

THE BUSINESS OF PROFITABLE BULK SALE OF ELECTRIC ENERGY: A CASE STUDY OF INDEPENDENT POWER PLANT (IPP) OKPAI, DELTA STATE, NIGERIA.

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ABSTRACT

Power generating companies involve in bulk sale of electric energy should at end of the investment, be at least able to get back their capital they invested in the business in addition to some profit made. The returns of the business is brought about by the energy tariff of the investor. However, care should be taken in fixing tariff for the bulk sale of energy to keep customers, make profit and remain in business. This paper have presented and compared two ways of fixing two – part tariff for bulk sale of energy for power generation companies to adopt and use depending on what and how they want to market their product (electric power) to consumers. These are the ascending and descending tariff plans. For the systems used as a case study, the result showed that the investor should peg his tariff at ₦239.08/kWh and ₦0.072/kWh for ascending and ₦257.54/kWh and ₦0.072/kWh for the descending plans for the start for the variable and fixed tariff respectively should be adopted to make a net profit of 5% if the investment capital. These figures will be increasing and decreasing with time for ascending and descending methods respectively.

Keywords: Fixing, Tariff, Methods Comparison, Electricity

I Introduction

Building any power plant especially by cooperate individuals is to a large extent aimed at making profit; however, the individual or cooperate entities must know that to make this profit, bulk energy buyers (transmission companies) should be willing to buy from him and this will be depend on the rate at which he sells his energy from the law of demand and supply (Jain, 2014). For a market with many sellers and buyers of this commodity (energy), selling electricity should be done considering among others the following.

- (i) Ability and willingness of the consumer to pay
- (ii) Leveled cost of electricity (LCOE)
- (iii) Quality of Services rendered.
- (iv) Total Asset Life Cycle (LCC)

Out of the above three factors, the second and fourth factors are quantifiable (Benth et al, 2014), (Goutam and Krishnendranath, 2017).

The rate at which electric energy is sold to consumers is known as tariff (Chiaroni et al, 2017); fixing competitive tariff by these generating companies especially in a competitive market shall be examined in this paper. Two methods that can be used by these companies shall be examined and compared in this work:

- (a) The ascending tariff method – Where the tariff at the beginning stage of the business is low and later begins to increase.
- (b) The descending tariff method – Where the tariff at the beginning stage of the business is high and later begins to decrease

Advantages of Ascending Tariff Plan include:

- 1. It is better to give little financial obligations to a new business with few customers by setting low initial tariff.
- 2. Setting low tariff at the early stage of the business will attract more buyers/costumers for the energy bulk seller.

However, it's disadvantages include:

- 1. This will place high tariff at a time the plant efficiency and reliability has dropped significantly.
- 2. At the later part of the plant's life where efficiency has dropped, costumers tend to go to another bulk energy seller. Increasing tariff at this stage will be harsh to the business as it will encourage loss of costumers.

The advantages of Descending Tariff Plan include:

- 1. High profits are made during the optimum efficiency stage of the plant.
- 2. It could be encouraging for beginners of a business to make more profit, it makes a business man put in more effort in his new found business.

However, the disadvantages of the Descending Tariff Plan is that with this tariff plan, the high tariff at the beginning of the business can militate against the bulk seller getting customers for his business.

II Model formulation factors

The formulation of the model to be used to determine electric energy bulk sale will depend on a number of parameters. These among others include

- 1. Cost of fuel to be burnt during the period under analysis. A percentage fuel consumption increment shall be adopted at the end of every three years during the plant's life time; say 2%. For first three years of the plant (1 – 3 years), annual cost of fuel burnt is ₦FC; the plant life of 04 -06 years, annual cost of fuel burnt is ₦1.02FC and so on
- 2. Taxation, Insurance and Interest payable on invested capital.
- 3. Expected profit (a percentage of the invested capital). The profit should be a very small percentage of the investment cost and should be spread throughout the lifetime of the plant.

$$P_T = a\% \text{ of } IC = \frac{a(IC)}{100} \tag{1}$$

IC = Installation cost; a = numeric value; P_T = Total expected profit

- 4. Expected energy to be generated in the period under analysis.
- 5. Estimated maintenance cost during the period under analysis.

