

Transmission Grid Decongestion Management in Deregulated Power Sector

¹A.U. Adoghe, ²T.F. Sanni, ³P.A. Amaize, ⁴A.E. Aioboman,

^{1,2,3,4}*Department of Electrical and Information Engineering, College of Engineering, Covenant University.*

Abstract: Nigeria as a nation has suffered from epileptic power supply which has affected negatively the economic activities of the citizen. For a sustained development, a constant power supply is needed. Available and reliable electric power supply promised as one of the major benefits of unbundling of nations' own utility is yet to be realized, five years after privatisation of the power sector.

This paper presents an approach that considers the Nigeria power sector in three models:

- power sector before privatisation,
- Current power sector during privatisation.
- The recommended model that consider the reduction of transmission grid congestion.

This model supports helpful technologies such as micro-hydro in rural community, solar power and photovoltaic in regions endowed with sun shines, wind farm in coastal region and energy efficient appliances. This technology when developed in these regions, is capable of reducing system load, site generation close to load centres, and thereby expands effective grid capacity to more rural community.

A common indicator of an economically inadequate grid is congestion, which by definition implies the cheapest available supply cannot be used; therefore a less-congested system can lead to lower electricity prices and less frequent power outages. This model offers significant benefits such as reduced transmission cost, lower congestion and generation costs, increased economic activities of the people and create a sustainable pollution free environment.

Keywords: Grid decongestion, Community development, Transmission grid, privatisation, Sustained development.

I. INTRODUCTION

Electricity has been said to be the fuel of development in any place; local or national. The nation, Nigeria has always has it as an agenda in every change of governance but has been incapable to fulfil its promise. Out of 8663MW installed generation capacity, only 4300MW is available generation about three years after privatisation.

The frequent interrupted power supply of the available generation has greatly affected the economy of the nation. This has resulted in the closure of many industries in Nigeria, most of which had re-located to neighbouring countries where the cost of production is lower. This is because the few remaining industries depend more on fuel-based generators to operate, thereby increasing the cost of production and hence a reduction in their profit margins. Even the man by the road side making his own way of living uses fuel-based generator to generate his own power. This is because of the unreliability of the utility grid.

The government's reform mission was met to improve efficiency in the sector, encourage private sector participation and strengthen the power sector as Nigeria engine of development amongst other goals. The transmission company of Nigeria (TCN) was given a five years management contract to oversee the entire TCN operations including market and system operations. Our transmission capacity was 45838 MVA before privatisation, about three years after, the story seem not to have changed. So even if GENCOS had fulfilled one of their obligations by adding 1000MW every year, the transmission networks do not have the capacity to wheel the generated power to the customers. To obtain a sustainable and reliable transmission system therefore, require a high financial budget which can cause a lengthy delay in achieving the power sector objective of electricity availability. This paper is therefore proposing an alternative regional multiple generating standalone facilities instead of grid connected networks.

A sustainable power supply with development will have to come therefore from smaller generation units which are closer to the consumers. This will also help the local community aware of environmental sustainability and their part in uninterrupted power supply. The consumers will be able to monitor and manage the electricity that is produced which will also come with other benefits; developments of the local community, mutual relationship, environment sustainability, long time uninterrupted power supply and also reduced load on the transmission lines.

With the nation's population, the generated capacity of approximately 4500 MW is not sufficient for a population of about 10 billion people, even if we generate at installed capacity of 8876 MW. A developed Country is said to have an estimation of 1MW to 1000 persons.

II. Power Sector before Privatisation

The electricity in Nigeria before privatisation is vertically integrated, which means the then National Electric Power Authority (NEPA) generated electrical energy, transmitted it from the power plants to the load centres and distributed same to the individual customers as shown in figure 1. In this traditional monopoly, a lot of problems exist that led to frequent power outages and lack of innovation on the part of the utility operators. In an effort to improve the operational efficiency of the power sector and boost the sector cash flow, facilitate mobilization of resources for capital investment on commercial basis, thereby releasing government funds for other investments, there was strong need for power sector reform. The reasons that led most African countries and Nigeria in particular to embrace power sector reform are:

- Access to electricity supply in Nigeria is currently less than 50% with total customer figures at about 5.4 million households.
- Only a tiny fraction of Nigerians are 'officially' connected to public power supply.
- Prolonged FG presence in all sector of the networks.
- Consistent under-investment since the early 80's.
- Poor Management of the gas advantage.

The obvious decline in the sector necessitates the electric power Sector reform agenda.

