MODELLING AND TECHNO-ECONOMIC SIZING OF A DC NANO-GRID FOR OFF-GRID NOMADIC SETTLEMENTS IN NORTH CENTRAL NIGERIA

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Abstract: *This paper focuses on providing solution for the incessant farmer/herdsmen conflict, using modern technology. It centered on electrification of nomadic settlement, with case study of three nomadic locations in North-central Nigeria, using DC-Nano grid. Research revealed that frequent clashes of herdsmen with farmers are as a failure of the herdsmen to ranch their animal in a single or confined location. However, the herdsmen are willing to ranch in one location if facilities such as irrigated ranches and sprinkler pumps are provided. Thus, this called for electrification of their settlement to improve their socio-economic way of life. Meanwhile, owing to the distance of their settlement from the national grid, it is therefore better and more economical to supply these settlements from an off-grid system. The preliminary research revealed that the load requirements of these nomadic settlements can be serviced from DC source, thus the reason for proposing a DC-Nano grid from renewable energy source. The research is carried out with sizing of the DC-Nano grid from possible options of wind and solar energy using particle swarm optimization (PSO). Results obtained shows that solar energy will be more economical to power the nomadic settlement than wind energy. In addition, with the designed load management system on the proposed renewable energy source, 50% reduction in energy consumption was achieved, while with PSO, 63.41% reduction in cost of electricity was achieved.*

Keywords: *DC-Nano grid, Renewable energy, Off-grid, Nomadic settlement, Farmer-herdsmen conflict and Techno-economic*

1. INTRODUCTION

Energy is debatably an important element in developmental processes. It has been posited that without energy, it is almost impossible to attain sustainable development. "Since access to modern energy lies at the heart of human development, it is evident that in order to meet the Sustainable Development Goals (SDGs), substantial improvements are needed in the type of energy services that the poor have access to"[1]. Therefore, Energy is surely an important aspect of socio-economic development that touches almost every sphere of human life, and an essential requirement for human development. The 2016 World Energy Outlook reported that about 1.2 billion people in the world do not have access to modern energy services. Research has also revealed that around 55% of this population is in Sub-Sahara Africa, and the vast majority of this energy-poor population resides in the rural communities, including the nomadic settlements which are located far from the grid-connected areas, [2]. This reflects in the level of infrastructural development such as educational services, water supply, healthcare, and communications system. It is un-economical to extend the existing conventional grid to the rural communities because of their remoteness [3, 4].

However, when the prospects of being connected to the national grid are low, alternative solutions energy solutions, such as the solar Nano-grids (S_{ng}), solar/wind Nano-grids (S/W_{ng}), solar/diesel Nano-grids (S/D_{ng}), solar/wind/diesel Nano-grids ($S/W/D_{ng}$) and the diesel Nano-grids (D_{ng}) need to be assessed [5, 6]. The rural areas form a part of a nation's economy due to their huge natural resources and the potential for agricultural production such as farming, fishing, livestock, including the hub for raw materials for industrial processes, [7]. Therefore, given the worth and contributions of the rural sector of the economy, the development of the rural communities and villages is expected to be central to the government of developing countries, including Nigeria.

The intent of this study is to propose a Nano-grid system template for a group of nomadic settlements in three locations of the North Central part of Nigeria. The locations are Niger, FCT and Kwara. At the end of this study, an option between solar Nano-grid and wind Nano-grid will be suggested based on their economic advantage. In particular, this study seeks to find possible solution to the incessant herdsmen/farmer clashes through application of modern technology and also serve as a reference point for considering new electrification systems for the energy-poor nomadic settlements in the future.