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GIS-BASED SUPPORT FOR IMPLEMENTING POLICIES AND PLANS TO INCREASE ACCESS TO ENERGY SERVICES IN GHANA

Executive Summary

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Francis Kemausuor; Abeeku Brew-Hammond; George Yao Obeng; Alfred Duker; Frank Ohene Annor; Festus Boamah; Isaac Adu-Poku; Daniel Ladzagla

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EU Energy Initiative
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Dag-Hammarskjöld-Weg 1-5
65760 Eschborn
Germany

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Executive Summary

Background to Project

One of the significant drivers of socio-economic development of a country is the country's access to energy. The importance of access to electricity compared to other forms of energy is so enormous. For instance, its contribution to health, education, agriculture and environmental sustainability has facilitated human development. Moreover and particularly in the rural areas, access to electricity has helped to reduce time and efforts spend (especially by women and children) in the collection of other fuel such as kerosene for lighting; and has also reduced rural to urban migration in search for jobs and modern facilities. In addition, potential benefits of electricity in rural areas include crop irrigation, agro-processing and preservation of farm produce.

Ghana's energy policy aims at ensuring reliable and cost-effective supply of high quality energy services for households, businesses, industries and the transport sector nationwide. The need to secure future electricity and modern fuel supplies has been touted as the pivot of the Millennium Development Goals (MDGs). However, in spite of the popular notion underpinning energy access-poverty reduction nexus, policies and plans intended to create enabling environment for an improved energy access are seldom evaluated in most developing countries.

This report encapsulates the activities undertaken under a project dubbed '*GIS-based Support for Implementing Policies and Plans to Increase Access to Energy Services in Ghana*' and its recommendations. The project was undertaken by The Energy Center (TEC) of Kwame Nkrumah University of Science and Technology (KNUST) with funding from the European Union Energy Initiative – Partnership Dialogue Facility (EUEI-PDF) to ensure timely cross-sectoral coordination of plans and data. The assessment sought to employ and complement existing policies, strategies, plans and recommendations from the Energy for Poverty Reduction Action Plan (EPRAP) and the Ghana Energy Development and Access Project (GEDAP) to achieve national goals and the MDGs, and is a pilot project whose results shall be replicated in other countries of the ECOWAS Sub-region.

Project Objectives

The objectives of the project were:

1. To review existing energy policies, strategies and plans for increasing energy access in Ghana with reference to the targets set in the Government's policy statements/documents, the ECOWAS White Paper and the MDGs.
2. To use GIS to collate and analyze national level data and provide timely information on population distribution, services, economic activities, and status of energy access programs.

3. To identify the gaps in energy policies and plans for achieving expected energy access targets by 2020 and proffer timely mitigation measures.
4. To develop methods and tools to facilitate business models, investment plans and capacity development to complement current planned activities to achieve the energy access targets by 2015.
5. To facilitate project identification, planning implementation and impact assessment for the Energy Commission of Ghana, the Ghana Ministry of Energy and the ECOWAS Commission for timely development, implementation and monitoring of energy access strategies.

Review of Energy Trends, Policies and Plans in Ghana

The intent of the energy policy review was to assess the trends, policies, plans and programmes developed over the years to ensure increased access to energy services in Ghana by 2020 and beyond. The review found that there has been a remarkable growth in electricity supply from the late 1990s buoyed by the National Electrification Scheme (NES) and later the Self Help Electrification Programme (under the NES). This has raised electricity access rates to about 72% in 2010 (Figure 1), a feat only rivalled by Cape Verde and South Africa in sub-Saharan Africa, but with disparity in rural and urban areas. Disturbingly, biomass in the form of woodfuel, remain the most prominent fuel in Ghana for cooking and heating. Firewood and charcoal contribute about 63% to the total energy consumed in the country and is a major source of worry considering the effects on deforestation and the health problems associated with indoor pollution from the use of biomass. Even though some strides have been made in LPG consumption in urban areas, especially in the Ashanti and Greater Accra Regions, access to LPG is still lower than expected and even worse in the rural areas. Renewable energy has not made much contribution to the energy mix in Ghana. Gains in solar PV have been modest when compared to the country's potential. Wind energy and small hydro resources have not been exploited fully and biofuel programmes are still in the feedstock stage with little to show in terms of the production of commercial fuels.

