

# **ECONOMIC EFFICIENCY ISSUES IN ELECTRICITY ECONOMICS**

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# Introduction

- Most developing countries electricity market is currently undergoing a restructuring and liberalization process which is at various stages of completion. The ultimate objective of this process as in many developed countries where this has been achieved is the creation of an internal competitive electricity market. This complex trajectory can only be completed when efficiency increases in the power supply chain are accomplished, while safeguarding security of supply. In addition, it necessitates severe reforms such as allocative changes in property rights, for national regulatory authorities, network and transmission operators, the power producers, wholesalers, consumers and other market participants in any reforming country.
- The continuing academic debate in liberalization and privatization theory, regarding industries that are of vital importance for the social welfare in an economy, and involve public good, such as electricity, centres around the proper level of government regulation in a market economy. It also centres on the level of efficiency gains by the choice of governance structure.
- This paper is structured as follows: In section 2, we give some operational definitions of economic efficiency and analyze types, section 3 discusses economic efficiency and security of electricity supply while section 4 looks at issues of efficiency in Nigerian electricity market.



# Economic Efficiency and measurement

- Economic efficiency is used to relate to a number of related concepts. It can be defined as the using of resources in such a way as to maximize the production of goods and services. One economic system is said to be more efficient than another (in relative terms) if it can provide more goods and services for society without using more resources.
- In absolute terms, a system can be said to be economically efficient if:
- No one can be made better off without making someone else worse off.
- More output can be obtained without increasing the amount of inputs.
- Production proceeds at the lowest possible per unit cost.
- The theory of economic efficiency is based on two strains of economic thoughts, which respectively, emphasized **(1) the distortions created by governments (and reduced by decreasing government involvement); and (2) the distortions created by markets (and reduced by increasing government involvement).**



# THEORY OF SECOND BEST

- Micro economic reforms (as being witnessed in the power sector) are policies that aim to reduce economic distortions via deregulation and increase economic efficiency. However, there is no clear theoretical basis for the belief that removing a market distortion will always increase economic efficiency. The theory of the 'second Best' states that **'if there is some unavoidable market distortion in one sector, a move towards greater market perfection in another sector may actually decrease efficiency'**. For example, if there is a distortion in oil and gas sector, which is viewed as unavoidable, a move towards market perfection in the electricity sector may only lead to inefficiency; since oil and gas complement electricity supply.

# Types of Economic Efficiency

- There are several types and criteria for measuring economic efficiency, these include:
- Pareto efficiency
- Kaldor-Hicks efficiency
- x-efficiency
- Allocative efficiency
- Productive Efficiency
- Optimization of social welfare function
- Utility maximization
- We will look at the main thrust of three of these criteria in relation to electricity economics viz, productive efficiency allocative efficiency and x-efficiency



# Productive efficiency and security of Electricity Supply

- Firms are assumed to be internally efficient and produce maximum output for a given set of input variables and therefore minimize production cost. There are two sources of productive efficiency viz – technical and allocative efficiency.
- **Technical efficiency:** firms are assumed to be technical in- efficient when they use more inputs than needed for a certain amount of output and efficient when a certain capital – labour combination is on the best practice isoguant.
- **Allocative Efficiency:** Allocative efficiency grasps the inefficiency arising from technical efficient capital-labour combinations given output prices. This type of efficiency is reached when the value that consumers place on a good or service (reflected in the price they are willing to pay) equals the production cost, hereby satisfying the condition that the price equals marginal cost.
- **X-efficiency:** Is based or rooted in the internal operation of the firm. According to Leibenstein who propounded the theory in 1966, this type of efficiency stems from substantial gains from sources such as motivation of decision makers, within the firm to use inputs optimally, and re-organization of materials handling.







# Monitoring Economic Efficiency

- Economic efficiency could be monitored by
  - identifying the indicators, such as the marginal cost function of a power generator, which are known to be highly dependent on the raw material used (in particular the fuel price and conversion efficiency curve),
  - the level of reserve capacity or power price levels.
  - A simple measure of allocative efficiency, that uses prices and volumes on the balancing market to monitor economic efficiency gains have been introduced.

# Security of Supply of Electricity

- Long-term availability of primary fuel supply.
- Security of a reliable power generation and distribution chain
- These will much depend on the power/energy portfolio mix.
- Security of supply is defined as the extent of continuity of power supply on mid-long term (two to seven years) determined by investment in production capacity, electricity consumption and its demand –supply matching mechanisms.