6. Estimated salaries and wages of staffs throughout the period under analysis.
7. Load factor.

$$Lf = \frac{\text{expected average power demanded}}{\text{expected maximum power demanded}} \quad (2)$$

This Lf decreases as the plant is aging.

8. Depreciation of the power plant over its expected useful life time.

III Ascending Tariff Plan

Formulating this model will employ the straight line depreciation method in depreciating the power generator.

We shall adopt the nomenclature below for this model

NOMENCLATURE

IC	Installation cost of the Plant (₹).
S	Salvage value of plant after m years (₹).
m	Lifetime of the plant (years)
CD_g^h	Cash deposit to be made for between year 'g' and 'h' (₹).
TI	Cash paid for tax and insurance per annum (₹).
r	Interest rate (% of IC).
z	Compound interest rate per annum on cash reservations.
I	Interest paid on capital per annum (₹).
MC	Expected/estimated maintenance cost per annum (₹).
MPD	Maximum power delivered (MW)
K	Fix tariff (₹/kWh).
t_g^h	Variable tariff for 'g' to 'h' year (₹/kWh).
SW	Expected salaries/wages per annum (₹).
M	Expected Miscellaneous expenses per annum (₹).
D_k	Dividend made from deposit from the k^{th} year to the m^{th} year (₹).
P_T	Expected total profit to be made in the investment (₹).
P	Expected profit to be made per annum (₹).
a	% of installation cost to be made as profit by investor
FC	Annual Cost of fuel burnt (₹)
Y	Period under analysis
x	Rate of depreciation per annum. n, g, h 1, 2, 3 year.
V_n	Value of plant after n^{th} year.
Lf	Load factor

The cash reservation made each year is given as (Gupta, 2009),

$$CD = \frac{IC-S}{m} \quad (3)$$

Hence, for three years, a reservation of $3CD = CD_1^3$ will be made. However, as long as these monies are deposited at the speculated time, they are compounded annually to yield some dividend to the investor;

$$D_k = CD \left[\left(1 + \frac{z}{n}\right)^{n-k} - 1 \right] \quad (4)$$

Dividend earned for the deposit/cash reservation for the first 3 years of the plant is

$$D_1 + D_2 + D_3 = D_1^3 = CD \left[\left(1 + \frac{z}{41}\right)^{41} - 1 \right] + CD \left[\left(1 + \frac{z}{40}\right)^{40} - 1 \right] + CD \left[\left(1 + \frac{z}{39}\right)^{39} - 1 \right] \quad (5)$$

And for any 3-year period, I, j and k, the dividend earned for the deposit/cash reservation is

$$D_i + D_j + D_k = D_i^k = CD \left[\left(1 + \frac{z}{42-i}\right)^{42-i} - 1 \right] + CD \left[\left(1 + \frac{z}{42-j}\right)^{42-j} - 1 \right] + CD \left[\left(1 + \frac{z}{42-k}\right)^{42-k} - 1 \right] \quad (6)$$

These dividends go to the investor as earnings that are considered and recorded when setting tariff plan.

A 3-year analysis period shall be used in this paper. However, using a smaller time frame will result in more number of equations but will give more accurate results.

Considering the first 3 years of the plant, the sum of all expenses made during the three years minus the total dividend that will be earned for the deposited monies must be equal to the total earnings during the period.

Hence,

$$CD_1^3 - D_1^3 + 3TI + 3MC + \frac{3rIC}{100} + 3FC + 3M + 3SW + \frac{3aIC}{100m} = Lf \times MPD \times 3 \times t_1^3 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 K \quad (7)$$

The next 3 years,

$$CD_4^6 - D_4^6 + 3TI + 3.1MC + \frac{3rIC}{100} + 3.02FC + 3.1M + 3SW + \frac{3aIC}{100m} = Lf \times MPD \times 3 \times t_4^6 \times 8.76 \times 10^3 + 3 \times 1.3 \times 8.76 \times 10^3 \times K \quad (8)$$