Ghana faces several challenges which frustrate efforts to achieve national energy access targets and goals. These challenges include growing demand for energy but with inadequate investment to match the demand, high levels of end-use inefficiency culminating in waste of final energy forms and inefficient pricing of energy services resulting in poor financial positions of the energy providers. Other challenges are operational inefficiencies of the utilities leading to high energy losses (averaging about 26.8% over the past ten years), under-exploitation of renewable energy sources and over reliance on woodfuels which could threatens the country's forest cover.

There have been several plans, policies and programmes aimed at increasing access to energy services in Ghana over the last few decades. Governments over the years have had the provision of energy services high on the developmental agenda but despite the good

intentions of all these governments to increase access to energy services, existing policies and plans have not delivered the best results, especially in the rural areas. Policies aimed, especially at reducing biomass usage and promoting environment friendly cooking fuels, have achieved very little results.

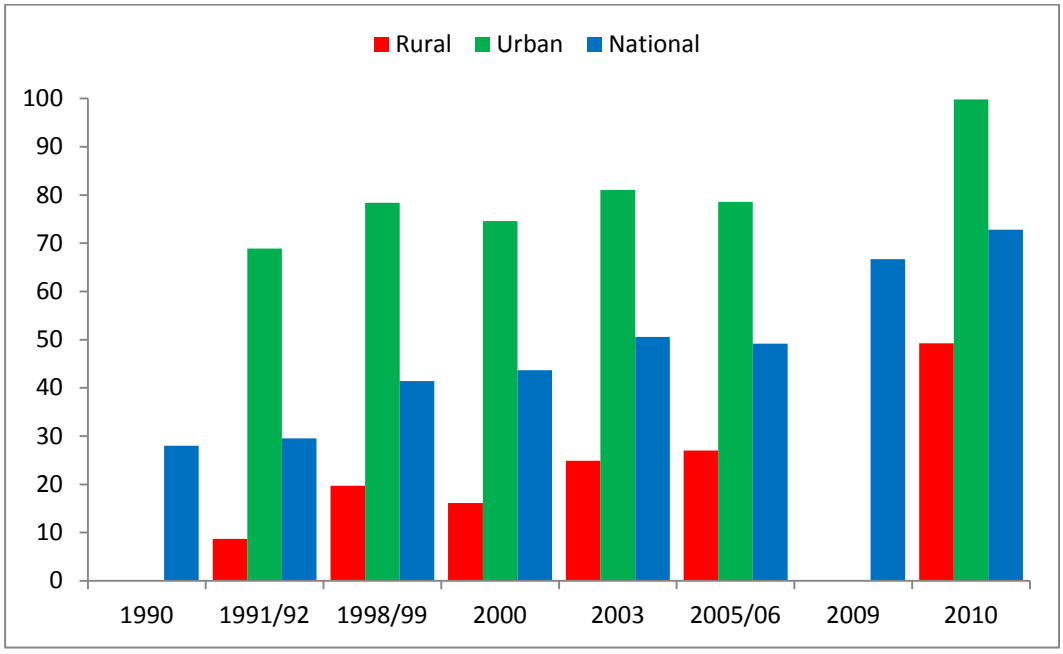

Figure 1: National, urban and rural electricity access rates for Ghana

Assessment of Energy Needs and Comparison with ECOWAS targets and MDGs

A comparative analysis of the country's electricity access with ECOWAS targets reveals that, Ghana has made significant strides. As of mid-2010, Ghana had surpassed the ECOWAS rural electricity targets of 36% access and is close to achieving the 100% urban access by 2015 (Figure 2). More so, Ghana is placed second to only Cape Verde in terms of electricity access and ranked higher than Nigeria, Cote d'Ivoire and Senegal given an estimated electricity access rate of 72% (percent of population) in 2010 (see Figure 4.2). However, Ghana's impressive electricity access rates have not translated into increased access to modern fuels for cooking and heating as countries like Cape Verde and Senegal. Access rates available for 2008 indicate that access to modern fuels in Ghana was only 12% as compared to Senegal's 41% and Cape Verde's 63%. Ghana's current access rate to modern fuels implies that it is not likely that the country will be able to achieve the ECOWAS target of 100% by 2015. The implication is that, the use of unclean energy sources (wood fuel and charcoal) and their dire consequences will continue to make a large proportion of the population vulnerable to numerous health risks as well as suffer the consequence of derailing the achievement of MDGs.

