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Deregulation of Electric Power in a Developing Economy: Prospects for Nigeria

Nnoli Kosisochukwu Pal[1], Bolu Jones Ifeanyi[2], Obazenu Jesse Obaro[3]

[1]*Field Service Engineer (FSE), Maintenance Department, MP-Infrastructure Limited, Nigeria*
[2]*Field Service Engineer (FSE), Maintenance Department, MP-Infrastructure Limited, Nigeria*
[3]*Field Engineer, Engineering Department, Valtech Electrical Services, Nigeria*

Abstract - *One of the major challenges facing developing countries is the need for the production of constant power supply. The economic development of any nation is as mostly observed, dependent on the capacity of its power sector. Various measures have been and are still being taken by these developing countries to stabilize the production and supply of electricity. Taking Nigeria for an example, the deregulation of its power sector is the latest approach towards realizing the proposed millennium goals. This invited paper is aimed at discussing the likely deregulation prospects for Nigeria.*

Key Words: Electric power, power sector, developing nation, deregulation, NEPA, PHCN and privatization

1. INTRODUCTION

Deregulation refers to freeing a business, firm or trade from rules and control. Up until10 years ago, we had only the now defunct Nigeria Electric Power Authority, NEPA (now referred to as the Power Holding Company of Nigeria-PHCN) responsible for generating, transmitting and distributing electricity, in addition to the responsibility for regulating itself, but today, Nigeria has different companies generating, transmitting and distributing electricity as well as an independent Commission responsible for regulating the sector. The separation of the different segments of electricity business is what is known as unbundling, inspired worldwide by the examples of Margaret Thatcher in Great Britain in the late 80s and early 90s. This has become a fad across the world today. Another component of the transformation in the sector is that before November 2013, the 10 successor companies that send power to the grid and the 11 companies that sell power to consumers were all owned by the government. Today, these companies are privately-owned and the transmission company is now under the management of the private sector. The liberalization and privatization of electricity sector in Nigeria is what we all know as deregulation'. This marks the end of a phase in the reform of the power sector, but it also marks the beginning of another phase. It ends the phase of structural transformation of the sector and marks the beginning of the phase of cultural and technical transformation [1].

2. CHARACTERISTICS OF THE PRE-DEREGULATION ERA

Since 1896 when the first 20MW of electricity were produced at Marina, Lagos for the lighting purpose, the utility was fully under the control of Government. In 1925, the first private power producer was introduced to the power market by name Nigerian Electricity Supply Company (NESCO) which generated 20MW in Jos for mining purpose [2, 3]. Before the conception of the idea of the deregulation of the power industry, the power supply facilities (Generation, Transmission and Distribution Facilities) were solely owned and operated by NEPA, a federal government agency. The result of this was that NEPA became highly monopolistic in their services due to lack of competition. Electricity supply was very irregular and unreliable. There was absence of private sector participation therefore the sector was commercially non-viable. Inefficient management and poor rate of investment in generation, transmission and distribution also rocked the boat of the power sector during this period. There was a continuous increase in load demand versus virtual static generation level and a high suppressed demand throughout Nigeria [4].

3. FACTORS THAT DROVE THE POWER SECTOR TOWARDS DEREGULATION

Statistics show that only about 40% of the population had access to electricity. From the record, the per capita consumption of those connected to the grid is 100kWh. This is quite poor when compared with that of South Africa, Brazil and China with per capita consumption of 4500kWh, 1934kWh and 1398kWh respectively [2]. The call for power sector reform in Nigeria was primarily as a result of inadequate electricity supply, incessant power outages, low generating plant availability and high technical and non-technical losses that characterized the Nigerian electricity industry. The federal government in 2000 adopted a holistic approach of restructuring the power sector and privatizing of business units unbundled from NEPA. By this development,

