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Energy consumption and economic development in Sub-Sahara Africa

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ABSTRACT

Sub-Saharan African countries' economic development is dependent on energy consumption. This paper assesses total energy demand, which is composed of traditional energy (wood fuel) and commercial energy (electricity and petroleum), in the Central, East, South, and West regions of Sub-Saharan Africa. Cross-sectional time series data for 20 countries in 25 years are analyzed, and the results of the study show that wood fuel accounts for 70% of energy consumption, followed by petroleum, with most industrial activities utilizing some form of wood fuel. Regression results suggest that energy demand is inversely related to the price of petroleum and industrial development, but positively related to GDP, population growth rate, and agricultural expansion, and that price elasticity is less than one. The model results also show that there are regional differences in energy demand. In addition, the interaction of population growth rates by regions generates mixed results, and there are regional differences in the use of commercial energy consumption, and GDP growth. The findings of this study suggest that countries must diversify their energy sources and introduce energy-efficient devices and equipment at all levels of the economy to improve GDP growth rate and GDP per capita.

1. Background

Sub-Saharan Africa (SSA) is home to 13% of the world's population. Although the majority of people in SSA countries live in rural areas, urban population increased from 22% to 36% between 1980 and 2005 (The World Bank, 2007). The region has the lowest total Gross Domestic Product (GDP) and GDP per capita in the world, although there have been notable improvements since 2000, when annual GDP and GDP per capita for the region grew by 5.7% and 3.2%, respectively. Both of these rates were higher than the world averages, which were 4.1% and 3.1%, respectively (ERS/USDA, 2008). The downturn in global trade and investment since 2001 has affected the world economy and, as a result, global GDP has dropped. The world GDP is expected to increase at an average annual rate of 3.2% over the period of 2000–2010, while that of Africa is predicted to increase at 3.8% (IEA, 2002). Anticipated economic growth is associated with increased utilization of fossil fuel energy, and it is expected that lower income countries, especially SSA countries, will increase their demand for fossil fuels in the next decade which may also affect climate change.

World energy consumption grew by 5.4% while SSA grew by 1.54% between 1980 and 2007 but SSA countries consumption accounted for only 2% of total world consumption (US EIA, 2009). Even with this energy consumption growth, rural energy from non-renewable sources is alarmingly low in SSA countries. Hence, the rhetorical question often asked is: 'Should countries with low rates of energy consumption, industrialization and rural electrification be asked to reduce their consumption of fossil fuels without research information on the factors influencing energy consumption in SSA countries?' In order to develop sustainable development strategies for SSA countries and to put an end to the controversy in terms of the use of fossil fuels for economic development, and to reduce vulnerability of climate change, it is important to understand the composition of energy sources used in SSA countries. Since economic growth is directly related to energy use and technological development, it is also critical to examine the factors influencing energy demand in SSA countries. The purpose of this paper is to assess the sources of energy and their relationship to GDP growth, along with factors to project energy requirements in SSA.

Energy generated from such resources as biomass, animal waste, wind, solar, geothermal, and fossil fuel has long been part of human history and development in SSA, where the majority of the population still resides in rural areas and where their livelihood is affected by the level of infrastructure, productivity, and energy use. Since the rate of energy use increases with development and the use of different sources of energy (Darmstadter, et al., 1979; Schurr, 1982; and Rosenberg, 1983), productivity, improved living standards, a higher level of socio-economic development, and a wide range of other economic activities are associated with a well developed energy

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sector. The transition from traditional use of biomass and animal waste to modern energy sources provides a variety of social benefits, including improved health, well-being, and income-generating opportunities for citizens, as well as access to employment, education, and social services in both urban and rural areas. Hence, both the quality and quantity of energy are important. Reliance on human power, draft animals, and traditional fuels cannot sustain the same level of economic activity as can the use of refined petroleum products and electricity.

Although energy systems have grown more complex over time, particularly with urbanization and industrialization, the use of commercial energy in SSA, except South Africa, has been limited. The percent of the population with access to electricity ranged from 1.0% to 51% in SSA countries in 2002 (IEA, 2002). Electricity in most African countries is produced as a social amenity and is heavily subsidized by government. However, the heavy cost of infrastructural expansion to satisfy a growing demand for energy is unsustainable because government-owned, financed and operated utility power companies produce and sell their energy at distorted prices (Olumuyiwa, 2008).

Modern manufacturing and service industries and today's urban environments rely heavily on electricity for everything from cooking and heating, and on gasoline for transport. Continued urbanization and economic development stimulate the growth of electricity needs to grow even faster than overall energy needs. However, electricity use per capita is low in SSA, and in most SSA countries, electricity consumption has stagnated because of low supply (ERS/USDA, 2008). One of the challenges of development in SSA is how to increase the GDP per capita by reaching out to the rural areas, where the majority of the population lives.