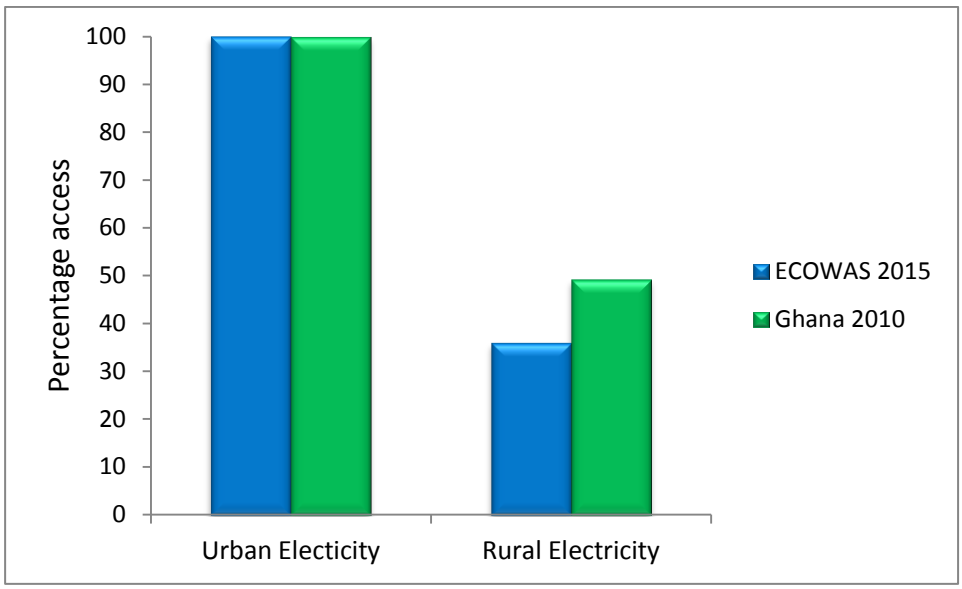

Figure 2: Comparing Ghana's electricity access rate with ECOWAS targets

Addressing MDGs through access to modern cooking fuel (especially LPG) for cooking remain a serious development challenge. Low access to modern cooking fuels presupposes the continuous use of traditional biomass with their associated health risks. The LPG access rate is far below the ECOWAS target of 50% for modern cooking fuels and the MDG target of reducing to 50% of those without access to LPG set by United Nation's Millennium Project.

There is scant data on improved cook stoves in the country. It is therefore difficult to measure how their availability is making up for the limited LPG use in the country. The low access rate to cleaner cooking fuels may therefore present a potential threat to achieving the MDGs. The situation is likely to be worsened in the Northern, Upper East and Upper West regions of Ghana where access to LPG is extremely low. Although the number of LPG station access across Ghana is inadequate, the situation in the three Northern regions (Upper East, Northern and Upper West) is very bleak as the few LPG stations are concentrated in the regional capitals. The difficulty of access to LPG by remote settlements (from the regional capitals) is evident in the large land areas/sizes of the regions coupled with the persistent transportation problems. This presupposes the high dependence on traditional biomass in the aforementioned regions.

Development of GIS e-maps for Energy Services

GIS e-maps for social services and amenities have been prepared and the data mapped include Electricity Company of Ghana substations, location of mini-hydro dams, potential wind sites, solar radiation, access to electricity in basic schools, access to electricity by hospitals and clinics and access to biogas. Geo-processing operations have been carried out on the base maps using the WGS1984 UTM Zone 30N and 30S geographic projections. All the maps have been exported to the JPEG format which can be opened on all computers with a

picture editor or viewer. Immense effort has been made to ensure that the data provided is very accurate and any apparent positional discrepancies between roads, railroads, forest reserves, rivers and town layers are due to the current Ghana Survey Department map accuracy that is available. To update and edit the developed GIS maps, any GIS software can be used. However specialized knowledge in GIS is required to be able to edit the information stored therein for the production of new maps. A manual has been prepared for end users in ArcGIS for basic editing, querying, navigation and updating of the e-maps.