NEPA would be unbundled into seven generation companies (GenCos), one transmission company (TransysCo) and eleven distribution companies (DisCos). This arrangement was expected to encourage private sector investment particularly in generation and distribution. This would definitely break NEPA's monopoly and pave way for the entry of independent power producers (IPPs). The structure had since come into effect in January 2004 into what was called the Power Holding Company of Nigeria, PHCN. This structure was to be test-run for two years with a down-pruned management team at the headquarters while the individual managers of the unbundled segments were expected to enjoy some level of autonomy. In the new arrangement, TransysCo would be government owned and managed by system operators (SO) and transmission operators, (TO). The reform bill, approved by the federal executive council (FEC) was intended to achieve five objectives:

- Unbundled NEPA
- Privatize the unbundled entities
- Establish a regulatory agency
- Establish rural electrification agency and fund
- Establish power consumer assistance fund.

4. CHALLENGES FACING THE DEREGULATION PROCESS

In order to tackle the problems identified by the Government, decision to embark on increasing generation capacity and subsequently, expansion of the transmission and distribution lines become key issues. Even so, the challenges of ensuring adequate reliable and widely accessible electricity service involves more than just summing up numbers (the mega-watts and the size of investment) and getting other technical things seemingly right. The fundamental policy issue is to ascertain what should be done, given the resource endowment, the political, economic, technological, environmental constraints in Nigeria. Some of these challenges include [5]:

4.1 Absence of Bankable Gas Supply Agreement

It is generally believed that for any power sector reform to be efficient, the gas supply to the generators must be continuous and certain. In Nigeria, source of fuel feed to most of the generators is gas; hence there is need for a very effective bankable gas agreement between the gas supply companies and the power generating companies. Below is a graph showing the allocation of gas to the power sector.

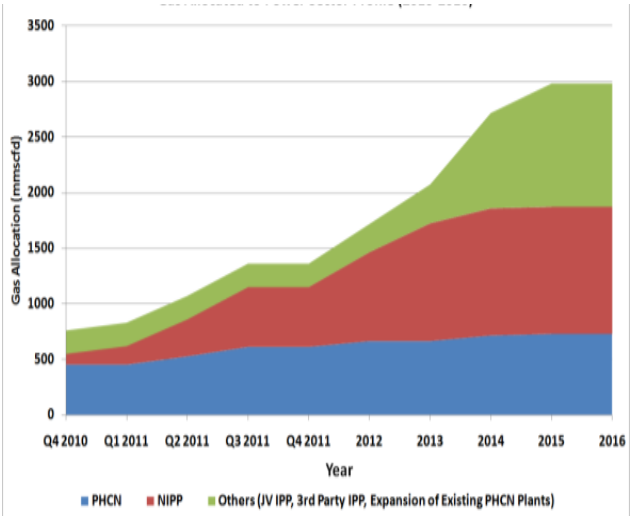

Chart -1: Allocation of Gas to the Power Sector

4.2 Reliability of Installed Power Equipment

It has been observed that most of the installed equipment and facilities already existing in the power industry are way too old. This affects the output efficiency of the utility, thus it is necessary to consider the age distribution of the facilities that are being offered for sale to the private investors. Even though, the Government has been making effort to build new stations, it can be seen that this effort has not been able to overcome the initial lack of provision of funds in the 1990s.

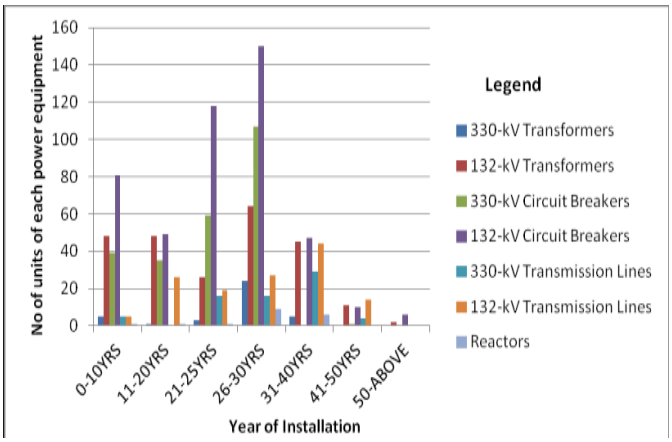

Chart -2: Age Distribution of Major Power Equipment

4.3 Inadequate Transmission and Distribution Facilities

It is observed that the Nigerian grid system is very fragile due to the network topology which is very much radial in configuration. This poses a great threat to the health and survivability of the network in case of any contingency. Thus the system reliability is greatly in need of additional investment on the network.

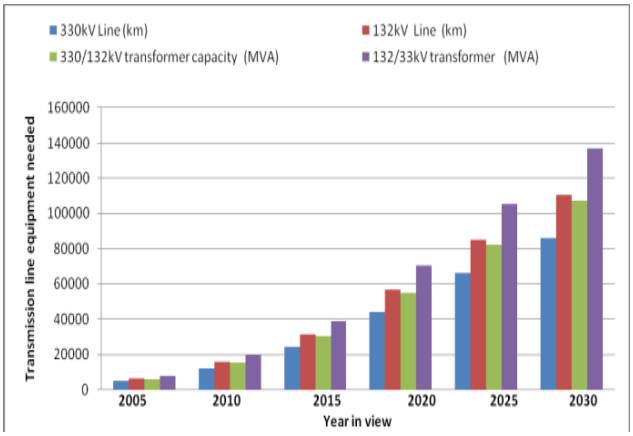

Chart -3: Transmission Network's Power Equipment

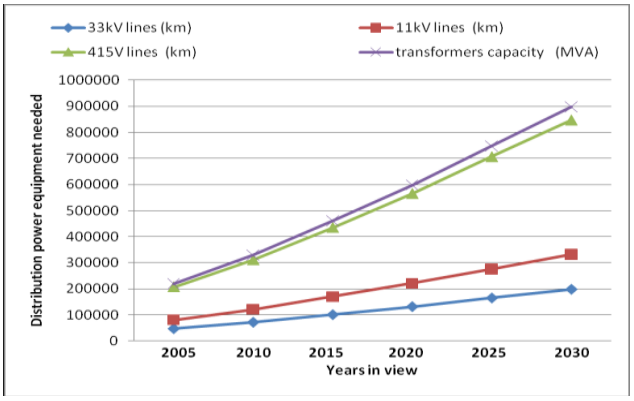

Chart -4: Distribution network's power equipment

There is a tremendous growth in electricity demand in many developing countries but it has been quite impossible for the power demand to be grossly met by the supply. Some of the reasons for inability of the utility to meet the load demand is due to inadequate power transmission and distribution facilities. Below is a graph illustrating the increasing electricity demand in Nigeria.