# Monitoring Indicators

- The experts claim that quality of monitoring the level of security of supply should be preferably based on a selection of set of indicators; which may lead to new insights in the current level of security of supply in near future (e.g probability of fall outs). The ranked sets of indicators are:
- **Validity** – does a change in indicator automatically imply a change in the security of supply?
- **Availability and reliability** of required data
- **The signaling value** – indicator should preferably provide insights two to seven years ahead, so that extension of capacity can be realized.



# Electricity productivity and Efficiency

- For effective analysis of economic efficiency in electricity use, we must analyze the electricity demand patterns and electricity productivity or a given economy, especially based on the impact of any improvements.
  - Electricity productivity of an economy is defined here as the ratio of the electricity consumed to the gross domestic product (GDP) in naira per kilo watt hour.
  - It is the inverse of the electricity intensity of the economy, defined as the kilowatt hours consumed per naira of GDP.
  - The electricity productivity of the economy which is the GDP produced per kilowatt-hour consumed is an aggregate indicator, and reflects the technological efficiency of electricity use.
  - A relative shift in output from electricity intensive activities such as smelting, to general manufacturing or services will cause electricity productivity (and hence efficiency) to increase.

# Issues of Economic Efficiency in Nigeria Power Market

- The motivation for electricity reform in Nigeria as in most developing and transition countries has been to improve the economic and financial performance of the sub-sector which must be balanced with improved welfare of the consumers. Many governments are no longer willing to support the burden of inefficiency of the sub-sector, marked by
  - high subsidies,
  - low service quality,
  - non collection of rates,
  - high network losses and
  - poor service coverage.





# Comparison of Dutch Electricity Reforms and Nigerian Reforms

- Netherlands has one of the most efficient electricity power systems in Europe. Nigeria in contrast has one of the worst power systems in sub-saharan Africa. Both are in reforming process.
- While internal market reform of the Dutch power market effectively started in 2003, that of Nigeria started in 2005.
- The models of Dutch wholesale power markets and that of Nigeria are shown in Fig 1.





### Dutch Reform 2003

Around 10 production companies, including 4 vertical integrated companies (VIC) that Account for approx. 50% of total demand

Tenne T

Derivative Market

APX Balancing

Around 12 distribution companies of varying size, including 4 large VIC

### Nigerian Reform 2005

Around 6 production/ Generation companies. With non vertically integrated

Nigerian Electricity Regulation Company  
NERC

1 Transmission Company

11 Distribution Companies, without a know VIC

*Fig. 1 Dutch and Nigerian Reformed Power Market Compared.*

**Tenne T** was establish for the Dutch Power Market to ensure that a competitive internal market is established, in which prices are determined by supply and demand, and that economic efficiency and continuity of supply would be guaranteed.



# Issues of Transmission

- Tenne T, is also a natural independent transmission operator, responsible for connecting all grids. Tenne T, also monitors the reliability (eg. Maintenance), and continuity of supply. The equivalent of Tenne I Dutch is the NERC of Nigeria. NERC is charged with all the above functions of Tenne T, but I do not think it is responsible for transmission, and connecting all grids. How independent and nationalistic is that singular company that would transmit the generated power in Nigeria) Efficiency may be compromised if care is not taken to properly define and align the roles of the transmission company with those of others in generation and distribution.



# Issues of Derivative Market

- The Dutch derivative markets and Amsterdam Power Exchange (APX) are other independent companies producing and supplying power, mainly from other sources of energy apart from gas, the major source of Dutch power generation.
- It is not yet clear which companies would generate power from other sources of energy such as coal, solar, biomass and wind and even nuclear, to complement our hydro and geo thermal being the only exploited sources.
- Much as we know what our electricity supply mix would likely be in the next 20 years, how and from where it will come is largely not known.



# Issues of Balancing Market

- Tenne T, Dutch manages a balancing market, which are companies obliged to offer reserve power to the market, called programme – responsible (PR) companies. PR companies have more than 60mw capacity supply power. With this Tenne T manages power flows on the grid and actively responds to possible total power deficit or surplus in a 15 minutes basis.
- **Balancing market** Companies' arrangement is not found in the Nigerian market reform arrangement. Issues of balancing market must be designed and incorporated in Nigerian Power Market if efficiency is to be guaranteed.
- Nigeria in an attempt to mitigate energy supply challenges and enhance efficiency has approved the establishment of a National Centre for Energy Efficiency and conservation, to operate under the auspices of the Energy Commission of Nigeria. How efficient this proposed efficiency centre will be in tackling issues and challenges of efficiency in the power market under reform is yet unknown.



## Conclusion:

- Reforms for efficiency in developing countries power market must be total and follow the best practices of countries with success stories. For Nigeria to achieve economic efficiency in reforming her power market, issue of transmission and grid management, development of derivative markets and market balancing must be critically addressed.