Development of Methods and Tools for Capacity Building

Electrification costs modelling

One of the key objectives of the GIS-EAP project was to develop methods and tools to analyse Ghana's energy access situation for capacity building of energy stakeholders in the country. The project team adopted a modelling tool called *Network Planner* developed by the Earth Institute of Columbia University to model electrification costs for un-electrified communities in the country. The network planner can be used to rapidly estimate connection costs and compare different regions and communities. The model determines the least-cost technology – either grid electrification or an off-grid alternative – to connect a community. The policy relevance of the model is to help planners estimate investment costs and financing requirements to support electrification programs and identify opportunities for cost-effective grid expansion.

The modelling was done on a regional basis to understand the total cost of electrification for the un-electrified communities in each region since each region has different characteristics of some of the inputs model parameter that have to be considered. In this study, the year 2010 was chosen to be the base year with a time horizon of ten (10) years due to the country's energy target of universal electrification in 2020. All the input model data were acquired in 2010 except the population data of the un-electrified communities which were projected from the year 2000 to the year 2010 using a population growth rate proposed by the Ghana Statistical Services.

The results obtained from the base scenario which represents the best estimates of parameters and assumptions used in modelling the un-electrified communities in each region are summarised in Table 1. The results are shown for 30%, 60% and 100% penetration rates.

The cost of electrification differs widely across the ten regions due to remoteness (distance from existing electricity grid network), size (land area), the number of non-electrified communities coupled with large population size and the projected electricity demand over the ten years time horizon. The scattered pattern of settlement in Northern Ghana and the existence of many non-electrified communities amply suffice the relatively high electrification cost compared to other regions especially Greater Accra region which has the reverse characteristics. The availability of such electrification cost ranges provide a useful

guide to the financing mechanisms or investments required either from private sectors or the government to achieve a certain level of penetration rate and eventually universal access (100%) by 2020. Sensitivity analyses were performed to determine the effect of changes in some of the key parameters on the costs of electrification.

Table 1: Total cost of all combined electrification technologies at each penetration rate

Region	No. of un-electrified Communities	Cost Of ALL ELECTRIFICATION, US$ (Grid, Solar off-grid and Diesel mini-grid)		
		*PR = 100%	PR = 60%	PR = 30%
Ashanti	221	61,127,135	43,951,886	27,144,968
Brong Ahafo	195	61,307,042	44,224,255	28,520,598
Central	175	57,147,309	41,096,753	25,779,605
Eastern	247	49,849,486	37,226,340	22,794,953
Greater Accra	11	2,859,040	2,124,197	1,346,978
Northern	660	147,276,999	103,512,748	67,212,069
Upper East	299	61,635,747	44,679,019	29,885,671
Upper West	294	68,720,385	48,699,311	30,324,558
Volta	179	84,270,636	57,834,609	37,482,525
Western	319	101,646,482	73,454,997	46,728,304
TOTAL	**2600**	**695,840,261**	**496,804,115**	**317,220,229**

*PR = Penetration Rate

GIS-based Energy Access Review (GEAR) Toolkit

Proper re-structuring and the provision of up-to-date information on energy issues are needed to inform energy policy formulation. The GIS-Based Energy Access Review (GEAR) Toolkit (Figure 3) focused on the development of a platform that can enable users get information pertaining to electrified and non-electrified communities in Ghana. The Toolkit is intended to partly display results of the modelling exercise as well as Liquefied Petroleum Gas (LPG) data in Ghana and show electrification trends in the country in order to facilitate planning.

Figure 3: GEAR Toolkit login interface

The production of a digital map and a functional geo-database of the facilities would assist adequately in the adequate distribution of energy in the following areas: Creation of a geo-database (spatial/attribute) for the features for updating, based on their conditions; capturing of the geometric and attribute data of electrified and un-electrified communities; update and modification of information concerning facilities for electricity distribution such as electrified and non-electrified communities in Ghana; faster and easier retrieval of information for instantaneous use in the area of planning, managing and monitoring of electrified communities as well as the trend of LPG access in communities.