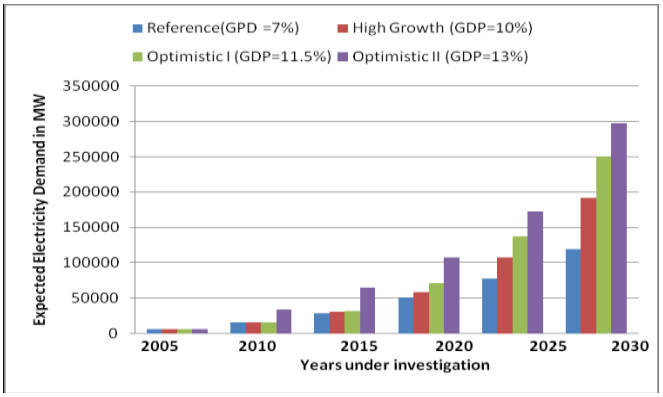

Chart -5: Electricity demand for 2005 to 2030

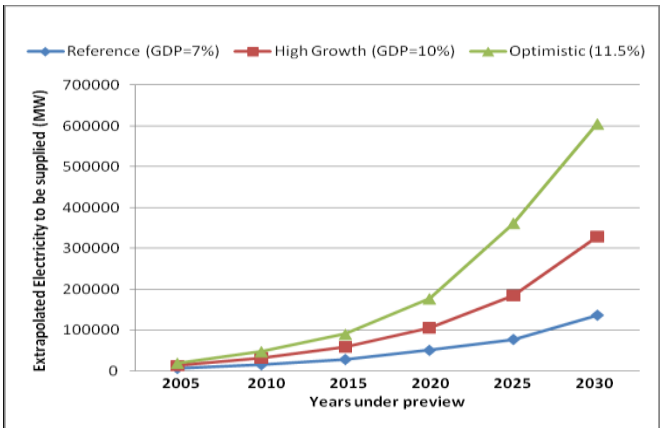

Chart -6: Electricity Supply Projection.

The challenges mentioned above are just a few among the many challenges faced by the deregulation process. Various measures could be taken though to conquer or at least manage these problems.

5. SOLUTIONS TO THE PROBLEMS FACED IN THE POWER SECTOR

A well-developed power system integrates a large number of generating stations so that the combined output is readily available throughout the nation. The location of hydro stations is fixed by the presence of water power while that of steam and gas stations are more flexible .Thus there are a number of solutions that can be able to take the Nigerian Power System out of the woods. These include:

5.1 Building of more stations

The total power generated presently by the power stations in the country cannot meet the demand of the populace hence the government has to work hard on the on-going power projects to see that their respective Megawatts generated are latch on to the national grids. An important condition is, however, the technical feasibility of the centralized and/or decentralized storage of large amounts of electricity More can thus be done in using the distributed generation where by small-hydro and run-of-river generating units are built for the villages and small communities in order to take care of their power requirement without any recourse to the national grid.

The three different scenarios for the future of the electricity grid mainly differ in the size of the electricity generation facilities. The scenario 'super networks' consists of large-scale production locations, transportation via high voltages, a considerable import of sustainable energy (in the form of biomass) and energy from offshore wind farms. The 'hybrid networks' scenario also includes large plants with high voltages that originate from offshore wind parks and large biomass stations. Whereby the load demand as at then could be calculated using a simple but effective long-term load

forecasting method as a factor of trend which could then be obtained using straight line trend as

$$y=a+bx$$

Where **y** is any point on the trend line determined by x.

a and **b** are the constants of the equation,

x is year in which forecasted load is required.

In order to evaluate **a** and **b**, the following equations must be simultaneously solved:

$$\sum y = na + b\sum x$$
$$\sum xy = n\sum x + b\sum x^2$$

Where n is number of data points of historical record. This will give us the accurate amount of energy required to satisfy the population as in the chart 7 below.

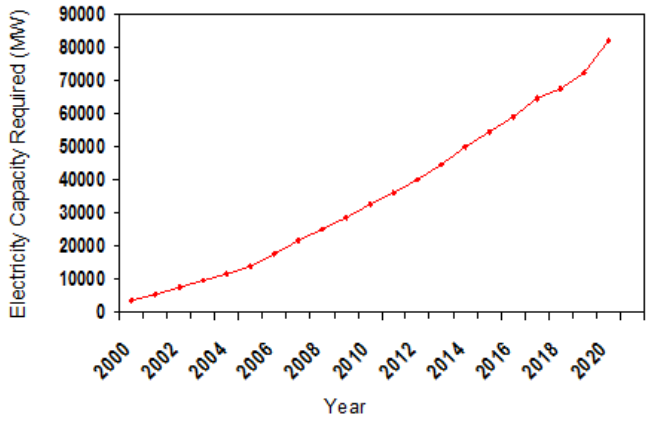

Chart -7: Future Electrical Power demand

While the effective short-term could be obtained thus:

$$Y(i,j) = ADP(j) + AWP(k,j) + WSC(i,j) + TR(i) + SEC(i,j)$$

Where y is load forecast for j^{th} hour of i^{th} day ADP is the average Daily Load pattern at j^{th} hour.
AWP(k,j) is average weekly load increment pattern at j^{th} hour and k^{th} day of the week (k=1, 2...7)
WSC is weather sensitive component at j^{th} hour of the i^{th} day.
TR(i) is trend component of load on i^{th} day

SEC(i,j) is stochastic error component which is assumed to be normally distributed. But in this work, since the long-term has not been met there is no need working for the short-term which is subjected to long-term processes and successes.

