The Implications of Changing Power Generation Mix on Energy Pricing and Security in Ghana

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4 August 2016

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Abstract: *Despite almost a decade of strong economic growth, Ghana still lags behind in its ability to generate enough power to catalyse this growth. The rapid deceleration in economic activity over the past three years has been primarily due to persistent energy supply constraints and rising energy-related input costs to production. This article analyses the implications of the changing power generation mix for electricity pricing in Ghana taking into account new capacity additions to the generation mix and tariff pricing structure. Based on the number of new power purchase agreements signed with IPPs, we find that thermal generation will continue to form the backbone of Ghana's energy mix in the medium term over the next five to ten years. But this also implies the need for cost-reflective tariffs in line with this new generation mix assuming import parity domestic gas prices are maintained.*

1 Introduction

Despite almost a decade of strong macroeconomic growth, Ghana still lags behind in its ability to generate enough power to catalyse this growth. The rapid deceleration in economic activity over the past three years has been primarily due to persistent energy supply constraints and rising energy-related input costs to production. The ripple effect of this on the economy has been damning as the load-shedding programme, locally referred to as *'dumsor'*, continues to severely impact industry profitability, liquidity, efficiency, productivity and costs particularly for those in the micro, small and medium enterprises (MSMEs) and industrial sectors such as mining, telecoms and manufacturing companies.

The Association of Ghana Industries (AGI), the umbrella body of industries, remarked in its Q1 2015 Business Barometer Report that several other companies and industries in the country may be forced to lay off thousands of workers if the energy crisis continues. The lack of power has increased likelihood of businesses closing and will have a serious impact on economic growth: lower domestic tax revenues and possibly weaken the cedi due to reduced foreign exchange earnings from exports.

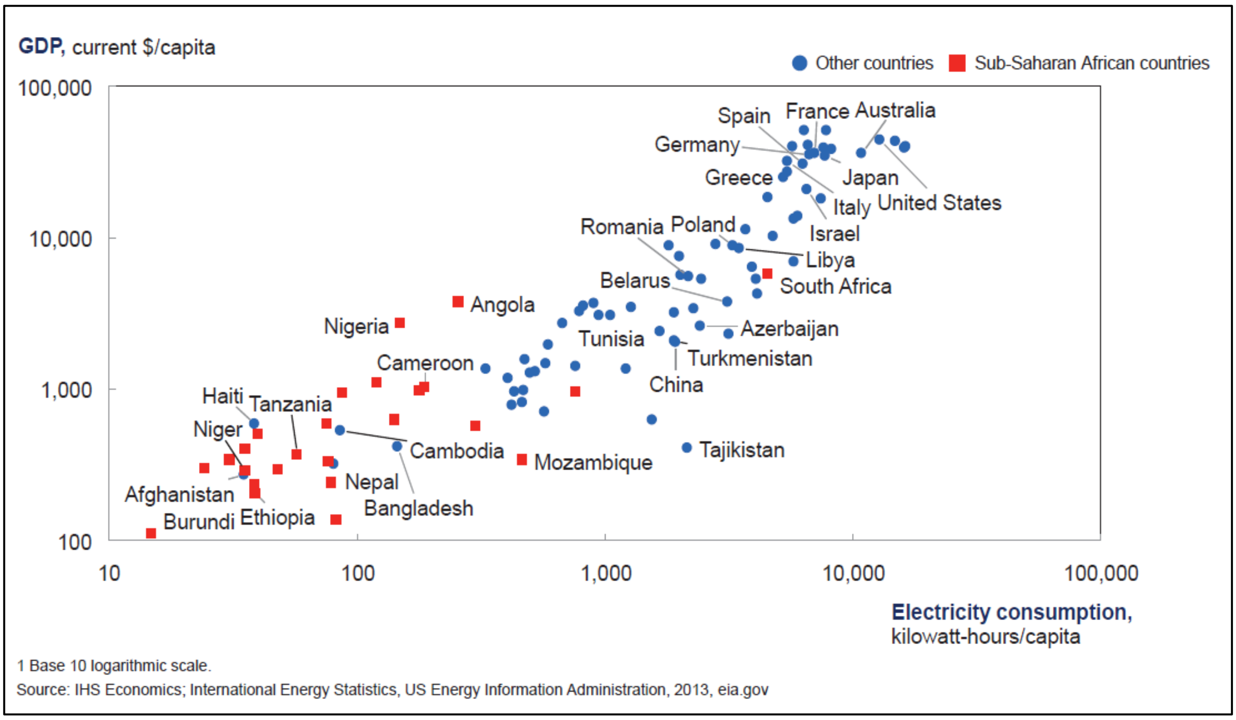
The Institute of Statistical, Social and Economic Research (ISSER) estimated that Ghana lost about 2% of GDP in 2014 due to the power crisis.[1] Ghana Grid Company (GRIDCo) also estimates that that Ghana loses between 2-6 percent of GDP annually due to insufficient wholesale power supply, not including a number of indirect costs.[2] It is also estimated that the average firm in sub-Saharan Africa (SSA) incurs outage costs of up to $1.25 per kWh of interrupted electricity, equivalent to $3,650 per kW or economic losses of up to 80 hours every month.[3]