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The last (k^{th}) ten years

$$150[CD_{k-2}^k - D_{k-2}^k + 3TI + 3MC + \frac{3rIC}{100} + 3 \dots FC + 3 \dots M + 3SW + \frac{3aIC}{100m}] = Lf \times MPD \times 3 \times t_{k-2}^k \times 8.76 \times 10^3 + 8.76 \times 10^3 \times 3 \dots \times K \quad (k)$$

The sum of the RHS of equations (8) to (k) is the sum of the present worth of the installation cost and the total profit to be made at the end of the investment by the investor.

$$Lf \times 3 \times MPD \times 8.76 \times 10^3 \times [t_1^3 + t_4^6 + \dots + t_{k-2}^k] + 3 \times 8.76 \times 10^3 \times [K + 0.3K + \dots + \dots \times K] = IC + P_T \quad (9)$$

IV Descending Tariff Plan

Formulating this model will employ the declining balance depreciation method in depreciating the power generator.

Using the declining balance depreciation method, the value of the plant at the end of the n^{th} year is

$$V_n = (1 - x)^n IC \quad (10)$$

$$\text{Where } x = 1 - \left[\frac{S}{IC} \right]^{\frac{1}{m}} \quad (11)$$

Hence, the cash deposit to be made at the end of each year is

$$CD = V_k - V_{k-1} \quad (12)$$

The deposited cash for any 3 consecutive years is,

$$CD_{k-3}^k = [V_k - V_{k-1}] + [V_{k-1} - V_{k-2}] + [V_{k-2} - V_{k-3}] \quad (13)$$

Now combining all the expensive incurred in running the plant for a 3-year interval plus 3 times the expected annual profit; should be equal to the total money realized from sale of energy for the 3 years.

Considering the first 3 years of the plant,

$$150 \left[CD_1^3 + 3TI + 3MC + \frac{3rIC}{100} + 3FC + 3M + 3SW + \frac{3aIC}{100m} \right] = Lf \times MPD \times 3 \times t_1^3 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 K \quad (14)$$

The next 3 years,

$$150 \left[CD_4^6 + 3TI + 3.1MC + \frac{3rIC}{100} + 3.02FC + 3.1M + 3SW + \frac{3aIC}{100m} \right] = Lf \times MPD \times 3 \times t_4^6 \times 8.76 \times 10^3 + 3 \times 1.3 \times 8.76 \times 10^3 \times K \quad (15)$$

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The last (k^{th}) three years

$$150 \left[CD_{k-2}^k + 3TI + 3MC + \frac{3rIC}{100} + 3 \dots FC + 3 \dots M + 3SW + \frac{3aIC}{100m} \right] = Lf \times MPD \times 3 \times t_{k-2}^k \times 8.76 \times 10^3 + 8.76 \times 10^3 \times 3 \dots \times K. \quad (k2)$$

The sum of the RHS of equations (15) to (k2) is the sum of the present worth of the installation cost and the total profit to be made at the end of the investment by the investor [4].

$$Lf \times 3 \times MPD \times 8.76 \times 10^3 \times [t_1^3 + t_4^6 + \dots + t_{k-2}^k] + 3 \times 8.76 \times 10^3 \times [K + 0.3K + \dots + \dots \times K] = 150[IC + P_T] \quad (16)$$

In developing the models, the following assumptions were made:

1. It was assumed that the maximum output power delivered by the plant will be constant throughout its useful lifetime.
2. The system is free from inflation.
3. Interest rates are constant throughout the period.

V Model Testing

Nigeria's first ever Independent Power Plant (IPP), capable of generating 490MW of electricity, commissioned by Former Nigerian President, Olusegun Obasanjo at Okpai, Kwalle, Delta State shall be used in testing of this model. This plant has a capital cost of \$480million and uses 75 million standard cubic feet of gas per day (scfd) for its operation. The parameters of the power plant are given in table 1.