With this level of forecasting done then, it will prepare the utility companies to build power stations ahead of time so that the load management can be effectively maintained. The table 7 below can serve that purpose but for a very short period.

Table -1: Planned Installed Capacity of electricity plants in Nigeria [6]

Planned plants	Types	Installed Capacity (MegaWatts)	Year to be commissioned
Papalanto	Gas	330	2007
Omotosho	Gas	330	2007
Geregu	Gas	414	2007
Alaoji	Gas	330	2007
IPP(Oil company)	Gas	3909	2007-2008
IPP (Non-Oil)	Gas	2584	2007-2008
Total Planed Installed Capacity		7897	

5.2 Implementation of modern techniques for electric power conservation

There are a number of ways of optimizing the power system such as the usage of energy efficient equipment and adoption of Demand Side Management (DSM) of the electric power quantity made available for the consumers [7] .Energy conservation is an effective means of stemming wastage of energy. The motivation depends on the sector in which it is to be applied. From the consumer side, the motivation is to keep the electricity bill at its lowest while at the same time the opportunity to procure new gadgets is made available.

5.3 Deregulation as a Solution

Competition needs to be encouraged by the government and the enabling environment needs to be made available for such competition, This has to do with unbundling of the powers system into Generation Company (GENCO), Transmission and system operation company (TRANSYSCO) and the Distribution Company (DISCO) with each of them serving the interest of the citizens to have affordable energy available to them.

5.4 Institution of energy audit

There should be a board that should be involved in the auditing of electric power at intervals of time to ensure that the future of the electricity industry will not jeopardize the growth of the national economy.

5.5 Curtailing the menace of vandals

The effect of vandalism and terrorism on the power industry is more than witnessed by the oil industry's installation in the Niger Delta region of the country hence there should be a concerted effort to formulate the way out of this problem.

5.6 Local Content in execution of new power projects

The government has to have faith in the Nigerian engineers by sending them for courses and making them have a say in any project to be executed by their foreign counterparts. This will ensure that easy maintenance of the projects after commissioning is ensured.

6. POWER DEREGULATION PRINCIPAL DRIVING FORCES

It is pertinent at this point to review the principal driving forces behind this deregulation movement, described by a number of authors [8,9,10,11], include the following:

- The poor performance of the state-run electricity sector in terms of high costs, inadequate expansion of access to electricity service for the population, and/or unreliable supply;
- The inability of the state sector to finance needed expenditures on new investment and/or maintenance;
- The need to remove subsidies to the sector in order to release resources for other pressing public expenditure needs; and
- The desire to raise immediate revenue for the government through the sale of assets from the sector.

7. PROSPECTS OF POWER DEREGULATION PROGRAM IN NIGERIA

In Nigeria for instance, reform of the power sector starts from a market structure that is dominated by a state-owned national power utility with a legally endowed monopoly and a vertically integrated supply chain encompassing power generation, transmission, distribution, and customer services. The rationale for this structure is minimization of the costs of coordination between these functions and of financing the development of power systems.

Power reforms are designed to introduce competition where feasible, which is in the upstream production and downstream supply functions of the industry structure, and to use economic regulation of the wholesale and retail power markets to promote competition and protect consumer interests.

A full-scale deregulation of power program generally consists of the following main objective elements.