Other predictable consequences of the power challenges include high unemployment and rising social costs such as increased crime rate, and the general despondency of populace resulting in anti-

[1] http://thebftonline.com/business/energy/13930/%E2%80%98Dumsor%E2%80%99-to-cost-economy-over-US$622m-ISSER.html
[2] http://www.gridcogh.com/media/photos/forms/rel-assessment/2010_GRIDCo_Reliability_Assessment_Report.pdf
[3] http://www.ecobank.com/upload/20140130120637783422UtM8wTMzbm.pdf

government unrests. From a competitiveness perspective, it could result Ghana's business environment becoming non-competitive within the West African sub-region and reduce the country's investment destination attractiveness especially as a manufacturing hub coupled with lack of access to credit, high utility prices and high levels of taxation amongst other factors. Many MSMEs often cite access to affordable credit and current fluctuations in supply of electricity as major constraints to business growth.

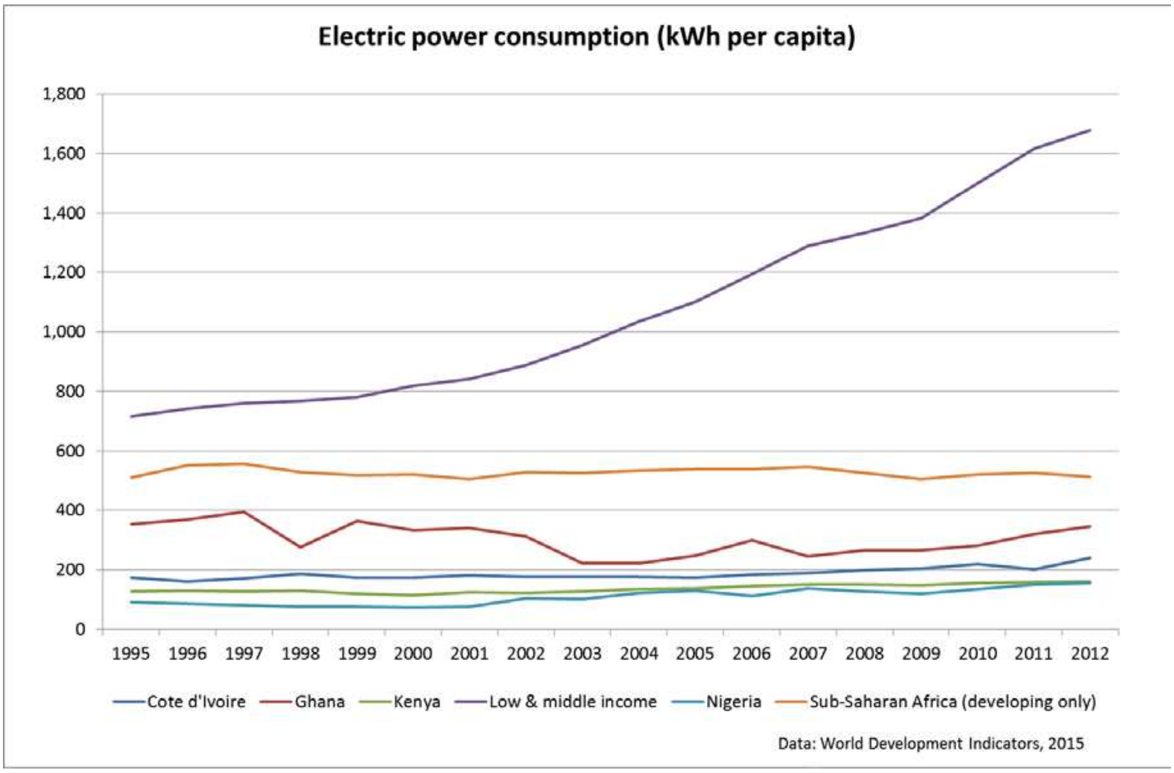
Figure 1 Relationship between electricity consumption and GDP