Table 1: Estimated Plant's Operational data

ITEM	VALUE	ITEM	VALUE
IC	\$480M	S	\$30M
TI	\$15,000	MC	\$25,000
M	\$50,000	SW	\$200,000
Lf (0-70% of lifetime)	0.896	Lf (71-100% of lifetime)	0.850
FC	\$1,000	MPD	460MW
r	5%	m	30 years
x	8%	a	5%
P _T	\$24M		

(Source: Nigerian Agip Oil Company, 2002)

In the analysis of this power plant to be used as a case study, the following assumptions shall be made:

1. Dollar to Naira rate of 2003 (₦150 to \$1) was used in the analysis.
2. An assumed Interest rate of 8% of the capital was used for the analysis.
3. A life span of 42 years was used as the actual 30 years was for when the plant runs for 24 hours per day for its entire life time which is practically impossible as a result of shunt down during maintenance, e.t.c.
4. The fuel here is a by-product of petroleum exploration; hence, no increase over the years was taken into account as most part of the fuel cost is the capital cost of the gas line from the flow station where the petroleum exploration is taking place to the gas plant. Hence, the per annum cost is the total cost of the gas line divided by the plant life time.
5. A profit of 5% of capital cost of the project was assumed to be targeted by investor.
6. It was assumed that the fixed tariff will be increasing at a rate of 30% at the end of every 10 years.
7. A bank compound interest rate z of 0.5% was used (common with most Nigerian banks)

For the Ascending tariff plan,

$$CD = \frac{\text{₦}150 \times (480 - 30) \times 10^6}{42} = \$10.71M$$

the plant tariff model for 1st to 3rd year is

$$150[3 \times 10.71 \times 10^6 - D_1^3 + 3 \times 15,000 + 3 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 10,000 + 3 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42}] = 0.896 \times 460 \times 10^3 \times 3 \times t_1^3 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times K \quad (17)$$

Tariff model for 4th to 6th year is

$$150[3 \times 10.71 \times 10^6 - D_4^7 + 3 \times 15,000 + 3 \times 1.2 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 1.2 \times 10,000 + 3 \times 1.05 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42}] = 0.896 \times 460 \times 10^3 \times 3 \times t_4^6 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times 1.3 \times K \quad (18)$$

Tariff model for 40th to 42nd year is

$$150[3 \times 10.71 \times 10^6 - D_{40}^{42} + 3 \times 15,000 + 3 \times 3.6 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 3.6 \times 10,000 + 3 \times 1.65 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42}] = 0.850 \times 460 \times 10^3 \times 3 \times t_{40}^{42} \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times 4.9 \times K \quad (19)$$

and

$$460 \times 10^3 \times 8.76 \times 10^3 \times [0.896 \times (t_1^3 + t_4^6 + t_7^9 + \dots + t_{28}^{30}) + 0.850 \times (t_{31}^{33} + \dots + t_{40}^{42})] + 10 \times 8.76 \times 10^4 \times K[1 + 1.3 + 1.6 + 1.9 + \dots + 4.9] = IC + P_T \quad (20)$$

Finding the solution to these fifteen set of equations using a program developed in MATLAB gives the following values on Table II.

Table 2: Results for ascending tariff plan

t_1^3	239.08	t_4^6	239.58
t_7^9	240.07	t_{10}^{12}	240.57
t_{13}^{15}	241.06	t_{16}^{18}	241.56
t_{19}^{21}	242.06	t_{22}^{24}	242.55
t_{25}^{27}	243.08	t_{28}^{30}	243.54
t_{31}^{33}	231.51	t_{34}^{36}	231.98
t_{37}^{39}	232.45	t_{40}^{42}	232.94
K	0.072		

Hence, the tariff within the period for this tariff plan is given in Table III

Table 3: Ascending Tariff for periods under analysis

S/N	PERIOD (YEAR)	VARIABLE TARIFF (₦/ kWh)	FIX TARIFF (₦/ kWh)	TOTAL TARIFF (₦/ kWh)
1	1 – 3	239.08	0.072	239.1520
2	4 – 6	239.58	0.0936	239.6736
3	7 – 9	240.07	0.1152	240.1852
4	10 – 12	240.57	0.1368	240.7068
5	13 – 15	241.06	0.1512	241.2112
6	16 – 18	241.56	0.1728	241.7328
7	19 – 21	242.06	0.1944	242.2544

