

# A Model for Transmission Grid Decongestion

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**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 privatization of the power sector. This paper presents an approach that consider the Nigeria power sector in three models: power sector before privatization, current power sector during privatization, 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. These technologies when developed in these regions, is capable of reducing system load, site generation close to load centers, and thereby expand 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**—power supply; grid decongestion; transmission grid; sustained development; privatization.

## 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 one of its agenda in every change of governance but has been incapable to fulfil its promise. The installed generation systems are not producing up to their capacity and many of the equipment need maintenance.

The interrupted power supply has greatly affected the economy of the nation which can be seen in the fact that most of the industries and enterprises in the nation; large or small depend more on the fuel-based generators. Generating electricity through this means increases the cost of electricity

which affect the turnover of these businesses. Even the man by the road side making his own way of living uses fuel-based generation. This is because there is little or no supply from the grid.

With the solution that comes from renewable energy, there comes the challenge of connecting it to our old installed transmission system. This is the system that was singularly monitored compared to the other two counterparts; generation and distribution. For a reliable transmission system, it will take some time and also high financial budget which can cause a lengthy delay [1]. An alternative therefore to grid connection is to have multiple smaller generating facilities.

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.

## II. POWER SECTOR BEFORE PRIVITISATION

Power generating plants in Nigeria is shown in the table below, with their installed capacity and what is being produced.

It has been single-handedly managed by the government under the name Nigeria Electric Power Authority (NEPA) which was later changed to Power Holding Company of Nigeria (PHCN).

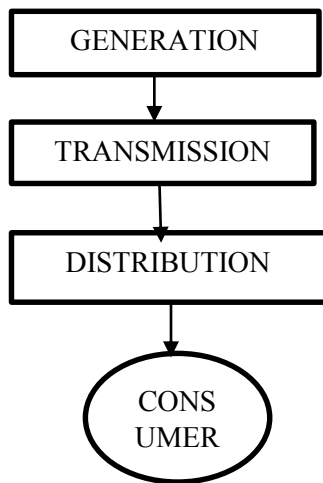


Figure 1: The model before privatization.

The highest generating units are shown below;

TABLE 1: Top quality Generation stations

| Generating Station | Type    | Installed capacity | Available capacity |
|--------------------|---------|--------------------|--------------------|
| Egbin              | Thermal | 1320               | 650                |
| Jebba              | Hydro   | 540                | 482                |
| Kainji             | Hydro   | 760                | 450                |
| Shiroro            | Hydro   | 600                | 450                |
| Afam VI            | Thermal | 650                | 450                |
| Okpai              | Thermal | 450                | 361                |
| Ughelli            | Thermal | 812                | 320                |

Some of the highest producing generation stations [1] having three of them to be hydro which is renewable.

It varies from hydro, natural gas, to coal generating systems [2] and they are expected in total to generate 6426 MW. This section of the power system has been challenged because of the following;

- Inadequate planning and maintenance
- Wrong costing and pricing
- Lack of energy mix
- Lack of adequate training
- Lack of local contribution.
- Non-conservative consumer
- Cost of energy efficient devices

Opportunities for smaller generation by individuals and industries will help for proper conservation and management, investing in power business open to all.

### III. POWER SECTOR DURING PRIVITISATION

It presently consists of 10 generation units with available capacity of 4500 MW, a transmission grid (132kV and 330kV) which was managed by NEPA and also when the name of the body was changed to Power Holding Company of Nigeria.

For transmission company and generating and distributing industries to be accepted has reliable, the following has to be in place [3].