The Energy Commission estimates that Ghana's annual electricity consumption per capita since 2010 has been averagely below 400 kWh compared to the global minimum average of 500 kWh for lower middle-income developing countries highlighting the fact that there is still a significant electricity energy deficit to be cleared in order to catalyse inclusive growth and development. It is estimated that Ghana requires a minimum of 12,500 MW (500 Watts per capita) in order to industrialize.[4] It is estimated that there is a 10% year-on-year electricity demand growth driven by increasing domestic (15.4% y/y demand growth in 2013), non-residential (33% demand growth in 2013) and industrial demand (1.7% demand growth in 2013) (ACET, 2015)[5]. About 47% of the electricity produced in Ghana is consumed by industry with the remaining 17% being non-residential and 36% going to residential users.[6] At the highest point of the load-shedding in 2014, the nation was shedding between 500-800 MW of electricity daily out of total installed capacity of 3,100 MW due to supply side constraints — namely fuel supply shortages, financing challenges, derelict infrastructure and poor maintenance planning among others.

[4] http://www.mida.gov.gh/pages/view/GOVERNANCE_PRIVATE_SECTOR_and_REFORM_CP_Final_1_11_12.pdf/95
[5] http://includeplatform.net/wp-content/uploads/2015/03/GTF-Energy-in-Ghana-SR-formatted.compressed.pdf
[6] http://energycom.gov.gh/files/Energy%20Commission%20-%202015Energy%20Outlook%20for%20Ghana_final.pdf

