Chapter 25
Emerging Technology Penetration:
The Case of Solar Electricity in Nigeria

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ABSTRACT

Considering the huge wastage associated with the present energy production and consumption pattern in Nigeria, solar electricity (SE) is acclaimed to be of great potentials as a viable alternative to fossil fuels and is being considered by policy makers to contribute to improving energy efficiency, security and environmental protection. The veracity of such claim is being ascertained in this study through analysis of solar electricity utilization for lighting, refrigeration, ventilation, water pumping and others by just 5% of about 100 million Nigerian rural dwellers who lack access to national grid. The study deduced that increase in rural access to SE will yield tremendous carbon credits for Nigeria under the clean development mechanism and that generating more SE at cheaper cost will enhance policy support for green energy. This connotes a great future for microelectronics and nanotechnology in processing high efficiency multi-junction solar cells and nanosolar utility panel being optimized for utility-scale solar electricity systems.

CURRENT STATUS IN ELECTRICITY ACCESS IN NIGERIA AND THE INCESSANT ENERGY CRISIS

The per-capita electricity consumption in Nigeria ranged from 68 to 95 kWh between 1980 and 1997, which is about 17% the African average and 2% that of South Africa (NCP, 2001) and (PHCN, 2005). Indeed, with the exception of relatively poor countries such as Benin, Sudan, Mozambique and Angola, per capita electricity consumption in Nigeria was very far below that of much of Africa during the period (Hart, 2000). Although further increase in the per capita con-

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sumption was achieved in Nigeria between 1998 and 2003, nevertheless only 34% and 45% of the population had access to electricity respectively during this period (Nigeria's Electricity Sector, Executive Report, 2006). So also, as observed by Energy Commission of Nigeria in a study (ECN 2004), electricity access is more pronounced in the urban areas (81%), than in the rural areas (18%).

This situation is rather unfortunate because it contrasts sharply with the impressive primary energy profile the country parades. Chiefly among these are over 33 billion barrels of proved recoverable crude oil reserves (the world's sixth largest) (Kupolokun F., 2007), natural gas proved recoverable reserves of 187 trillion cubic feet (the world's ninth largest), about 2.7 billion coal and lignite reserves, 10,000 MW of large scale and 734 MW of small scale hydro-electricity power exploitable capability. The fuelwood reserve is estimated to be 13,071,464 ha. The country also has 31 billion Tar Sands reserves, 61 million tonnes/year and 83 million tonnes of animal waste and crop residue reserves respectively, 3.5-7.0kWh/m^{2}-day of solar radiation potentials and 2-4 m/s annual average of wind reserves (ECN, 2005)).

In spite of the country's very rich energy resource endowment, Nigeria is still greatly plagued with acute energy crisis which permeates all sectors of the economy. Close to 100 million Nigerians remain "in the dark" without access to electricity (NBS 2006) and estimates of the new connections to the national utility grid system is well under 50,000 per year (ESMAP 2005). The country requires over 10000 MW of electricity to meet present demand, has deteriorating installed capacity of 6000 MW, but her current output is less than 3000MW, much of which is not put to use due to poor power transmission and distribution infrastructure. Only 18% of the 70% Nigerians living in rural areas have access to electricity, which shows that the country's rate of electricity access is far less than population growth rate. The country's 2003 per capita electricity consumption is put at 106 Kwh per year, far lower than that of South African which is 4546.4 Kwh per year (IEA, 2003).

Most remote rural settlements are placed at a very serious disadvantaged due to relatively high grid (generation, transmission and distribution) expansion cost. Obvious potentials of solar technology as readily deployable stand-alone facilities for provision of electricity, with long service life (about 30yrs) and low maintenance cost suitable for rural areas are yet to be fully harnessed. Applications of solar PV technologies such as mini-grid systems; solar home systems; solar water pumping; street and traffic lightings; solar vaccine refrigeration and solar PV power back-up for communication gargets only exist in skeletal urban and rural demonstrated pilot projects. Thus, the real impact of solar electricity (for instance) for lighting is yet to be felt as good substitute for kerosene (Siyanbola et al 2004) and palm oil in the rural areas of Nigeria (NBS 2006).

From the foregoing, it becomes obvious that living within the barriers of the old conventional fossil fuel energy systems may not be sufficient in providing solution to the rural energy problem. Therefore, assessing constraints to rural solar electricity utilization as basis for determining its optimal contribution to the rural energy mix become imperative due to dart of information in this area in Nigeria. This also offers a means to ascertain the trajectory of an emerging technology penetration in a developing economy.

SOLAR ELECTRICITY OPTION FOR RURAL ACCESS TO ENERGY SERVICES AND CRITICAL ISSUES FOR POLICY

Consequence upon the challenges posed by the various energy problems in the country, certain pertinent research questions constantly agitate the minds of policy makers, energy planners, researchers and energy analysts in their search for optimal solutions to the Nigerian Energy problems. Some of these are: