Energy Policy 92 (2016) 92–101

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Gas-to-power market and investment incentive for enhancing generation capacity: An analysis of Ghana's electricity sector

Jorik Fritsch [a], Rahmatallah Poudineh [b,*,1]

[a] University of Oxford, Oxford, UK
[b] Oxford Institute for Energy Studies, Oxford, UK

HIGHLIGHTS

- We examine if domestic gas can improve the Ghanaian electricity sector performance.
- We compare domestic gas-to-power market utilisation versus gas export.
- It shows that gas-to-power market is more economical compared to gas export.
- Ineffective investment regime, skill shortage and inefficient tariffs are barriers.

ARTICLE INFO

Article history:
Received 20 August 2015
Received in revised form
15 January 2016
Accepted 25 January 2016

JEL classifications:
L97
L98
L50

Keywords:
Gas to power
Electricity in Ghana
Generation adequacy
Investment
Tariff setting

ABSTRACT

Ghana's electricity generation capacity is currently insufficient to meet demand, making power outages and load shedding common. The resulting impact is potentially devastating for the country's growth prospects. Traditionally, lack of an affordable and reliable fuel supply for power generation, coupled with ineffective institutions and an unfavourable investment climate, have resulted in Ghana's electricity sector performing poorly. In light of the 2007 discovery of natural gas reserves in Ghanaian waters, this paper examines whether domestic gas could advance the performance of the electricity sector, and if so, how. The results of our analysis show that utilization of gas reserves in Ghana's gas-to-power market is an economically superior strategy compared to an export-oriented utilization scheme. The lack of an effective regulatory framework for investment, skill shortages, and an inefficient electricity pricing structure continue to be the main constraining factors. Our analysis also considers possible approaches to modification of the electricity tariff in order to send the right signal to potential investors in generation capacity, without compromising the affordability of power supply.

1. Introduction

Suffering from high inflation rates, falling commodity prices, and massive unemployment, Ghana was at the brink of economic collapse at the start of the new millennium. Since then, however, the economic climate in Ghana has improved and the country has received frequent praise from international observers (IMF, 2013: 4; The Economist, 2013). Indeed, many have referred to Ghana as Africa's rising star (Lenhardt et al., 2015: 7; Brunts, 2008), thanks in no small measure to the country's stable multi-party democracy – by regional standards – and annual economic growth rates in excess of 6 per cent over the last decade. With the increase of economic activities and households' income, the demand for electricity in Ghana has surged too. Crucially, however, because Ghanaian generation capacity has not risen proportionally, electricity is presently in short supply. Since 2008, load shedding has

Abbreviations: AAF, Automatic Adjustment Formula; Bcf, Billion cubic feet; BOST, Bulk Oil Supply and Transport Company; CAPEX, Capital expenditures; ECG, Electricity Company of Ghana; ESSDP, Energy Sector Strategy and Development Plan; GDP, Gross Domestic Product; GRIDCo, Ghana Grid Company; IBT, Inclining block tariff; IOC, International oil and Gas Company; IPP, Independent power producer; kWh, kilowatt-hour; LCO, Light crude oil; LNG, Liquefied natural gas; MMBtu, Million British thermal units; MMscfd, Million standard cubic feet per day; NEDCo, Northern Electricity Distribution Company; NES, National Electrification Scheme; NGV, Natural gas vehicle; PPP, Public Private Partnership; PURC, Public Utilities Regulatory Commission; SME, Small and medium-sized enterprise; VALCO, Volta Aluminium Company; VRA, Volta River Authority; WAGP, West African Gas Pipeline

* Correspondence to: Oxford institute for Energy Studies, 57 Woodstock Road, Oxford OX2 6FA, United Kingdom.
E-mail address: rahmat.poudineh@oxfordenergy.org (R. Poudineh).

[1] The authors would like to thank Bassam Fattouh and Jonathan Stern and two anonymous referees for their invaluable comments on the earlier version of this paper.

http://dx.doi.org/10.1016/j.enpol.2016.01.034
0301-4215/

become an ordinary aspect of life for households and firms in Ghana. As the cost of compensating for poor electricity reliability through back-up diesel generators is immense, many of the small businesses have adjusted their opening hours in order to avoid the worst of the load shedding and power outages in their local area. Such adaptive measures significantly lower productivity. The lack of electricity therefore forms a serious barrier to further economic growth and development in Ghana.[2]

According to the World Bank, Ghana currently loses 1 per cent in economic growth per annum due to frequent power outages and systematic load shedding (World Bank, 2013: 76). Ghana Grid Company (GRIDCo) – the public company in charge of electricity transmission – goes further, estimating that the shortfall in electricity supply reduces economic growth by 2–6 per cent per annum (2010: 9). Either way, comparing these estimates to Ghana's average annual GDP growth of 6.5 per cent over the last 10 years makes it clear that a shortage of electricity is taking a substantial toll on economic growth in Ghana. On a microeconomic level, Ghanaian companies experienced additional operating costs of $62 m per month in 2014, due to power outages and load shedding (Boateng, 2014).