The GEAR toolkit allows a user or a planner to interrogate (query) the system to obtain a piece of information such as electrified and un-electrified communities with their corresponding spatial units. In the Toolkit application, electrified or un-electrified settlements can be displayed on a map. To make an emphasis on a particular population centre (settlement) of interest like un-electrified settlements, the user must select from a drop-down button to make the query of interest; in this case 'un-electrified' and then press the query button for the programme to display the output. The user can then flash the output to know the locations of those settlements that met the query. The output will pop-up repeatedly in a brighter light. The system can also give a graphical report on electricity access rate for a community/town, district, and region or even at a national scale. The percentage of the communities with or without access to electricity, distance between towns (as a crow flies) and so on could be displayed in the programme. The application could be installed onto a server and then networked for use at a local level without necessarily having an internet connection and without the need for any proprietary software. Users only have to be registered before accessing the system. Users of the program could be a lay man,

a district planner, the utilities, Energy Commission, Ministry of Energy and their allied agencies.

Conclusions and Recommendations

The review and assessment carried out has shown that Ghana has made significant strides in electricity access due to long-range energy planning with clear targets, availability of external funding, political/popular demand and active role of central government in the implementation of energy policies. With urban electricity access rate of about 99% and rural access of 49%, the country has made a very good progress when compared with the ECOWAS target values of 100 for urban and 36% for rural households by 2015. This suggests that, Ghana is well on the way to meeting the ECOWAS targets for electricity especially in higher-income regions like Greater Accra and Ashanti.

Access rate to LPG is low, at approximately 12%. Due to the health effects of traditional cooking fuels, the low LPG access rate present a potential threat to achieving the MDGs. Generally, LPG stations in the country are inadequate to meet the rising demand and recent shortages have even compounded the problem. Current trends indicate that government may not be able to meet its LPG target of 50% access by the year 2015.

This project has shown, with the aid of electrification modelling, that by the end of the ten year planning period (2020), the majority of un-electrified communities will be viable for grid expansion with some small percentage number being off-grid compatible. This is due to the Ghana's pre-existing network coverage reaching the whole country (at least running through every district capital in each region).

The GEAR Toolkit developed in this project will serve as a tool to manage energy access data for Ghana and facilitate easy planning and capacity building. A user can find information on whether a community is electrified, the population of the community, the spatial coordinates of the community, grid installation cost (US$) and proposed electrification technology for the community if it is un-electrified, etc.

There is the need to ensure a proper integration of Solar PV and other renewable energy systems into electrification programmes at both national and sub-national levels. In some cases, as with most parts of Ghana, grid-connected solar PV systems can be employed so that the problems associated with the promotion of off-grid electrifications options in soon-to-be-electrified areas would be avoided or at least reduced.

There is a need for more studies to generate a database for determining the pattern of energy access improvement over the years, challenges and prospects as well as the main drivers of energy access in the country. This will help provide useful information for accurate projections about how to achieve a certain time-bound access rate given certain sets of prevailing conditions especially on LPG.

The project proposed the setting up of an Energy Access Data (EAD) Task Force. The intent of the proposed EAD Task Force is to facilitate the development of a shared database using

harmonized methodologies on access to electricity and LPG in Ghana. The project director has recommended the formation of the EAD to the Minister of Energy and a forum for Energy-sector Board Chairs and CEOs and they have agreed to form the EAD Task Force. The EAD Task Force will initially consist of the following agencies (with the power to co-opt additional members as needed):

1. Energy Commission (Convener and Chair);
2. National Petroleum Authority;
3. Volta River Authority /Northern Electricity Department;
4. Electricity Company of Ghana;
5. Ghana Statistical Service;
6. The Energy Center, KNUST
7. CERSGIS, University of Ghana
8. Ministry of Local Government & Rural Development (representing MMDAs).

This project recommends Msc/Mphil and PhD research works to address data gaps and to complement extant studies. The project also recommends further research into the energy demands by specific sectors of the economy such as health and education to facilitate sectoral energy access evaluation. In particular, it is recommended that further studies be undertaken on the availability of improved cook stoves in households and the improvements made so far across the ten regions of Ghana.