- Independent natural monopoly to operate
- Large capital base
- Strategic planning
- Enforcement of policy
- Management and maintenance

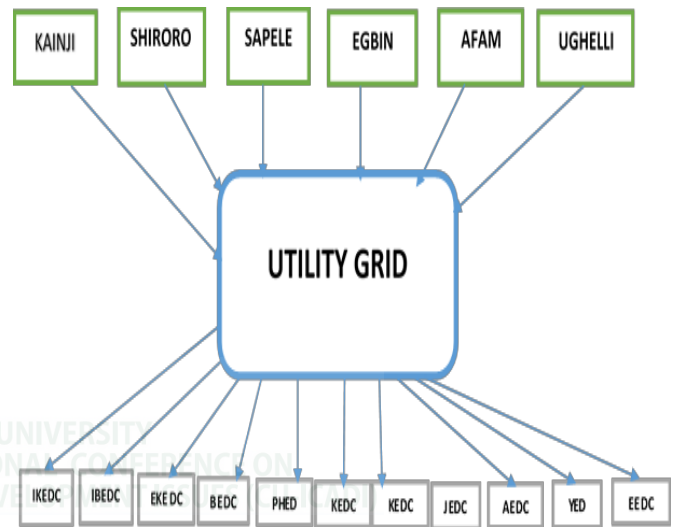


Figure 2: The power sector at privatization.

- Ikeja electricity distribution company plc.
- Eko electricity distribution company plc.
- Ibadan electricity distribution company plc.
- Benin electricity distribution company plc.
- Port Harcourt electricity distribution company plc.
- Kaduna electricity distribution company plc.
- Kano electricity distribution company plc.
- Jos electricity distribution company plc.
- Abuja electricity distribution company plc.
- Yola electricity distribution company plc.
- Enugu electricity distribution company plc.

Figure 2 shows what is achieved especially from the transmission company at the time of commercialization.

At a count, we have 5650 and 6687 kilometers of 330kV and 132kV lines which has no redundancy therefore not reliable and not sufficient [3].

#### IV. PROPOSED MODEL FOR THE POWER SECTOR

A suggestion that was once made from [1] for reliable power supply in the country is the removal of congestion on the grid and also development of human capacity. This is well achieved when we have the society aware and trained to help themselves with the supply of electricity [3].

With the nation's population, the generated capacity of approximately 4500 MW is not sufficient for a population of approximately 170 million even if we generate at installed capacity of 8876 MW. An estimation of 1MW to 1000 persons is estimated for a developed country. With most of our generation from thermal, we can do a shift to renewable.

Electricity in Nigeria has always taken a great part of the country's budget year in year out without adding to the economy. We have been successful in privatising which has helped reduce the GDP percentage that goes for electricity but we have to take a step to increasing its contribution to the nation's economy which can be achieved by having individual private smaller generation units [1].

Renewable energy is defined as a source of energy that is capable of reproducing itself without going into extinction, continuous and unending. Renewable energy has been harnessed in the country in the form of hydro-generation, but a combination of the renewable sources can be of help. This include wind, solar, geothermal and also biomass. Renewable is introduced in every country even the developed for future sustainability; long term or medium term challenges. It is a quick and easy to install with a good study of the environment. It is also a stable and constant power supply source.

Nigeria relatively has a good mix of renewable energy sources which can be harnessed. It has hydro power plants, solar and wind spread across the nation. The northern part of the country has high solar radiations and wind and also the coastal regions. For smaller generation, a study is done at the immediate environment to suggest which will give a better efficiency.

The start-up cost of installation is distributed in the community over a period of years and this will be covered for in years to come. This will play a role in poverty elimination and sustained development. It will also reduce energy waste and misuse.

The one opportunity renewables gives is the possibility of installing smaller generating units and also its direct availability to the consumers. The installed capacity will be enough to serve closer community who is the first priority with the left-over sent to the grid. This is defined and modelled in Figure 3.