1) Obliging electricity enterprises to operate according to commercial principles. This obligation extends to state-owned entities that undertake one or more of the basic functions in the supply chain, namely generation, transmission, system control, distribution, and supply services to users of electricity. The supply services function encompasses the sale of electricity procured on the wholesale electricity market to electricity users and the associated customer services of billing, collection, and maintenance. These principles require that enterprises pay taxes and market-based interest rates, earn commercially competitive returns on equity capital, and have the autonomy to manage their own budgets, borrowing, procurement, and labour employment[12].

2) Introduction of competition in order to improve sector performance in terms of efficiency, customer responsiveness, innovation, and viability: Competition can be developed in the generation- and supply-service segments but in most cases is not feasible in the network segments (transmission, distribution, and system control) because these functions are natural monopolies. Supply services to large electricity users is an intrinsically competitive segment because the cost of competing for their business is small compared with the potential profits. Supply services to all but large electricity users, however, has usually been a monopoly in practice because the profits per customer are too small to stimulate competition. Hence, this element of supply service has generally been carried out by the entity that distributes electricity to these users because both these functions serve the same market. The threshold level of customer demand at which the supply to meet it becomes competitive has been coming down. A further consideration is that consumers must be able to switch between suppliers at low cost, any arrangement in which consumers have to remain with their original supplier gives market power back to the sellers even when the sellers have only modest market shares.

3) Restructuring of the electric power supply chain to enable the introduction of competition. This involves breaking up ("unbundling") the incumbent power utility into multiple generators and distributors of power that trade with each other in a competitive wholesale power market. To prevent the acquisition of anticompetitive amounts of vertical market power by any generators or distributors, transmission, and system control are placed with independent companies (or they may be combined) with restrictions on ownership or on control (through governance arrangements) of such companies by generators and distributors. Independent electricity suppliers should be allowed to compete with

distributors for the custom of large users (this could be delayed in those countries where distribution and supply systems are so dilapidated at the time of privatization that new owners need a period of assured revenues to remedy the worst deficiencies before having to compete for the business of their largest customers), and supply licenses can be granted to generators as well as to firms that specialize in energy trading.

4) Privatization of the unbundled electricity generators and distributors under dispersed ownership, because competition is unlikely to develop properly between entities that are under common ownership—whether state or private.

In Nigeria, furthermore, private investors and operators are expected to bring in financial resources and technical and managerial expertise that will rectify the prevailing low standard of electricity supply by state-owned power utilities.

5) Development of economic regulation of the power market that is applied transparently by an agency that operates independently from influence by government, electricity suppliers, or consumers. In the wholesale market, the focus of regulation is to prevent anticompetitive abuses of market power. In the retail market, the focus of regulation should be on balancing the interests of suppliers with the interests of their captive customers.

6**)** Focusing of government's role on policy formation and execution while giving up the roles of operator and investor with divestiture of state ownership in generation and distribution.

The process of a full deregulation program therefore consists of the following four main stages: (a) formation and approval of a power policy by government that provides the broad guidelines for the reform program and the heavy political commitment needed to sustain the reform process, followed by the enactment of legislation necessary for implementing this policy; (b) development of a transparent regulatory framework for the electricity market; (c) unbundling of the integrated structure of the power supply and establishing a market in which electricity is traded at arm's length; and (d) divestiture of the state's ownership at least in most of the electricity generation and distribution segments of the market.

8. CONCLUSIONS

If the synthesis of the elements of deregulation as discussed in this paper are accurately integrated under all necessary technical requirements, the successful implementation of the power deregulation process at stabilizing power supply in Nigeria will be attainable. The Nigerian power sector has gone through a lot of hard times and a lot of lessons must have been learnt during these times leaving one with the hope that this (deregulation) will be the final step towards solving this lingering problem. I'm still of the opinion that the problem in the power sector was not totally as a result of government ownership because if the deregulation process is handled improperly it may not cause any significant change. If Nigeria must achieve its millennium development goals, this deregulation has to work.