Figure 2 Electricity Consumption in select SSA Countries

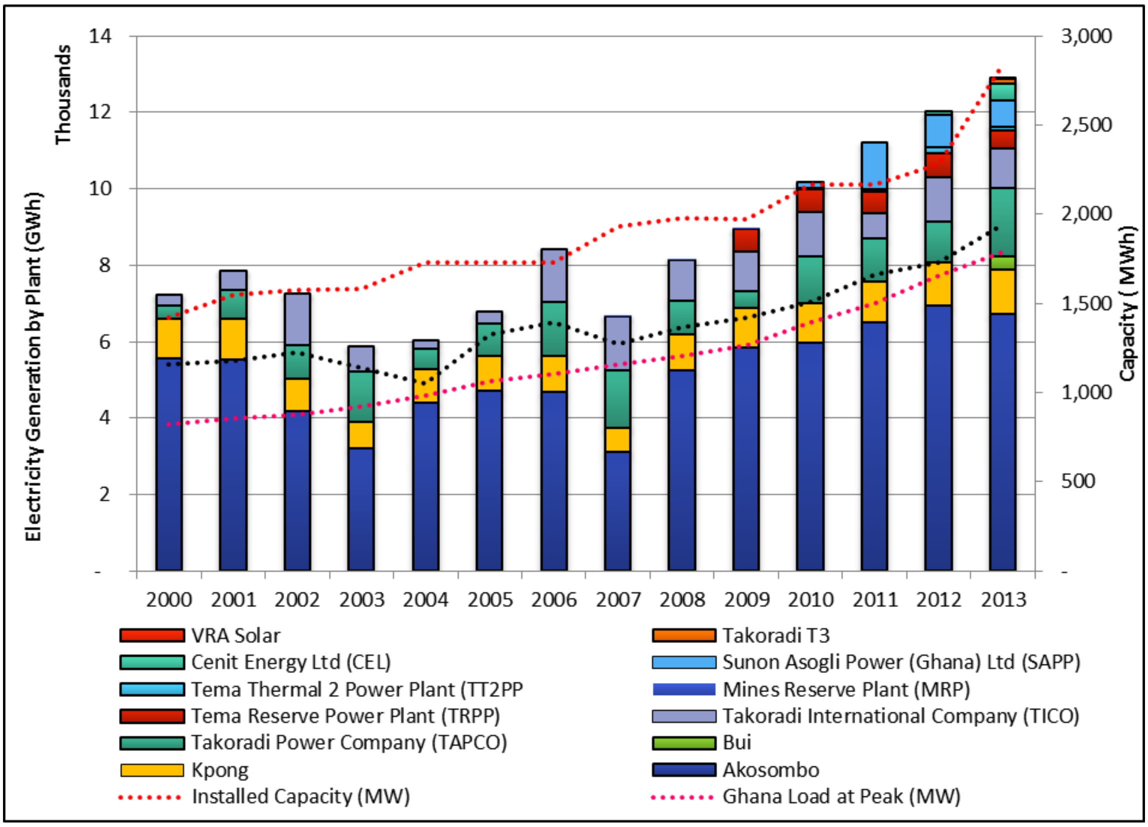


2 Power Generation Mix

Historically, Ghana has had the majority of its base load supply coming from the Akosombo hydroelectric dam and it was not until years of weak rainfall commencing in the mid-1980s forced a radical rethink of the nation's energy policy and security of supply concerns (Amin-Adam, 2014)[7]. Thus came the Power Sector Reform Programme (PSRP) which commenced in 1995 with an aim to rationalize Ghana's power sector by bringing competition and efficiency through expanding capacity for electricity generation by opening the market to private investment and deregulating part of the market, improving the efficiency of the sector through performance contracts, competition among power producers, and tariffs that reflect the cost structure (i.e. moving tariffs toward full cost recovery) (Keener and Banerjee, 2005).[8]

[7] http://www.aceplive.com/chronology-of-power-crisis-and-lessons-for-ending-the-current-crisis/
[8] http://siteresources.worldbank.org/INTPSIA/Resources/490023-1120841262639/ch8_ghana.pdf

Figure 3 Electricity Generation by Plant (GWh) per Installed Capacity: 2000-2013



Source: Ghana Growth and Development Platform, 2014.

It is estimated by the Energy Commission that installed generation capacity available for grid supply as at the end of December 2014 was about 2,831 MW though the generation was only 1,479 MW comprised of 65% percent hydroelectric generation (from Akosombo, Bui and Kpong) and 35% thermal generation from the dual-fuel natural gas, light cycle oil and diesel plants located within the Tema and Takoradi (Aboadzi) power enclaves.[9] A major reason for the disproportionately low share of thermal power generation in 2014 was fuel unavailability especially natural gas from the West African Gas Pipeline and maintenance upgrades which took capacity offline in addition poor plant uptimes.

