and to cover foreign exchange under-recoveries in the downstream petroleum sector. On the other hand, the PGISA was designed to facilitate the payment of power sector debts, ensure the sustainability of the power sector, and support the development of power generation infrastructure.[19]

In 2017, the government of Ghana introduced ESLA PLC, a special-purpose vehicle, to issue long-term bonds (ESLA bonds). These bonds were utilised to settle the outstanding debts held by government agencies within the energy sector. The EDRL funds have been used to offset coupon payments on the issued ESLA bonds. From 2017 to 2022, ESLA PLC has received approximately GHS 9.65 billion, of which around GHS 7.25 billion has been used to cover coupon payments. Additionally, about GHS 218 million has been utilised for administrative and transaction costs. As of the end of 2022, approximately GHS 8.7 billion of the bonds remained outstanding.[20]

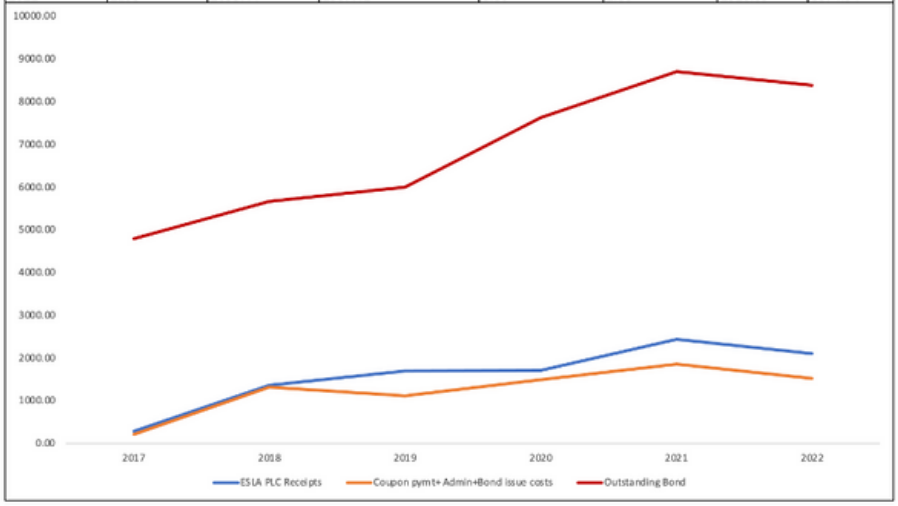
Considering coupon payments and EDRL receipts, about GHS 2 billion would be available to cover ESLA principal payments. This amount represents approximately 24% of the total outstanding bond value of GHS 8.3 billion. However, the government has included about GHS 3.6 billion ESLA bonds in its debt exchange program. This inclusion can free up additional funds and reduce the debt burden on ESLA bonds.

[19] Energy Sector Levies Act (2015), Act 899.
[20] ESLA PLC financial statements (2017-2022)

Nevertheless, it is worth noting that ESLA may not prioritise the amortisation of outstanding bond principals due to the ongoing challenges in the energy sector. Instead, there is a risk that EDRL receivables might be used to offset recurring debts, as has occurred in the past. Therefore, the most favourable course of action for the government is to ensure the efficiency of power sector institutions to mitigate the recurrence of debts. By enhancing the effectiveness of these institutions, the government can better address its ongoing financial obligations without solely relying on EDRL receivables.

Figure 9: ESLA receipts and payments

Year	EDRL Collections	ESLA PLC Receipts	Coupon payments	Admin costs	Bond issue costs	Coupon pymt+ Admin+Bond issue costs	Outstanding Bond
2017	1293	279.73	145.92	1.32	54.84	202.07	4783.97
2018	1472	1353.71	1243.13	6.77	65.59	1315.49	5664.72
2019	1713	1687.87	1086.26	6.20	11.07	1103.53	6000.00
2020	2040	1711.30	1462.52	6.76	18.67	1487.95	7629.52
2021	3046	2437.38	1812.52	9.47	27.54	1849.54	8700.59
2022	1153	2095.44	1507.42	8.86	1.80	1518.09	8374.54



Source: Authors' construct with data from ESLA PLC

Private sector participation in power distribution

Despite the government's efforts toward revenue generation, Ghana's increasing distribution sector challenges demonstrate governance inefficiencies in the sector's management. Private Sector Participation (PSP) was introduced in Ghana's power sector to improve efficiency while minimising the impact on the government's budget. This was to be operationalised under the Millennium Challenge Corporation (MCC) Power Compact.