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REFERENCES

[1] Sam Amadi, "Opportunities, Challenges and Prospects in Nigerian-Electricity" http://www.dailytrust.com.ng/sunday/index.php/business/16745-opportunites-challanges-and-prospects-in-nigerian-electricity-market/ visited on 27/11/216

[2] Isaac Malgas and Anton Eberhard; "Hybrid power markets in Africa: Generation planning, procurement and contracting challenges", Energy policy, vol. 39, pp. 3191-3198, 2011.

[3] Stephen Karekezi and John Kimani; " Status of power sector reform in Africa: impact on the poor", Energy Policy, vol. 30, pp. 923-945, 2002

[4] Bart Nnaji," Power Sector Outlook in Nigeria: Challenges, Constraints and Opportunities", NAEE 4th annual conference April, 2011.

[5] P.O. Oluseyi, T. O. Akinbulire and C. O. A. Awosope," Evaluation of the Roadmap to Power Sector Reforms in a Developing Economy", 9th International Conference on the European Electricity Market (EEM 12), Florence (Italy), May 10 – 12, 2012.

[6] F.I.Ibitoye and A.Adenikinju; "Future Demand for Electricity in Nigeria", ScienceDirect Applied Energy, vol 84, 2007, pp 492-504.

[7] P.O.Oluseyi, T.O.Akinbulire and C.O.A Awosope; "A Novel Improvement of Electric Power Reliability Scheme in Nigeria: Demand-Side Management Approach", 22nd NSE (Electrical Division) Int. Conf. proc., ICEPT 2006, pp1-5.

[8] Bacon R. W.. "Privatization and Reform in the Global Electricity Supply Industry", In Annual Review: Energy and the Environment." 20: 119-43, 1995.

[9] World Energy Council, "The Benefits and Deficiencies of Energy Sector Liberalisation", Volume I. World Energy Council, London. 121 pp. 1998

[10] Patterson, W., "Transforming Electricity", Earthscan, London. 203 pp, 1999.

[11] International Energy Agency, "Electricity Market Reform: An IEA Handbook". OECD/IEA, Paris. 106 pp., 1999.

[12] R. W. Bacon and J. Besant-Jones," Global Electric Power Reform, Privatization and Liberalization of the Electric Power Industry in Developing Countries", Energy & Mining Sector Board Discussion Paper Series Paper no.2 June 2002.

BIOGRAPHIES

Nnoli Kosisochukwu Pal graduated from the Department of Electronic and Computer Engineering of the Nnamdi Azikiwe University, Awka. He was a Support Engineer at Redington Nigeria (a subsidiary of Redington Gulf). He was also a Drive test Engineer at Spectrum Communications Ltd as well a Field Service Engineer with MP-Infrastructure Limited. He is currently running his post-graduate studies in Electrical Engineering at the University of Rostock, Germany. A member of IEEE, IAENG, NSE, NSBE, NIM (Chartered). His research interests spans across telecommunication power sources, expert systems, Power systems and machines, Renewable Energy and Energy Conversions.

Jones Bolu Ifeanyi graduated from the Department of Electrical Electronics Engineering (Power Systems) of the Federal University of Technology, Owerri. He was an Engineer with Power Holding Company of Nigeria. He is a Field Service Engineer with MP-Infrastructure LTD. He is currently seeking for a Post-graduate Program in Electrical Electronic Engineering at a recognized University in Germany. A member of IEEE, NSE, SEEES. His research interests spans across Power Systems-and-Machines, Telecommunication power sources, Expert Systems, Electrical Power/Energy Generation, Renewable Energy and Energy conversion.

Obazenu Jesse Obaro graduated from the Department of Electrical and Electronic Engineering of the Federal University of technology, Owerri. He is a Field Engineer with Valtech Electrical Services. A member of IEEE, SEES and NSE. His research interests spans across Electrical power /energy Generation, distribution and transmission, expert systems, Power systems and machines, Renewable energy and energy conversions.