The main challenges with regard to the low reliability of power in Ghana have been identified[10] as: (1) a complex governance and regulatory framework which does not meet all stakeholders needs; (2) Insufficient power supply to meet growing demand estimated at 10-15% per annum; (3) transmission capacity which is severely constrained from years of underinvestment and (4) a distribution system that is constrained, obsolete and inefficient with almost 25% of all power purchases lost through technical and commercial losses. In addition, underpinning these broad constraints in the power sector is the weak financial position of the utilities especially the Electricity Company of Ghana (ECG) and Northern Electricity Department (NED), responsible for distribution and the Volta River Authority (VRA), Ghana's single largest electricity generator, contributing 75% of Ghana's total generation – all state-owned monopolies.

[9] http://energycom.gov.gh/files/Energy%20Commission%20-%202015Energy%20Outlook%20for%20Ghana_final.pdf
[10] http://www.mida.gov.gh/pages/view/Introduction_and_Exec_Summary_Final_1_11_12.pdf

3 Boosting Output with New Capacity Additions

Ghana plans to address power crisis with more investments through privatisation and concessions. The government demonstrated some commitments to improve the power situation the short to medium term by promising to close to 3,800MW of new capacity in the next five years. At the core of this new generation capacity is a fundamental policy shift from to move from hydropower to thermal power as main source of electricity. In light of the power supply challenges, the government has ordered the following power contracts through independent power producers (IPPs) to mitigate the situation in: (1) Karpower Ship from Turkey (450MW); (2) AKSA Power from Turkey (370 MW); (3) APR/AMERI from UAE (250MW); and (4) General Electric (300MW). This is in addition to the following domestic expansion projects that are expected to be complete by close of the year: (1) the 220MW Kpone Thermal Power Project (KTPP); 180MW first half of Asogli 360MW Phase 2 Project and the VRA TT2PP (38 MW) expansion project. The status of these IPP projects under the so called emergency power agreement is:

i. 225MW Karpower Powership (Preparatory works in progress), which is an IPP project. First of two barges arrived in the country and expected to be commissioned late December 2015 or early January 2016.
ii. 250MW Ameri Project in Takoradi, which is a Build Own Operate and Transfer (B.O.O.T) arrangement with Government for 5 years after which the plant will be handed over to Government to run for the remaining 15 years of the plant’s lifespan. Civil works have commenced under this project.
iii. 370MW AKSA Project (Commercial Contract sent to Parliament), which is an Emergency Power Agreement (EPA) Project for 5 years with option to negotiate a further term with ECG. Agreement signed and approved by Parliament.
iv. 110MW TEI project (Commercial proposal submitted to Parliament), which is an Emergency Power Agreement (EPA) Project for 4 years with option to negotiate a further term with ECG; and
v. 300MW GE Early Power Project (Commercial Agreement under review), which is also an Emergency Power Agreement (EPA) Project.