8	22 – 24	242.55	0.2160	242.7660
9	25 – 27	243.08	0.2376	243.3176
10	28 – 30	243.54	0.2592	243.7992
11	31 – 33	231.51	0.2808	231.7908
12	34 – 36	231.98	0.3024	232.2824
13	37 – 39	232.45	0.3240	232.7740
14	40 – 42	232.94	0.3456	233.2856

Using these data for descending tariff plan,

$$x = 1 - \left[\frac{s}{tc} \right]^{\frac{1}{m}} = 0.064 \quad (21)$$

The cash deposits for every three years is given below

Table 4: Computed cash deposit to be made in stated periods

PERIOD (YEAR)	CASH DEPOSIT (\$)
1 – 3	86.39
4 – 6	70.83
7 – 9	58.10
10 – 12	47.63
13 – 15	39.07
16 – 18	32.03
19 – 21	26.27
22 – 24	21.54
25 – 27	17.66
28 – 30	14.12
31 – 33	11.88
34 – 36	9.74
37 – 39	7.99
40 – 42	6.55

The plant tariff models for years are

Between the 1st to the 3rd year,

$$150 \left[CD_1^3 + 3 \times 15,000 + 3 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 10,000 + 3 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42} \right] = 0.896 \times 460 \times 10^3 \times 3 \times t_1^3 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times K \quad (22)$$

4th to 6th years is

$$150 \left[CD_4^7 + 3 \times 15,000 + 3 \times 1.2 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 1.2 \times 10,000 + 3 \times 1.05 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42} \right] = 0.896 \times 460 \times 10^3 \times 3 \times t_4^6 \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times 1.3 \times K \quad (23)$$

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40th to 42nd year

$$150[CD_{40}^{42} + 3 \times 15,000 + 3 \times 3.6 \times 50,000 + \frac{3 \times 0.08 \times 480 \times 10^6}{100} + 3 \times 1,000 + 3 \times 3.6 \times 10,000 + 3 \times 1.65 \times 200,000 + \frac{3 \times 0.05 \times 480 \times 10^6}{100 \times 42}] = 0.850 \times 460 \times 10^3 \times 3 \times t_{40}^{42} \times 8.76 \times 10^3 + 3 \times 8.76 \times 10^3 \times 4.9 \times K \quad (24)$$

and

$$460 \times 10^3 \times 8.76 \times 10^3 \times [0.896 \times (t_1^3 + t_4^6 + t_7^9 + \dots + t_{28}^{30}) + 0.850 \times (t_{31}^{33} + \dots + t_{40}^{42})] + 10 \times 8.76 \times 10^4 \times K[1 + 1.3 + 1.6 + 1.9 + \dots + 4.9] = 150[IC + P_T] \quad (25)$$

Again finding the solution to these fifteen set of equations using a developed MATLAB program gives the following values:

Table 5: Results for descending tariff plan

t_1^3	257.54	t_4^6	251.70
t_7^9	247.01	t_{10}^{12}	243.24
t_{13}^{15}	240.24	t_{16}^{18}	237.87
t_{19}^{21}	236.01	t_{22}^{24}	234.58
t_{25}^{27}	233.48	t_{28}^{30}	232.53
t_{31}^{33}	220.19	t_{34}^{36}	219.83
t_{37}^{39}	219.62	t_{40}^{42}	219.53
K	0.072		

Hence, the tariff within the period for this tariff plan is given in Table 5.