The Millennium Development Authority (MiDA) led the process of transferring the management of ECG's assets to a private entity. Initially, over 60 companies expressed interest in acquiring ECG's assets, but only six were shortlisted by MiDA.The shareholding structure was subsequently changed to ensure majority Ghanaian ownership, leading to four companies withdrawing from bidding.

The winning consortium, Power Distribution Services Limited (PDS), comprised the Manila Electric Company (MERALCO), along with partners TG Energy Solutions Ghana, Anergia SA, Santa Baron Ventures, and GTS Engineering Ltd. PDS took over the management of ECG in 2019.

Unfortunately, the government suspended the concession with PDS just three months into the agreement. This was due to PDS's inability to secure the guarantees required to manage ECG's assets. The failure of the PDS deal can be attributed, at least in part, to a perceived lack of due diligence and transparency in the procurement process for selecting a qualified entity to manage ECG's assets.[21]

The failure of the PDS deal must be a lesson for the government in future PSP processes. The government must clarify its strategic priorities and balance the need for local content with the goal of an efficiently managed distribution system. Additionally, the selection process must be transparent and merit-based to guarantee the selection of qualified entities.

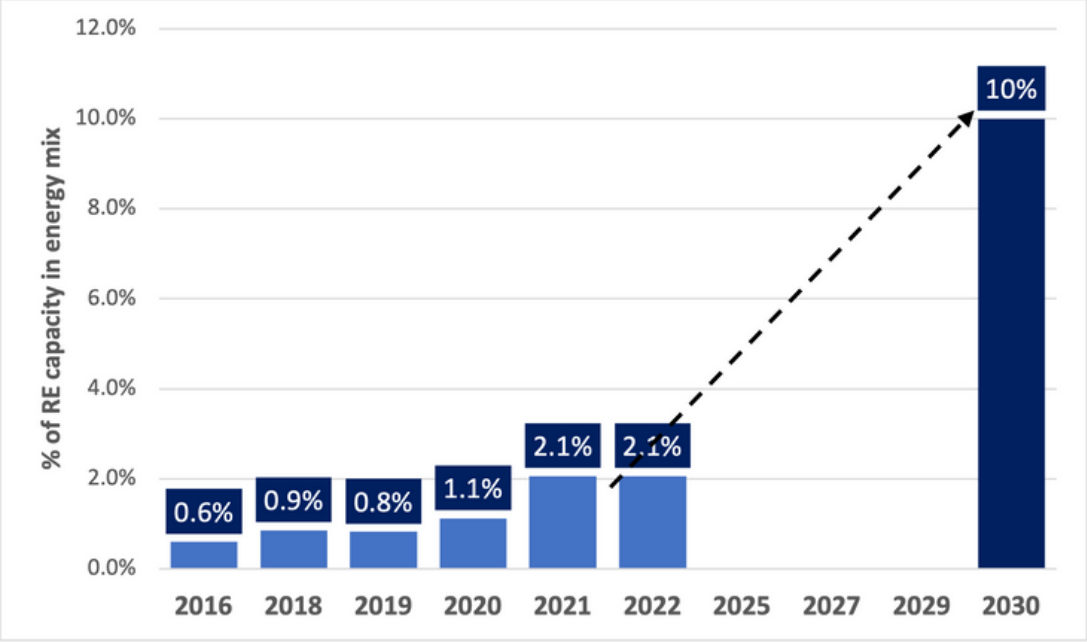
[21] Boakye B., Ofori, C. G., Zuanah, S. (2020). An assessment of the implementation challenges of the Power Compact. Available at https://storage.googleapis.com/stateless-acep-africa/2020/07/d4f305fb-an-assessment-of-the-implementation-challenges-of-the-power-contract.pdf

Ghana's Readiness for Renewable Energy Integration

Ghana has actively aligned itself with global commitments on climate action. In 2010, the Ministry of Energy set a target to increase the share of non-hydro renewable energy[22] in the national energy mix to 10% by 2020, which has been revised to 2030. As part of this commitment, the government has implemented various policies and strategies to attract investment and support renewable energy deployment in the country.