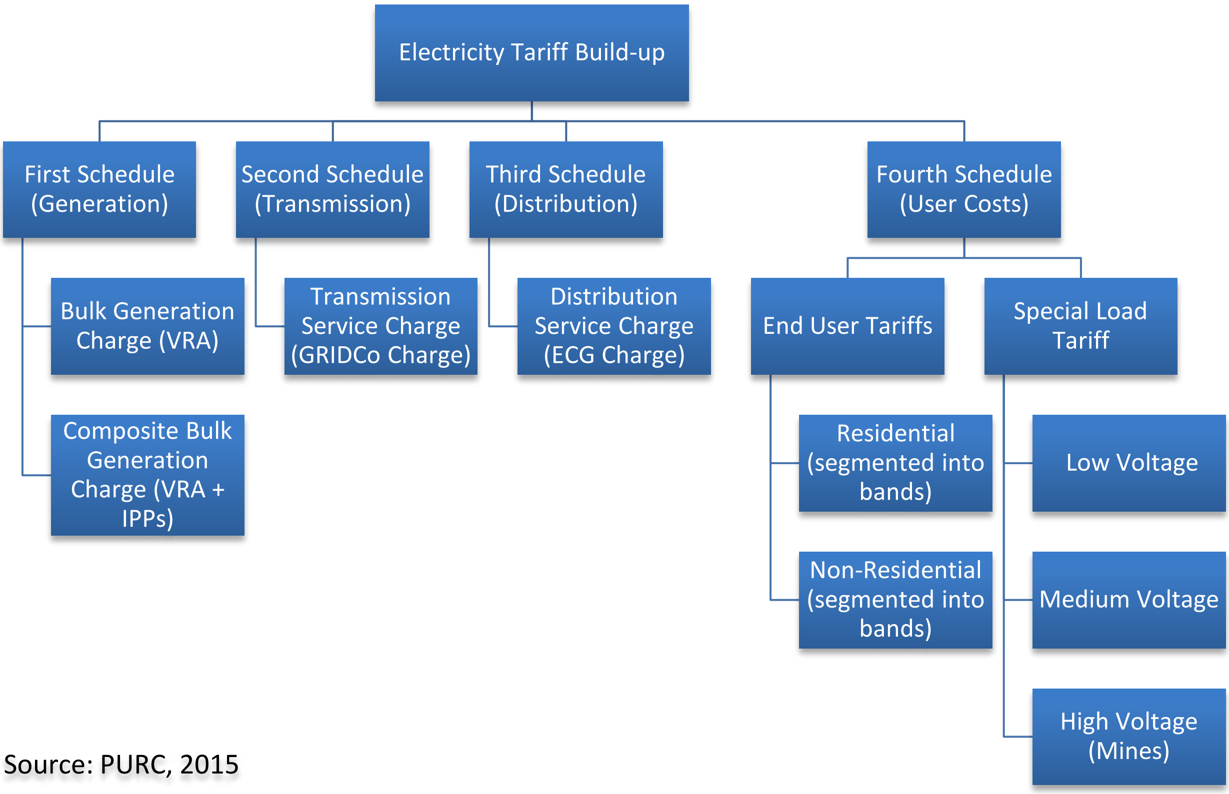
4 Power Economics: Tariff Structure and Ghana’s Energy Security

The change in the generation landscape from hydro towards thermal power generation has fundamental implications on how power is priced, and ultimately, end-user tariffs. The economics of power generation focuses on the generative capacity of typically an integrated natural monopoly where the installed plant type plays a critical factor in determining end-user tariffs. Supply normally comes from two plant types: Type 1 plants provides the base load to meet the minimum underlying demand that utilities must provide to consumers contingent on the daily demand schedule and Type 2 plants provide peak and/or mid-merit load. Type 1 plants have high fixed capital expenditure (CAPEX) and low marginal operational expenditures (OPEX) whereas Type 2 plants have lower fixed costs but higher marginal costs.

The majority of the new thermal generation capacity being procured by the government through the IPPs can be classified as Type 2 plants and though these typically also have high levels of safety and reliability, their generation costs are comparatively higher than Type 1 plants such as the Akosombo hydro plant. Typically, blended thermal generation costs about US¢15 per KWh[11] excluding transmission and distribution service charges. As per the PURC’s published rates of April 2015, the Composite Bulk Generation Charge at which the ECG shall procure power from producers (VRA and IPPs) is set at GHp24 (US¢6.9) per kWh.

[11] World Bank Ghana Energy Sector Report, pg 3 , June 2013

Figure 4 Ghana Electricity Tariff Components



Source: PURC, 2015

The estimated fuel costs for combined-cycle generation are US¢6.5/kilowatt-hour (kWh) for gas and US¢17/kWh for LCO. For simple-cycle generation, the estimated costs are US¢9.5/kWh for gas and US¢26/kWh for LCO. While LCO-based generation is expensive, it is still cheaper than generation from small, stand-alone diesel generators, where the fuel costs can reach US¢40/kWh. Solar Feed-in-Tariffs (FiT) are expected to cost about US¢20 per kWh; US¢11.18/kilowatt-hour (kWh) for small hydro projects with generation capacity less than 100MW and US¢12.55/kilowatt-hour (kWh) for wind generation [World Bank Ghana Energy Report, 2013]. Thus, it becomes evidently clear that consumers are only paying about 40% of the full cost of delivered power if net out transmission and distribution charges.