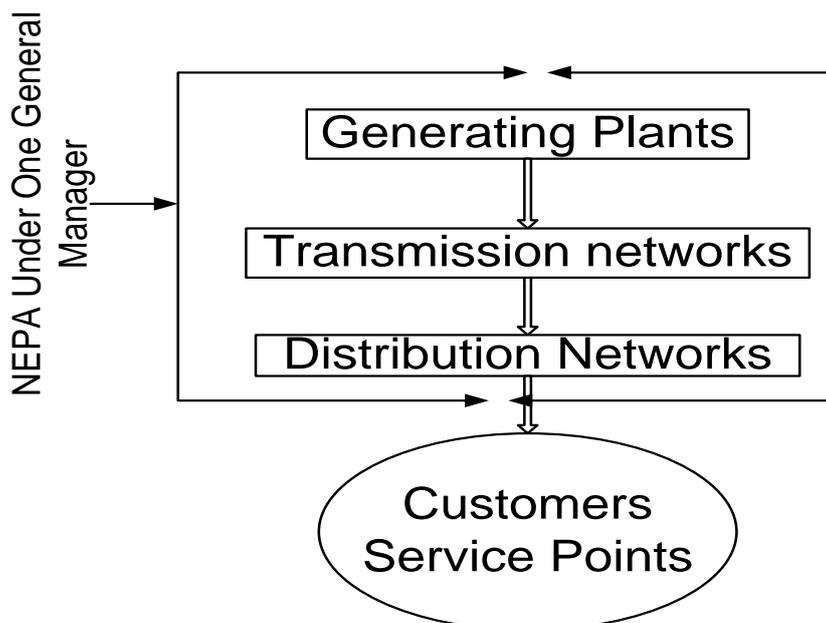


Figure 1 Power sector before Privatization

III. CURRENT POWER SECTOR AFTER PRIVATISATION

The Power sector reform started in 2000 with the Electric Power Implementation Committee (EPIC). The Electric Power Service Regulation (EPSR) Act was drafted in 2001 and became law in March 2005. The then National Electricity Power Authority (NEPA) was transformed into Power Holding Company of Nigeria (PHCN) Plc and later unbundled into 6 Generation Companies (Gencos), One Transmission Company of Nigeria (TCN) and eleven distribution Companies (Discos). The Government's reform agenda was to accomplish one or all of the following: - improve efficiency, - encourage private sector participation, - strengthen the power sector as Nigeria's engine for development, - promotion of competition, - good corporate governance, - financial discipline, - social accountability and efficient use of resources. The privatization of the power sector currently had successfully developed the policy frame work that will enabled all the practitioners in the development of a successful electricity trading system that is hinged on the following key principles:

- That all market activities are governed through enforceable contracts.

- That all the Stakeholders, collectively adhered to the rules guiding market and grid operations.
- There exists fair regulatory practices and cost reflective tariffs that is acceptable to customers.
- That there is competition at all stages of the power system operations that will results in contributory power sector delivery for better cost savings to the end user.

All these were captured in figure 2 that defines and outlines the activities of all the practitioners.