In 2016, the installed capacity of renewable energy in the energy mix was 22.6 MW. Between 2016 and 2022, renewable energy integration increased fourfold (from 22.6MW to 112MW). However, renewable energy still accounts for a relatively small portion of Ghana's overall energy mix, constituting around 2% by the end of 2022. The pace of renewable energy technologies growth in Ghana questions Ghana's ability to meet its 10% by 2030. To facilitate a more favourable investment climate for renewable energy, it is essential to identify and implement key policies that can positively impact investment generation in this sector. These policies should address regulatory barriers, provide incentives, and foster long-term stability.

Figure 10: Growth of renewable energy generation in Ghana's energy mix



Source: Authors' construct with data from Energy Commission

[22] Non-hydro renewable energy is used to refer to any renewable energy sources (e.g. solar, wind, biogas) which excludes hydroelectric sources with a capacity of more than 100MW. Without loss of generality, we use renewable energy throughout the text to represent non-hydro renewable energy sources.

Moratoriums on renewable energy generation

In 2017, the Energy Commission suspended issuing provisional licenses for large-scale grid-connected power plants, including renewable plants. The Commission adduced two reasons for their action: [23]

- The alarmingly insignificant proportion of inactive provisional licenses that had been issued. According to the Energy Commission, out of the estimated 124 issued since 2011, only three projects had been developed.
- Numerous Power Purchase Agreements signed by ECG create exposures to excess generation capacities.

In 2020, the government extended the suspension to include embedded generation and other off-grid, large-scale Commercial and Industrial (C&I) solar installations. The suspension was anchored on the dissatisfaction of distribution entities regarding the extent to which bulk customers were transitioning to off-grid solutions, thereby depriving them of their expected revenues. While the directive to suspend the issuance of licenses was in force, the government issued another directive to ECG to conduct an auction for 100MW utility-scale solar PV power capacity, indicating the government's policy inconsistency on renewable energy generation.

The various suspensions on renewable electricity generation and the subsequent policy inconsistency have implications for renewable energy development in Ghana. They hinder the growth of renewable energy generation, making it difficult for the government to meet its 10% target by 2030. The intermittent shifts in policy direction create an uncertain environment that impedes investors' ability to plan and execute long-term and large-scale renewable energy investments. Stakeholder interactions reveal that the regulatory environment has resulted in some investors withdrawing their investments from Ghana.

In April 2023, the government lifted the moratorium on issuing licenses for embedded generation. This means entities seeking to develop private renewable energy generation projects can apply for a wholesale electricity supply license. The Energy Commission has indicated that it is developing guidelines for Distributed Renewable Energy Generation to provide clear rules for all licensed entities operating within the industry. While suspending the moratorium is necessary, the government must ensure that the guidelines for distributed generation are not inimical to businesses and investment generation in renewables in Ghana.

[23] Energy Commission (n.d.) Suspension of Issuance of Provisional Wholesale Electricity Supply Licences. Available at https://www.energycom.gov.gh/public-notices/93-suspension-of-issuance-of-provisional-wholesale-electricity-supply-licences

Ghana's Net Metering Scheme

Net metering is a billing mechanism that allows electricity consumers to receive credit for the excess electricity they generate from their renewable energy systems by feeding it to the national grid. The Renewable Energy Act and its amendment establish a net metering scheme for electricity generated from renewable sources, clearly indicating that the scheme prioritises power cost reduction and climate change mitigation over income generation. Net metering is helpful to consumer-generators as well as it reduces their long-term cost of energy consumption.

In 2015, the Energy Commission developed a net metering code to facilitate the integration of renewable energy sources into the distribution network under the net metering scheme. Subsequently, the government undertook a pilot phase of the implementation. However, implementation challenges derailed the progress of the scheme. The consumers reported that they had not been credited with the power as assured, despite their continuous exports to the grid.[24]

A key challenge was the nature of the rate setting, which indicated that customers would obtain full credits for energy injected into the grid at the expense of the distribution utility. With these initial concerns, ECG demanded a revision of the existing rate to include service charges by proposing an additional 4% billing rate for commercial and domestic customers and 6% for industrial customers.[25] In addition, ECG was concerned that the 200kw capacity ceiling had the potential to narrow their already deficient revenue streams if more customer-generators became more independent of the distribution company. The issues on the rate-setting raised important questions regarding the extent of engagement of relevant stakeholders, such as ECG, in its development. That was particularly important because the distribution utilities are central to the success of the net metering scheme.