Corollary to this is that even with the current generation mix; power tariffs in Ghana do not in any way reflect the supply costs. Therefore, given that the current policy approach has been a gradual shift from legacy hydro – the subsidizing element - to thermal, one wonders why IPPs would want to set up in Ghana if they cannot be guaranteed full payment (including a return on investment plus asset depreciation) for the power they produce. Any wonder most of these IPPs are chasing Sovereign Guarantees and Letters of Comfort from the government?

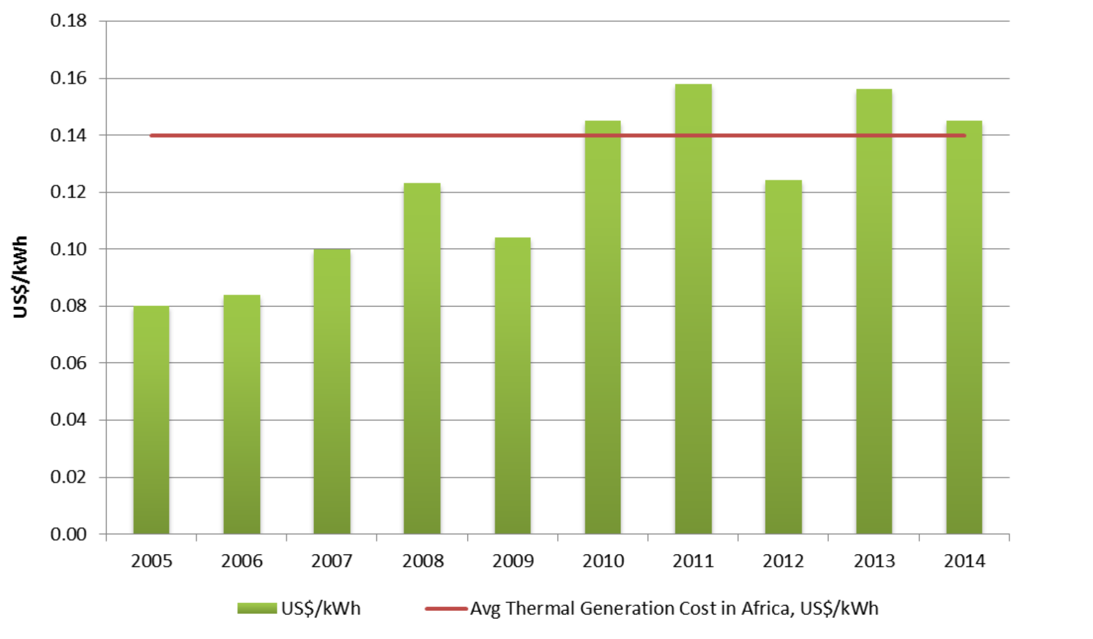
Table 1 PURC Published Tariffs

Schedule	Category	GHp/kWh	US¢/kWh
First Schedule	BGC VRA	14.6047	4.1728
	Composite BGC (VRA and IPPs)	23.7408	6.7831
Second Schedule	Transmission Service Charge	4.2958	1.2274
Third Schedule	Distribution Service Charge	16.4575	4.7021
Fourth Schedule	Residential		
	0-50	21.0795	6.0227
	51-300	42.2910	12.0831
	301-600	54.8855	15.6816
	601+	60.9839	17.4240
	Service Charge (GHp/Month)	397.7200	113.6343
	Non-Residential		
	0-300	60.7983	17.3709
	301-600	64.6949	18.4843
	601+	102.0817	29.1662
	Service Charge (GHp/Month)	662.8682	189.3909