The 2007 discovery in Ghanaian waters of the Jubilee gas and oil field, which is estimated to hold 3 billion barrels of oil (bbl) and 335 billion cubic feet (Bcf) of natural gas, could have a significant impact on the Ghana's electricity sector. This paper discusses the resulting opportunities and challenges faced by the electricity sector and explores the possible approaches for enhancing generation adequacy. We examine how domestic gas could advance the performance of the electricity sector, and outline the economic principles upon which the regulatory model for investment and electricity tariffs need to be based in order to send the right signals to the potential investors in generation capacity.

The next section provides an overview of the electricity sector in Ghana, before Section 3 describes the discovery of natural gas in 2007 and its implications for the sector. Section 4 explores the economic value of gas-to-power and export utilization and also considers their institutional and political economy perspectives. Key challenges facing the electricity sector in its bid to enhance its reliability are explained in Section 5, before concluding remarks are set out in Section 6.

2. The state of Ghana's electricity sector

2.1. Power generation

Ghana's current total dependable installed capacity for electricity generation amounts to 2,125 MW (World Bank, 2013: 9), of which 51 per cent is hydroelectric, 48.9 per cent thermal, and 0.1 per cent renewable (see Table 1).

Despite the addition of approximately 1,000 MW of capacity through the construction of thermal plants since 1998 – before which the country exclusively relied on hydroelectric power generation – the installed capacity does not currently meet electricity demand in Ghana. According to World Bank projections, Ghana remains some 625 MW of capacity short of satisfying total electricity demand (World Bank, 2013: 10). Taking into consideration Ghana's economic growth trajectory and its expanding population, it is estimated that in 2020 the country will need a total installed capacity of 4,000 MW (World Bank, 2013: 9) – almost double the current total.

Table 1
Installed electricity generation capacity Ghana, 2013.Source: World Bank (2013)

Generation company	Installed capacity (MW)
Volta River Authority (VRA) Hydro	1,080
Volta River Authority (VRA) Thermal	771
Volta River Authority (VRA) Solar	3
Independent Power Producers (IPPs) Thermal	271

Given its geographic endowment, Ghana's hydroelectric generation potential is already largely exhausted, while the large-scale installation of renewable electricity generation types, such as solar and wind, is not feasible in a region which has such little experience with renewable energies. Therefore, efforts to catch up with Ghana's rising demand for electricity are focused on increasing thermal power generation. The state-owned Volta River Authority (VRA) – Ghana's main electric power utility corporation – is in the process of upgrading simple-cycle plants to combined-cycle plants (VRA, 2015). Together with greenfield thermal developments, the VRA is planning to add 1,000 MW of thermal capacity within five years.

Ghana's thermal power plants have been (and are being) built with the intention to fuel them with natural gas supplied to Ghana through the West African Gas Pipeline (WAGP). Contrary to the expectations of the Ghanaian government, the WAGP has hitherto been unable to fulfil its role as a reliable supplier of gas. Whereas 120 m MMscfd (million standard cubic feet per day) of gas exports were contractually agreed upon between the Nigerian and Ghanaian governments, this quantity has never been provided by Nigeria due to high domestic demand and political instability in Nigeria's oil-producing regions. Even if Ghana was supplied with all of the contracted 120 MMscfd, this quantity would still not be enough to fuel Ghana's existing thermal power plants, let alone the future thermal developments (Energy Commission, 2014: 43).

Due to the lack of reliable gas supplies, Light Crude Oil (LCO) has been the predominant fuel in Ghana's thermal power generation. Though LCO is less complex to import, its use in electricity generation is extremely costly: compared to gas, thermal power generation using LCO is three times more expensive (World Energy Council, 2013: 7). Since 2010, oil from Ghana's Jubilee field can be refined in the coastal town of Tema to be used as LCO in Ghana's thermal plants. Yet this only makes LCO marginally cheaper, as the opportunity cost of using Ghana's oil as fuel for thermal generation is high.

To secure a comparatively inexpensive fuel for thermal generation capacity, the availability of which the VRA and Independent Power Producers (IPPs) can rely on, is thus a key challenge in 'curing' Ghana's electricity sector. The significance of this situation is elevated by the steadily decreasing water levels of Lake Volta at the Akosombo Dam – home to Ghana's crucial 1,020 MW Akosombo hydroelectric plant. Thus, considering the existing power generation capacity, Ghana's electricity sector appears to be in a crisis.

2.2. Electricity sector institutions

Ghana's electricity sector is largely comprised of state-owned companies. Private sector participation can only be found in electricity generation: two independent power producers (IPPs) are operating thermal plants that contribute 271 MW of installed capacity, which amounts to approximately 13 per cent of Ghana's overall capacity (World Bank, 2013: 9). The public VRA is the

[2] The supply of electricity provides an imperative foundation upon which economic growth can be achieved. According to Bernard (2012, 41), reliable electricity supply 'mostly acts as an enabler of development, potentially affecting a large array of outcomes (economic, social, environmental, etc.)'. Also, Eberhard (2007: 236) concludes that connecting South African townships to the electricity grid created the basis for more economic activity in townships (which some townships went on to utilize better than others).