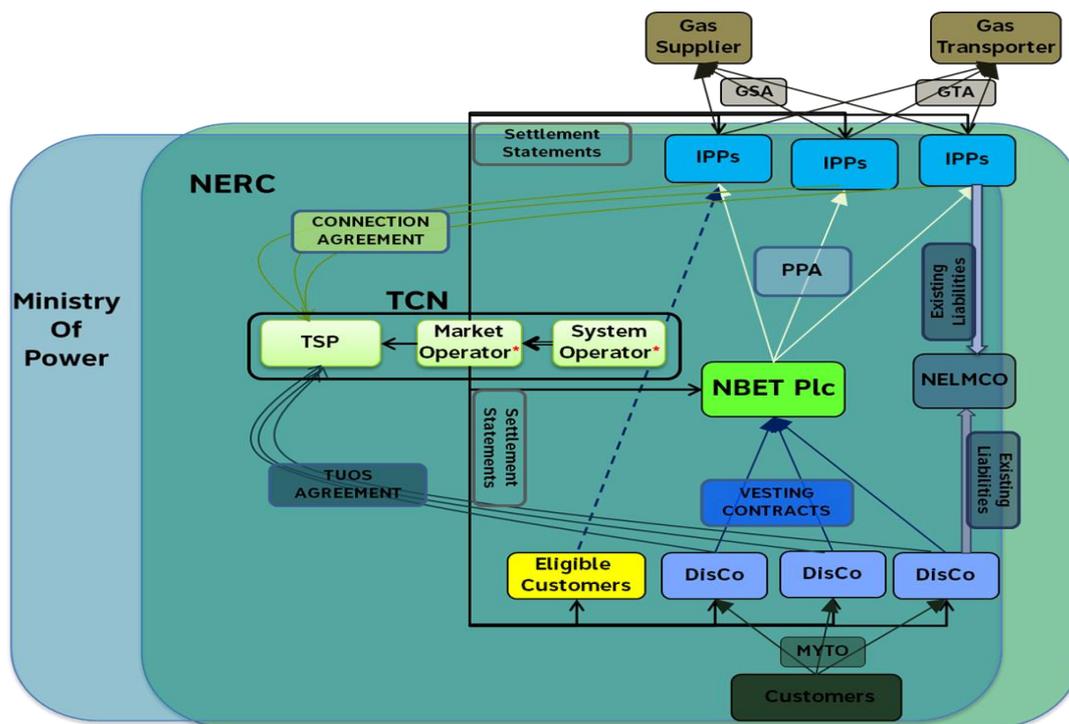


Figure 2 Overview of the Nigeria privatised power sector.
[Source: NBET Plc.]

The function of some of the key items listed in figure 2 is stated for better understanding of the operational model of the current power sector privatisation agenda. This is a gradual transition from a vertically integrated utility to a multiparticipant and competitive electricity industry.

Ministry of Power: This is responsible for broad policy formulation that guides the industry.

NERC: This body regulates/Surveillance of the market and licenses its participants.

Genco / IPP: Produce electricity.

TCN: Responsible for the physical infrastructure that moves bulk power from generators to the various distribution companies.

Market Operations (MO) administers the wholesale electricity market.

System Operations (SO): Responsible for planning, maintenance coordination and scheduling and dispatch of generation.

Distribution Companies (Discos): Responsible for getting electricity to the customer's location and collecting the revenues that feed the entire industry.

Nigeria Electricity Liability Management Company (NELMCO): To manage legacy liabilities and stranded assets.

Eligible Customers (EC): Large consumers who are permitted to purchase electricity directly from the generation companies.

PSA: power sale agreements

PPA: power procurement agreements

Key challenges facing current TCN

The key challenges facing Nigeria TCN after privatisation are as listed below:

- Limited Funds for Development projects.
- Overloaded 132kV Transmission lines and Substations
- Radial Transmission Lines with insufficient redundancies to meet up with N-1 contingency criterion.
- High Technical and Non –Technical losses.
- Obsolete transmission substation equipment.
- Ageing workforce without trained and innovative personnel for replacement.

A high performing TCN is key to extending the network and improving reliability and security of supply as well as facilitating market development.

To improve TCN network performance and decongest the grid therefore requires the provision of autonomous functions for MO, SO and TSP. Establishment of the local staff training center, transfer of knowledge and development of succession plan for personnel of the power sector. The proposed model that considers grid decongestion is presented in the preceding section.

IV. PROPOSED MODEL FOR CONGESTION MANAGEMENT IN DEREGULATED POWER SECTOR.

Congestion management refers to the activities performed to eliminate the congestion in the network. It can also be considered as an organized mechanism used to dispatch, schedule and adjust the generation units and demands in order to handle congestion in the power grid.

Grid congestion is a situation wherein the existing transmission and /or distribution lines are unable to accommodate all required load during periods of high demand or during emergency load conditions, such as when an adjacent line is taken out of service or damaged by a storm or fire, commonly referred to as an N-1 or N-2 condition. Grid congestion not only impacts reliability, it also reflects a decrease in efficiency. Under high load conditions, line losses escalate exponentially.

The model required to manage the congestion comprises of the following:

- 1) There is need for energy policy that will help improve the efficiency, reliability and capacity of the grid by creating incentives for Utilities to invest in grid improvements and leverage new technologies including high capacity low-sag conductors.
- 2) Grid modernization to enable the addition of new alternative ‘clean’ sources of generation and develop and leverage new technology.
- 3) The construction of robust new transmission lines to link new generating plants, existing transmission and distribution lines. This will be robust enough to handle additional load, especially during peak or emergency conditions depending on where and how the new lines are integrated into the existing grid.
- 4) Grid decentralization into four zones comprising of Northern zone grid, southern zone grid, Western Zone grid and the eastern zone grid. This will enable Nigeria power sector divided into four zones with each generating and distributing what is generated within those zones. There will be information and data exchange between zones. This is illustrated in figure 3.

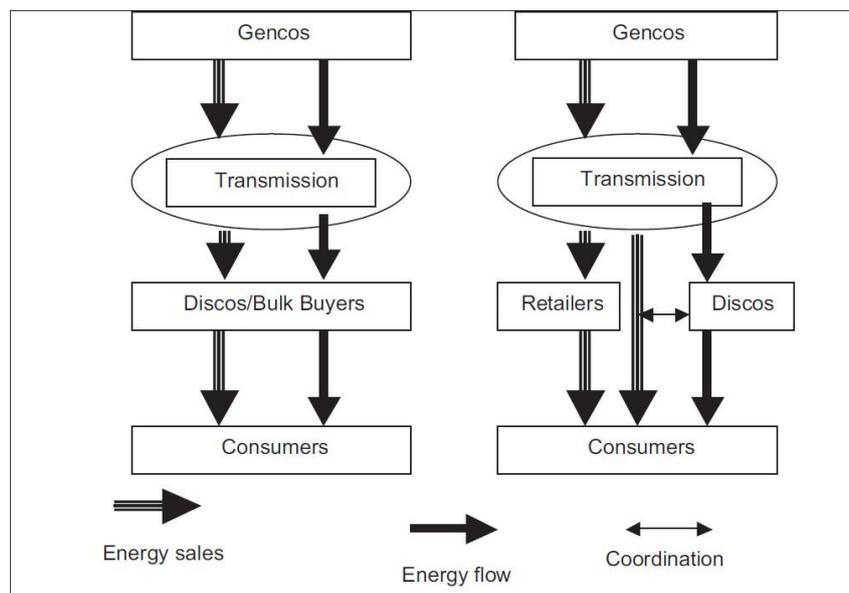


Figure 3 Zonal energy generation and distribution model

V. CONCLUSION

The Nigerian grid which is presently made up of 5650km of 330kV lines and 6687km of 132kV lines are presently operating as a ring grid network with only one control centre at Oshogbo and no redundancy provided. This exposes the grid to a lot of reliability issues and congestion challenges. This paper has discussed the various problems arising from a congested grid system as well as proposing a model for managing congestion issues in Nigeria restructured power sector. It is in this wise that a new model for managing congestion in Nigeria power transmission and distribution sector is proposed in section four. This considers Nigeria power sector splint into four zones, with each zone generating and distributing electricity within those zones thereby reducing the stress on the transmission grid network.

REFERENCES

- [1]. Bjorndal, M &Jornsten, K, "Benefits from coordinating congestion management" The Nordic power market .Energy policy, (2007), vol. 35, pp1978-1991..
- [2]. Engr. H. S. Labo , "Current Status and Future outlook of the Transmission Network" in Investors' forum for the privatisation of PHCN successor companies. Available online: <http://www.nigeriaelectricityprivatisation.com/wp> Content upload / download 2011/02/transmission_company
- [3]. EMOVON, I; KAREEM, B&M.K. ADEYERI" POWER GENERATION IN NIGERIA; PROBLEM AND SOLUTION" CONFERENCE PAPER.NAEE.ORG.NG/FILES/PAPER1.PDF.2015
- [4]. Engr. A.S.A.Bada, "The future of TCN: Ensuring professional management of and investment in the transmission network".unpublished book.
- [5]. Xiaojiang Yu, "An overview of legislative and institutional approaches to China's energy development" 3rd Asian energy conference, Hong Kong, 2008.
- [6]. ShaliniVajjhala, Anthony Paul, Richard Sweeney, and Karen Palmer, "Green Corridors: Linking interregional transmission expansion and Renewable Energy Policies" Article in SSRN Electronic Journal, Jan. 2008.
- [7]. RATNESH K. SHARMA AND KOJI KUDO, " INTEGRATEDMANAGEMENT OF ENERGY STORAGE FOR SUSTAINABLE OPERATION OF ENERGY MICROGRIDS" IN THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, IMECE, VOL. 65711, PP. 255-261, 2011
- [8]. David Meyer, "National Electric Transmission Congestion Study in ENERGY" US Department of Energy Office of Electricity delivery & Energy Reliability, 2015
- [9]. Abeeku Brew-Hammond, "Energy access in Africa: Challenges ahead" A journal of Energy policy, Vol. 38, Issue 5, Pp. 2291 – 2301, 2010.
- [10]. Christian Nissing, Harro vonBlottnitz, "An economic model for energisation and its integration into the urban energy planning process" A journal of Energy Policy, Vol. 38, Issue 5, Pp. 2370 – 2378, May, 2010.