Computed Metrics	GHp/kWh	US¢/kWh
Composite BGC	23.7408	6.7831
Composite BGC + TSC + DSC	44.4941	12.7126
Average Thermal Generation Cost*		14.0000
Average Residential Tariff	44.8100	12.8029
Average Non-Residential Tariff	75.8583	21.6738

Data: PURC, 2015
Exchange Rate US$1 = GHS3.5

Figure 5 Trend in Average Electricity End-User Tariffs



Data: PURC Ghana. Note end-user tariff includes transmission and distribution charges

The critical factor in the economics of thermal power generation, and their viability, is the cost of natural gas or LCO. The economics of these thermal power plants look particularly attractive if the cost of fuel, particularly natural gas is low. Though Ghana has discovered significant domestic associated and non-associated gas reserves from the Jubilee, TEN and the Sankofa-Gye Nyame offshore oilfields, it remains to be seen if government will allow power generators to purchase natural gas at comparatively prices (price discriminate) than supply from the WAGP. Given that the Ghana's Natural Gas Pricing Policy envisages that "all natural gas shall be sold by the aggregator at no less than import parity prices to all users" and "that the import parity price shall be determined by government on the advice of PURC"[12], one can immediately begin to see that affordable and locally available natural gas for power generation, though a viable policy proposition, is not likely to happen. The government notes that it expects the surplus revenue being accumulated to go into a Gas Rent Fund which would *inter alia* be used to resolve investment deficits in the power sector, cross-subsidise fertilser production and other strategic sectors.

Therefore, we are led to conclude that a fundamental change in the generation mix in favour of thermal power even in the presence of domestic gas availability, implies consumers having to pay relatively higher tariffs over the medium term as domestic associated gas is likely to sold at landed costs ranging from US$7-8 per MMBtu compared to US$2.5 per MMBtu actual costs. There is not that much economic justification for adopting import parity pricing for the associated offshore gas reserves and/or prioritising the fertiliser sector over other industrial sectors, instead of giving pre-eminence to power sector via lower gas tariffs that should ultimately reduce the cost of electricity to end users. Besides, this approach runs contrary to the other policy approach of promoting export-led industrialization with the country as the sub-regional manufacturing hub, of which availability of power is critical.

5 Policy Implications and Conclusions

It is evidently clear from the number of new power purchase agreements signed with IPPs that thermal generation will continue to form the backbone of Ghana's energy mix in the medium term over the next five to ten years. This implies the need for cost reflective tariffs in line with this new generation mix assuming import parity domestic gas prices are maintained. But historically, Ghana's tariff pricing regime has failed to incentivise power generating companies to make economic returns while ensuring investments in equipment upgrades in order to ensure energy security. For 2015, PURC approved a tariff rate of 14.6047 pesewas per kWh (US$0.04 per kWh) for electricity produced by the VRA and 23.7408 pesewas per kWh ($0.06 per kWh) for electricity produced by IPPs. The electricity generation tariff in Ghana is thus approximately US$0.09 below the average of $0.14 per kWh in Sub-Saharan Africa. The financial fragility of the power sector – in large part caused by low generation tariffs – has acutely compromised investments.

This inefficient market structure has created the situation where full operational costs including a capital recovery factor are not guaranteed in the tariffs set by the PURC. It is only in the past two years that the quarterly automatic tariff-adjustment formula introduced by the PURC in 2011, which incorporates fuel mix (crude oil, natural gas, distillate fuel), Ghana Cedi-US$ foreign exchange rate, the hydrothermal generation mix, and changes in the consumer price index, demand forecast and chemical cost has been allowed to be functional.

In conclusion, the current tariffs being paid do not reflect the full cost of power generated, and is even likely to be further exacerbated with more thermal generation capacity coming online over the next five years. On 2 November 2015, the Minister of Power said that Ghanaians needed to brace themselves to

[12] Sections 4.4.3 of the Natural Gas Pricing Policy.

pay more for power as the generation mix has fundamentally changed from hydro (generation costs of about US¢2-5 per KWh) towards thermal (generation costs of US¢15 per KWh).

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