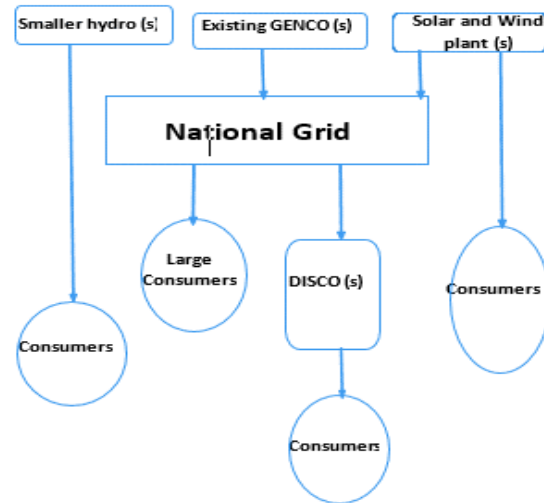


Figure 3: Proposed new model for power sector.

There is also need to have a well-informed statistics of household appliances as to know the capacity needed in a region to know the amount to be generated. Also to help private industries and enterprises [1].

Every nation has its energy policy including Nigeria and it should be practised. There need to be a policy made to enable private generation and distribution. Enforcement of the policies will help to pursue its sustainability.

Though policy interventions have been put forward in exchange for aging infrastructure especially aging transmission systems. These renewable energy based policies will help reduce the load that is being transmitted because needed electricity is generated nearby [3]. This can therefore be sustained by the legal institutions [4]. The following can serve as guides;

- ✓ Energy conservation
- ✓ Green energy production
- ✓ The use of local resources to aid in community development
- ✓ Ecology protection
- ✓ Research institutes and training
- ✓ Inter-community cooperation for generation

Figure 4 is a hierarchy that helps to manage and to see that the policies and operating rules are adhered to.

The above will help to build and sustain a growing economy and also to build a stable, clean and safe energy environment. The business enterprise and social development will also be improved.

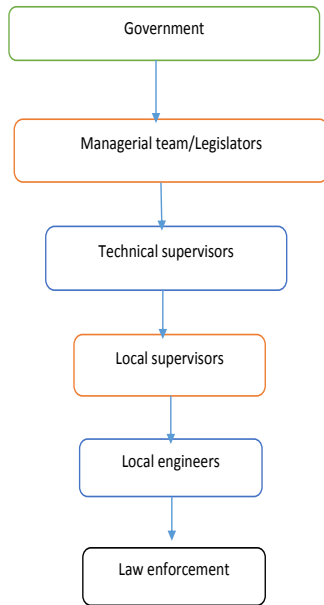


Figure 4: Hierarchy of Policy

Energy efficient devices is also one of the means for constant power supply by reducing power consumption. It is able to reduce home appliance whereby the small capacity that is produced is efficiently managed.

## V. BENEFITS OF THE PROPOSED MODEL IN GRID DECONGESTION

Grid connected transmission are most times affected by geographical locations because the consumers are far from the generation centre or mostly favourable locations [5].

- a. Proper management of the generation, transmission and distribution
- b. Local area development
- c. Reliability of power supply with reduced cost
- d. Preventive maintenance and quick corrective maintenance of installed equipment.
- e. Examples of smaller generation unit

Some locations in the country are more favorable for renewable energy which can be studied and used as generation points. For example, the northern parts.

Constant power supply in local environment will definitely affects business returns, a clean environment, local development and national economy as a whole [1].

## VI. CONCLUSION AND RECOMMENDATION

The Nigerian grid which is presently made up of 5650km of 330kV lines and 6687km of 132kV lines are presently operating without redundancy. Therefore, making the grid unreliable in term of transmitting more power. This paper has discussed the various problems arising from a congested grid system as well as highlighting the benefits of decongesting the grid. It is in this wise that if the recommendations made are adhered to then improvement in power supply will be recorded and the overall effect will be an improvement.

The making of policies to admit private distribution and also awareness of the local community on how they can generate electricity and its efficient use is suggested. Recommendations are as listed below;

1. Those capable of generating can be allowed for private businesses.
2. There should be available policy to allow for power business and augmentation from the federal government.
3. Development in every sector is aided by real time services, this should also be encouraged and enforced in the rural community.
4. New transmission line should be constructed for access to areas where the climate doesn't favour electricity generation.

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