The progress on net metering had stalled since the introduction of the net metering code. However, in November 2022, PURC issued a revised rate-setting guideline that seeks to balance the interests of customer-generators and distribution companies.[26] The guideline has a formula incorporating reasonable service charges into the billing rate to cater to electricity distribution. In addition, there is an added provision for distribution companies to include future costs associated with the scheme in their tariff proposal for consideration by PURC. This adjustment enables the distribution companies and all other players in the value chain to recover associated costs while accommodating the growth of the renewable sector.

[24] Boamah, F., Williams, D. A., & Afful, J. (2021). Justifiable energy injustices? Exploring institutionalised corruption and electricity sector "problem-solving" in Ghana and Kenya. Energy Research & Social Science, *73*, 101914.
[25] Boamah, F. (2020). Desirable or debatable? Putting Africa's decentralised solar energy futures in context. Energy Research & Social Science, *62*, 101390.
[26] Public Utilities Regulatory Commission. (2022). Rate Setting Guidelines for Net Metering of Renewable Energy Generation Systems Connected to Distribution Networks in Ghana. Available at https://www.purc.com.gh/attachment/772548-20221128101136.pdf

Successful implementation of the net metering scheme holds promise for developing renewable energy in Ghana. Therefore, PURC must ensure transparency in the design of subsequent guidelines and regulations to balance the interests of the customer-generators and distribution companies.

Conclusion

Ghana possesses the potential for a sustainable power supply; however, achieving this requires deliberate reforms in the sector's governance to address fundamental challenges in power generation, transmission, and distribution. Policy distortions present a significant threat to a financially sustainable power sector, which encourages state intervention to address revenue shortfalls at the expense of other critical sectors of the economy.

Effective power planning is crucial for assessing fuel and generation capacities required to meet power demand. Therefore, the government must align its decisions on long-term gas imports with the option of optimising domestic gas resources. A long-term LNG supply introduces substantial costs and uncertainties in gas prices, which can affect electricity tariffs. In the context of generation capacities, the government must strategise to create demand for potential excess power generation. These strategies should consider more realistic and productive uses of electricity through industrialisation and the development of efficient business value chains that benefit both large-scale and small-scale enterprises.

An effective power sector not only relies on increasing generation capacities but also on strengthening the transmission and distribution components of the value chain. Power outages caused by disruptions in transmission lines affect a wider geographical area. This underscores the need for investments in robust transmission infrastructure capable of withstanding system overloads, thereby providing more reliable and stable electricity transmission.

Power outages are exacerbated by deficiencies in the transmission system, a persistent issue attributed to inadequate investment in the transmission sector. A primary cause of GRIDCo’s limited capacity to enhance transmission infrastructure and minimise losses is the significant shortfall in revenue. To address this matter, the government should intensify efforts to ensure the allocation of ample funds to the transmission sector, thereby enhancing its infrastructure and mitigating transmission losses.

The power distribution sector is a significant source of revenue generation in the power sector as it directly interfaces with stakeholders. However, escalating technical, commercial, and collection losses in the sector hinder the objective of a financially sustainable power sector. Regulating power distribution entities is crucial to ensure compliance with policies on revenue generation, loss reduction, and equity in energy distribution.Simultaneously, the government should consider the option of private sector participation, where competent entities are selected through a transparent process.

The government has made efforts to integrate renewable energy technologies into the power sector. However, renewable energy accounts for a relatively small portion of Ghana's energy mix. Various suspensions on renewable electricity generation and subsequent policy inconsistency negatively affect the sustenance of this energy source in Ghana’s energy mix. The government should enforce guidelines for integrating distributed renewable energy generation and intensify efforts to operate a transparent and inclusive net metering system.

The power sector is characterised by significant governance deficits and managerial challenges, which have hindered its ability to provide reliable and affordable electricity to its citizens. To ensure a more robust and efficient delivery of service among the sector’s value chain, the government should strengthen regulatory frameworks, build capacities of personnel within the sector and invest in infrastructural development, promoting the utilisation of renewable energy technologies.

Africa Centre for Energy Policy

26 Lemming St. || North Legon || GM-058-1968
P. O. Box CT 2121 || Cantonments || Accra
+233 (0) 302 900 730
info@acep.africa
acep.africa

ACEP is a thought leader in Africa's energy and extractives governance space, working towards improving economic transformation and inclusive sustainable development. We contribute to developing alternative and innovative policy interventions through high-quality research, analysis, and advocacy in Africa's energy and extractives sector.