Energy Optimization at GSM Base Station Sites Located in Rural Areas

Vincent Anayochukwu Ani, University of Nigeria Nsukka, Nigeria

Nzeako Anthony Ndubueze, University of Nigeria Nsukka, Nigeria

ABSTRACT

This paper explores the best energy options by which the choice of the most energy optimized solution for a given GSM Base Station Site and location in any rural area in Nigeria can be made. The patterns of load consumption by mobile base stations at various geographical locations in rural areas are studied and suitably modeled for optimization using HOMER software. Simulation results show the optimized energy options to be superior to conventional solutions whereby diesel generators are currently used to power GSM Base Station Sites around Nigeria. Total Net Present Cost (NPC) and total impact on the environment are used as indices for measuring the optimization level of each energy solution. The solution with the highest optimization value is considered to be the best energy option for that Base Station Site.

Keywords: *Diesel Generator, Economic Cost, Energy Optimization, Energy Simulation, Environmental Cost, Mathematical Model, Mobile Base Station, Renewable Energy*

INTRODUCTION

In Nigeria, over 80,000 villages remain un-electrified (Okoro & Chikuni, 2007). The energy situation in many parts of Nigeria poses a challenge to sustainable deployment of GSM base station sites. Like several other developing countries, Nigeria is characterized by severe energy deficit. In most of the remote and non-electrified sites, extension of utility grid lines experiences a number of problems, such as high capital investment, high lead time, low load factor, poor voltage regulation and frequent power supply interruptions (Miguel, 2008). The costs to install and service the distribution lines are considerably high for remote areas. This poor power quality substantially increases the capex and opex of telecom installations and also leads to unsatisfactory quality of services (Miguel, 2008).

One popular solution to this problem is the use of diesel generators. Unfortunately, these generators have been found to be very expensive and environmentally unfriendly. From environmental standpoint, diesel gensets exhaust harmful hydrocarbons into the atmosphere during their operation. Their operation and maintenance accounts for about 35 percent

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of the total cost of ownership (TCO) of base transceiver station (BTS) (Richard, 2007). These have made diesel generators a much less viable option for network operators in many developing countries of the world (Lipman, 1994; Schmid & Hoffman, 2004).

The irony of this situation is that Nigeria is endowed with very abundant renewable energy resources that remained unexplored and unexploited for alternative energy solutions for telecommunications particularly for the largely populated rural areas in the country. Nigeria lies along the Equator, with abundant sunshine all the year round. According to Bala, Ojosu, and Umar (2000), Nigeria is endowed with an annual average daily sunshine of 6.25 hours, ranging between about 3.5 hours at the coastal areas and 9.0 hours at the far northern boundary. Similarly, it has an annual average daily solar radiation of about 5.25 KW/m^2/day, varying between about 3.5 kWm^2/day at the coastal Area and 7.0kW/m^2/day at the northern boundary. Nigeria receives about 4.851x 10^{12} KWh of energy per day from the sun. This is equivalent to about 1.082 million tons of oil equivalent (mtoe) per day, and is about 4 thousand times the current daily crude oil production, and about 13 thousand times that of natural gas daily production based on energy unit. This huge energy resource from the sun is available for about 26% only of the day. Based on the land area of 924 x 10^3 km^2 for the country and an average of 5.535 kWh/m^2/day, Nigeria has an average of 1.804 x 10^{15} kWh of incident solar energy annually (Chendo, 2002).

There are lots of canals, several minor streams and rivulets that crisscross the entire Nigerian land mass, tributaries of main river Niger, Benue, as well as tiny waterfalls having potentials for setting up mini/micro hydropower units that can power GSM Base Station Site. These can be found mainly in coastal regions of the country. Harnessing micro-hydro resources and setting up decentralized small-scale water power or micro-hydro schemes are a particularly attractive option in terrain areas without hampering the ecosystem.

Two principal wind currents affect Nigeria. The south-western winds dominate the rainy season of the year, while north-eastern winds dominate the dry season. Depending on the shifts in the pressure belts in the Gulf of Guinea, these winds are interspersed respectively by the south-eastern and the north-western winds in different parts of the year. The wetter winds prevail for more than 70% of the period due to the strong influence of the breeze from the Atlantic Ocean. Mean annual wind speed varies between 2 to 6 m/s. Speeds in dry season (November - March) are lower. In the wet season (April–October), daily average speed could rise to 15 m/s. Values of up to 25 m/s are sometimes experienced due to inducement by convective rainfall activities and relative diffusion. From meteorological centres in Nigeria and satellite-derived meteorology and solar energy parameters from National Aeronautics and Space Administration (NASA), the average daily wind speed across the country, at 50meter height above the earth, is within the range of 2.7m/s in the central western parts to 5.4 m/s in the North East.

There are now a number of energy conversion technologies, and applications that make renewable energy options either equal or better in price and services provided than the prevailing fossil-fuel technologies. For example, in a growing number of settings in industrialized nations, wind energy is now the least expensive option among all energy technologies—with the added benefit of being modular and quick to install and bring on-line (Mazza, 2000). Photovoltaic (solar) panels and wind turbine placed on a mast can help reduce energy costs, dramatically shave peak-power demands, produce a healthier living environment, and increase the overall energy supply.

There is therefore a great promise for alternative renewable energy for the telecommunications industry in Nigeria, if only the country could endeavour to explore and exploit these available resources. This study is part and perhaps the beginning of this endeavour. Its major goal is to explore best alternative renewable energy solutions to progressively increase

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