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Ghana's bioenergy policy: Is 20% biofuel integration achievable by 2030?

Insah Iddrisu, Subhes C. Bhattacharyya *

[a] Business Development Manager, Deen Petroleum Limited, Accra, Ghana
[b] Institute of Energy and Sustainable Development, De Montfort University, Leicester, UK

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In dealing with the climate change externality of the fossil-fuel dominated transport sector, bio-fuels are widely seen as a solution. Through its Bioenergy Policy, Ghana seeks to improve oil supply security, save foreign exchange, create jobs and reduce emissions from the transport sector by integrating 20% biofuels into the transport fuel mix by 2030. This paper systematically analyses the transport fuel demand in Ghana to determine the biofuel supply target in 2020 and 2030 and evaluates the resource input requirements for integration of biofuels into the transport fuel mix. It provides a detailed picture of bio-fuel prospects in Ghana in the 2030 horizon. The research concludes that though significant yield improvement is required to meet the target, the target is achievable.

Contents

Abbreviations: ALA, agricultural land area; ATK, kerosene for aviation; BAU, business-as-usual; CCS, carbon capture and storage; CO_2, carbon dioxide; EC, Energy Commission, Ghana; EU, European Union; FAO, Food and Agriculture Organization; GDP, gross domestic product; GHG, green house gas; HGS, high growth scenario; IEA, International Energy Agency; Lde, litres of diesel equivalent; Lge, litres of gasoline equivalent; LPG, liquid petroleum gas; MGS, moderate economic growth scenario; MOFA, ministry of food and agriculture; Mtoe, million tonnes of oil equivalent; NPA, National Petroleum Authority, Ghana; OECD, Organization for Economic and Corporate Development; RD&D, research, design and development; TLA, total land area; USA, United States of America

* Corresponding author.
E-mail addresses: subhesb@dmu.ac.uk, subhes_bhatatcharyya@yahoo.com (S.C. Bhattacharyya).

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1. Introduction

High dependence on fossil fuels has been the norm in the past and may continue even in the future in the business-as-usual (BAU) scenario. This in turn has led to two grand energy challenges of our times, namely the security of energy supply and the climate change problem. The transport sector, contributing about a quarter of global CO_2 emissions, is the most fossil-fuel dependent sector of all. Limited substitutes for oil in transport and poor adaptability of mitigation options like Carbon Capture and Storage (CCS) and geo-sequestration to this sector propagates the tendency to follow the business as usual path, thereby posing a real future challenge [1].

In this context, bio-fuels have been suggested as a solution to achieve supply security through fossil fuel substitution and to abate climate change. Since the 1990s, the domestic bio-fuel sector was actively supported in North America and Europe as well as in other countries, leading to a significant growth in bio-fuel use globally. According to Renewables 2014 – Global Status Report [2], global ethanol production reached 87 billion litres while about 26 billion litres of biodiesel were produced in 2013, thereby contributing about 3% of road transport fuel demand [2].

However, increased bio-fuel production also led to the debate about sustainability of this alternative that lies at the interface of agriculture and energy. The food crisis in 2007–08 and the resultant rise in commodity prices fuelled the bio-fuel versus food security debate. In addition, issues of land use change, deforestation, loss of biodiversity and possible increase in greenhouse gas emissions were also debated [3]. It has also been argued that while a rapid increase in biofuel production can bring in an agricultural renaissance thereby offering employment and income generation opportunities that can reduce poverty incidence, there is also the possibility of loss of access to land by the poorer groups, particularly in countries where the appropriate governance systems are not in place [4].

With its Bioenergy Policy, Ghana seeks to ensure energy security, save foreign exchange, create jobs and contribute to climate change mitigation through the integration of 20% biofuels into transport fuels by 2030. But at present the country does not use bio-fuels at all, although the country heavily relies on biomass-based energies to meet its energy needs. The question then is whether Ghana can achieve its bio-fuel targets given its initial condition. Although other country cases have appeared in the literature, there is limited academic research on Ghana's bio-fuel policy for the transport sector. Duku et al. [5] analysed the bio-fuel potential in Ghana but did not consider the policy target of the government. This paper attempts to bridge this gap by undertaking a critical analysis of bio-fuel supply chain in Ghana.

The paper is organized as follows: the second section presents a review of relevant literature on biofuel policies and country cases. Section 3 presents the estimation of biofuel demand in Ghana up to 2030. Section 4 presents the supply-side analysis and finally Section 5 presents the policy implications and concluding remarks.

2. A brief review of literature on biofuel policies

According to Ref [2] at least 63 countries used regulatory policies in 2013 to promote biofuels for transport and Ghana is one of the African countries that are actively promoting biofuels. A wide variety of feedstocks has been used to produce biofuels but a few dominant feedstocks can be identified in any given country, led by the specific support schemes. For bioethanol, either starch crops (e.g. maize, wheat and cassava) or sugar crops (e.g. sugar cane, sweet sorghum, and sugar beet) are used, with sugar cane in Brazil and maize in the USA being the dominant examples. Similarly, oil crops (e.g. rapeseed, oil palm, sunflower seed, jatropha, and soybean) are used for biodiesel, with oil palm in Indonesia and Malaysia and rapeseed in the EU as dominant feedstocks for biodiesel [3].

Brazil invested in bioethanol since the first oil shock in 1973 as a reaction to rising oil prices and invested in ethanol through its National Alcohol programme to mitigate oil supply security concerns. The favourable climatic condition for growing sugar cane (plentiful rain, and dry winter) and the massive government support for infrastructure development and research turned Brazil into a world leader in bioethanol production. Although sugar cane is an efficient crop in terms of yield per unit of land, its production requires large volumes of water and a 12 month growing cycle [3]. High water demand along with the potential land use change can impose adverse environmental impacts unless care is exercised.

Maize and rapeseed on the other hand are moderately efficient feedstocks that require high input energy compared to output (i.e. poor input–output energy balance) and compete with food supply. Accordingly, maize has found limited encouragement outside USA while rapeseed got only promoted in EU through subsidy and renewable energy targets [3]. The European Union has been pushing for alternative transport fuels through its policy targets since 2003 and its Renewable Energy Target of 2009 requires at least 10% renewable energy use in the transport sector by 2020 [6]. EU countries use a variety of policy instruments to support the industry – including fiscal incentives (tax reductions and subsidy for agricultural production of biofuels in set-aside lands), economic instruments (such as quotas), and command and control approaches (such as standards). Although tax exemptions were very effective in creating the demand, the loss of revenue to the government has prompted many countries to move to biofuel obligations where the supplier and the final consumers bear the additional cost burden [6]. It is reported in [7] that EU member states have spent between EUR 5.5 and 6.9 billion in 2011 to support biofuels. Ethanol was subsidized between 15 and 21 eurocents per litre while biodiesel received a subsidy between 32 and 39 eurocents per litre [7]. Concerns about the environmental and sustainability credentials of food-based first generation biofuels in the EU have led to some rethinking about the biofuel policy. The emphasis has now shifted to second generation sustainable biofuels, which is in line with its emphasis on greenhouse gas emissions [6]. Given the limited use of biofuels in transport so far, the energy security benefits of EU policy are not significant and the impact on rural development through job creation and income generation opportunities remains unclear [7]. Similarly, Searchinger et al. [8] argued that the GHG benefits of corn-based ethanol in the USA would pay-back emissions from land-use change in 167 years. Over a 30 year period, GHG emissions from corn-ethanol will be double of those from gasoline for each kilometre driven, when land-use change is considered [8].

Palm oil, in terms of yield per unit of land, is the most efficient source for biodiesel and most of the production is located in Malaysia and Indonesia at present [3]. Both the countries enjoy relative abundance of the feedstock due to large plantation areas, which in turn leads to a competitive cost advantage compared to other producers of biodiesel [9]. However, the expansion of palm oil plantation in both countries has resulted in loss of forested areas and the consequent loss of biodiversity [9].

To avoid conflicts with food supply, some countries have adopted non-food based bio-fuel policies. China for example has imposed a ban on biofuel production from food crops while India is promoting alternative non-food crop feedstocks such as jatropha. However, Achten et al. [10,11] argue that although jatropha is a wild plant, it requires inputs like any other crop to achieve high yield and profit-motivated investors may move away from marginal lands to agricultural or forest land to reduce financial risks, thereby damaging food security and environmental credentials of