Factors that contribute to sustainable development include access to an affordable and efficient energy supply, reliable and mixed energy sources, reduced reliance on traditional fuels, and emphasis on renewable, sustainable sources of energy (e.g., biomass, solar, wind, and geothermal). Energy in SSA is supplied in insufficient quantity at a cost, in a form and of a quality that results in limited consumption by the majority of SSA's population. SSA has the lowest per-capita consumption of modern energy of all regions of the world (UNECA, 2007). The gap between energy supply and demand in SSA has been increasing during the last four decades, and it is forecasted that this gap will continue to grow.

2. Energy sources in Sub-Saharan Africa

Sub-Saharan Africa is endowed with a diversity of energy resources that are unevenly located across the continent. Oil and gas reserves are mainly concentrated in the western regions of the continent, while the southern regions of the continent harbor the bulk of coal reserves. Africa's uranium deposits are among the largest in the world. South Africa, Namibia, and the Republic of Niger currently ranked among the 10 leading global producers of uranium. About 16% of the world secured supplies of uranium is found in Namibia and Niger the main fuel for nuclear energy production (Nuclear Energy Agency, 2006). Africa is also home to the largest river courses in the world, including the Nile, the Congo, the Niger, the Volta, and the Zambezi river systems, which together represent 13% of the world's potential hydropower (UNECA, 2007; Olumuyiwa, 2008).

Africa has a tremendous solar energy potential, since a large part of its land mass is near the equator which is exposed to strong sunlight year-round. The continent also enjoys relatively strong wind power potential in parts of western, southern, and eastern Africa. The eastern regions of Africa have tremendous geothermal potentials, especially along the Rift Valley (UNECA, 2007). However, despite the potential of all these primary energy sources, Africa lags behind in energy production and consumption.

The current energy supply is composed of commercial and non-commercial energy, the latter of which includes charcoal, wood, and animal waste. More efficient commercial energy (coal, petroleum, natural gas, and hydro-electricity) production is unevenly distributed throughout the continent. About 99% of coal is produced in southern Africa (mainly South Africa), while crude oil production is concentrated in West Africa (Nigeria), Central Africa (Gabon), and southern Africa (Angola). East Africa produces almost no oil, gas, or coal. Most of the primary energy produced in Africa is exported to other continents, sometimes with minimal benefit to local populations (Olumuyiwa, 2008). Angola, Cameroon, Congo, Gabon, and Nigeria are net exporters of oil, and coal exports are almost exclusively from South Africa.

3. Energy consumption

Energy consumption in Sub-Saharan Africa is largely dominated by combustible, non-commercial, renewable resources (biomass, animal waste, municipal and industrial wastes). Energy from biomass accounts for more than 30% of the energy consumed in the continent, and more than 80% for many SSA countries. Biomass is the main source of energy for a majority of African households and is predominantly used for cooking, drying, and heating. Data concerning access to electricity vary based on the reporting sources, but the International Energy Agency (IEA) reports that an average of 23% of SSA has access to electricity, with large disparities between countries and between urban and rural areas within countries (UNECA, 2007).

Table 1 shows the composition of energy consumption in SSA. Wood fuel, a traditional source of energy, accounts for 70–77% of the total energy use between 1980 and 2005, with the peak of 77% reached in 1995. Wood fuel is used to meet the basic necessities of cooking and heating. Petroleum is the second-largest source of energy, at 23% of total energy used, while electricity accounts for about 5% of the total energy consumption. Together, the commercial energy sources of petroleum and electricity account for about 28% of energy consumption.

The sectoral distribution of the total energy used in Africa shows that residential energy use accounts for 37% of energy utilized, with industry and transportation accounting for 11% and 9%, respectively. Agriculture/forestry and commercial/public services each account for 1% of the consumption, while the remaining 40% is used by other sectors (IEA, 2005). The electrification rate, that is, the number of people with electricity, varies from 50% in Cote d'Ivoire to 4% in Uganda, with about 10 countries having an electrification rate lower than 10%. The urban and rural electrification rates in 2000 were approximately 51.3% and 7.5%, respectively (IEA, 2002).

Commercial energy consumption is small for a variety of reasons, including low per-capita incomes, low levels of industrialization, and low rates of ownership and operation of automobiles and electric appliances (e.g., refrigerators and freezers). On the supply side, there has been an inadequate investment in and development of infrastructure, such as pipelines and electricity grids, to deliver commercial energy to customers.

The IEA forecasts that by 2030, the use of traditional biomass will decrease in many countries, but it is likely to increase in South Asia and SSA, where biomass consumption will increase alongside population growth (IEA, 2000). While the use of traditional energy

Table 1
Sources of energy use in Sub-Saharan Africa.

Year	Petroleum[a]	Electricity[a]	Woodfuel[b]
1980	0.23	0.06	0.71
1985	0.23	0.04	0.73
1990	0.24	0.05	0.71
1995	0.19	0.04	0.77
2000	0.22	0.04	0.74
2005	0.23	0.05	0.72

[a] EIA (2009).
[b] FAO (2008).