Table 6: Descending Tariff for periods under analysis

S/N	PERIOD (YEAR)	VARIABLE TARIFF (₦/kWh)	FIX TARIFF (₦/kWh)	TOTAL TARIFF (₦/kWh)
1	1 – 3	257.54	0.072	257.6120
2	4 – 6	251.70	0.0936	251.7936
3	7 – 9	247.01	0.1152	247.1252
4	10 – 12	243.24	0.1368	243.3768
5	13 – 15	240.24	0.1512	240.3912
6	16 – 18	237.87	0.1728	238.0428
7	19 – 21	236.01	0.1944	234.2044
8	22 – 24	234.58	0.2160	234.7960
9	25 – 27	233.48	0.2376	233.7176
10	28 – 30	232.53	0.2592	232.7892
11	31 – 33	220.19	0.2808	220.4708
12	34 – 36	219.83	0.3024	220.1324
13	37 – 39	219.62	0.3240	219.9440
14	40 – 42	219.53	0.3456	213.8756

VI Discussion of Results

With a targeted profit of 5% of the investment capital at the end of the useful life time of the power plant/business, two set of two – part tariff (fixed and variable) have been developed for the investor to use. The first is when the investor increases tariff as the business progresses (ascending tariff plan) while the other is decreasing tariff as the business progresses. The results generated provides a clear picture of how the investor should fix tariff when the plant is in the business of power generation.

The results show a tariff of ₦239.08/kWh and ₦0.072/kWh for the variable and fixed tariff respectively for the first three years for the ascending tariff plan while for the descending plan, the investor should sell energy at a rate of ₦257.54/kWh and ₦0.072/kWh for the variable and fixed tariff respectively for the same period under analysis. The result also showed a tariff of ₦242.55/kWh and 0.2160/kWh for the variable and fixed tariff respectively between the 22nd and 24th year of the business for the ascending tariff plan; the descending tariff plan for same year period is 234.58/kWh and 0.2160/kWh for the variable and fixed tariff respectively.

However, it is noticed that from the 31st year of the plant/business existence, where the load factor/efficiency is expected to drop from 0.896 to 0.850 [6], output will drop, maintenance cost will increase, e.t.c. This will affects the tariff, hence, between the 31st to 33rd year, the tariffs are ₦231.51/kWh and 0.2808/kWh for the variable and fixed tariff respectively for ascending tariff plan and ₦220.19/kWh and 0.2808/kWh for the variable and fixed tariff respectively for the descending tariff plan. Finally, between the 40th and 42nd year of the business, (which is supposed to be the end of the business), the ascending two – part tariff plan are ₦232.94/kWh and ₦0.3456/kWh for the variable and fixed tariff respectively and 219.53/kWh and 0.3456/kWh for the variable and fixed tariff respectively for the descending tariff plan.

VII Conclusion

Models developed in this paper shows how investors in power generations can fix tariff from the start to end of the business (life span of the power plant) in such a way that a targeted net profit will be made. Annual cash inflow was considered to be at its peak at the middle of the business and the net value of the business on a three – year interval was taken into account. Two patterns have been presented here, the investor should make the choice on which pattern he is to adopt for his business. The implication of using this model in a country like Nigeria is that energy tariff may rise unless governments will as usual subsidies it for her citizens.

References

1. Benth, F. E., Kholodnyi, V. A. and Laurence, P. (2014): Quantitative Energy Finance Modeling, Pricing and Hedging in Energy and Commodity Markets. *Springer New York Heidelberg Dordrecht, London*, pp 41 – 80.
2. Chiaroni, D. Chiesa, V. Franzò, S. Frattini, F. and Latilla, V. M. (2017): The impact of the electricity tariff reform on renewable energies and energy efficiency investments: The case of the Italian residential market, *International Journal of Green Energy*, pp. 889 – 898.
3. Goutam D. and Krishnendranath M. (2017): A literature review on dynamic pricing of electricity, *Journal of the Operational Research Society, Palgrave Macmillan; The OR Society, Vol. 68, Issue 10*, pp. 1131 – 1145.
4. Gupta J. B. (2009): Generation and Economic Considerations. *S. K. Kataria and Sons, Delhi – 110006, India*, pp 245 – 306.

5. Jain, E. (2014): Impact of Law of Demand & Supply on Stock Market: A Study of Most Active BSE Indices with the Help of RSI, *IOSR Journal of Economics and Finance (IOSR-JEF)*, Vol. 5, Issue 6, pp. 6 – 15.

6. Nigerian Agip Oil Company, (N.A.O.C) (2002): 490MW Independent Power Plant (IPP), Okpai, Data book.

Biography



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