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Analysis of Cost for Power Generation Plants Case Study Nigeria

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Abstract:
Nigeria is blessed with oil and natural resources but the country cannot be said to have ever had adequate supply of electric power in the history of its electricity generation. This might get worse, as the country's population increases and economic development is calling for more demand of energy. It is therefore, imperative that adequate measures should be taken from our power plants to cater for Nigeria impending industrialization and its energy crisis which leaves many industries running at high cost and keeps many private homes in blackout. Since power generating plant is the engine room that drive industrialization, well-being and comfort for man and its environment. This work considered the analysis of cost for power generation plants case study Nigeria with the view to determine the best technique that can be used to achieve future planning installation of thermal and hydro power plant in order to optimize cost savings. Calculations and analysis were made using annual straight line depreciating reserve ($ASLD_R$), annual diminishing value reserve (ADV_R) and annual sinking fund reserve (ASF_R) with the aim to input the best technique that will investigate the true trend of cost of installation into the projected future plans between years 2011–2035 (25 years). The study revealed that $ASLD_R$ gives consistent linear values as compared to the two other techniques (ADV_R and ASF_R). The annual straight-line depreciation reserve ($ASLD_R$) cost of installation of afam thermal power plant in 2011 was (₦185, 480,000,000.00) and ASF_R was ₦53, 914,223,700.00 while ADV_R was ₦0.6195. In the case of Kainji hydro power plant, the $ASLD_R$, ADV_R and ASF_R was N5, 155,200,000, ₦0.7229.00 and ₦149, 848,300.00 respectively. The subsequent cost of installation of thermal and hydro power plants was obtained and conducted via excel platform from 2011-2035.

Keywords: *Cost analysis, sinking fund reserve, annual diminishing value reserve, thermal plant, annual straight line depreciating reserve, optimization*

1. Introduction

The power sector is a critical infrastructure needed for the economic, industrial, technological and social development of Nigeria. Power consumption has become one of the indices for measuring the standard of living of a country. In Nigeria, power sector is presently being managed by the Power Holding Company of Nigeria (PHCN) as a vertically integrated utility comprising generation, transmission and distribution segments. The national electricity grid presently consists of fourteen generating stations, three (3) hydro and eleven (11) thermal with a total installed capacity of about 8,351.4 MW. The Transmission network is made up of 5000 km of 330 KV lines, 6000 km of 132 kV lines, 23 of 330/132 KV substations, with a combined capacity of 6000 MVA or 4600 MVA at a utilization factor of 80%. In turn, the 91 of 132/33 kV substations have a combined capacity of 7800 MVA or 5800 MVA at a utilization factor of 75%. The Distribution sector comprised of 23,753 km of 33 kV lines, 19,226 km of 11 kV lines, 679 of 33/11 kV substations. There is also 1,790 distribution transformer and 680 injection substations. Although the installed capacity of the existing power stations is 8,351.4 MW, the maximum load ever achieved was little above 4000 MW. Some of the power stations generate less than 45% of their installed capacities. By May, 2009 the average, generating capacity was about 2800 MW daily owning to corruption, political, grossly inadequate funding and mismanagement reasons. Currently, most of the generating units have broken down due to limited available resources to carry out the needed level of maintenance. Hence, the electricity network has been characterized by constant system collapses as a result of low generating capacity by the few generating stations presently in service. Repositioning of the power sector is a key stimulus to the rapid industrialization of all key sectors of the economy like manufacturing, telecommuni-cations etc.
Since electrical energy is produced from energy available in various forms in nature, it is desirable to look into the various sources of energy.

These sources of energy are: (i) The Sun (ii) The Wind (iii) Water (iv) Fuels (v) Nuclear energy. Out of these sources, the energy due to Sun and wind has not been utilised on large scale due to a number of limitations. At present, the other three sources viz., water, fuels and nuclear energy are primarily used for the generation of electrical energy.

A hydro power station uses potential energy of water at high level for generating electrical energy. This power station is generally located in hilly areas where dams can be built conveniently and large water reservoirs can be obtained. This kind of power station can be used to produce large amounts of electrical energy. In most countries these power stations are used as peak load power stations. This is because they can be started and stopped easily and fast.

A steam/thermal power station uses heat energy generated from burning coal to produce electrical energy. This type of power station is widely used around the world.

This power station uses the Rankine cycle. This is the cycle of the steam produced in the boiler, then taken to the Steam turbine (Prime mover). From the turbine the steam is cooled back to water in the Condenser**,** the resulting water is fed back into the boiler to repeat the cycle.

Because of the abundance of fuel (coal), this kind of power station can be used to produce large amounts of electrical energy. In most countries these power stations are used as base load power stations. This is because steam power stations are slow to start and cannot be used to cater for peak loads that generally occur for a short duration.

These power stations (together with nuclear power stations) are kept running very close to full efficiency for 24 hours a day (unless they are being maintained). They have typical life of 30 to 40 years (although most governments have reduced this number to 35 years).

This project aims at analyzing the cost of power generation plants in Nigeria using the Methods of Determining Depreciation. The targeted thermal and hydro power stations are the (Egbin, Ughelli, Afam) and (Kainji, Shiroro, Jebba) power stations respectively.

2. Problem Statement

Nigeria has been burdened with the problem of inadequate electricity generation for a long time now; the PHCN generates electricity from 9 power stations and more are still proposed construction, which are six thermal and three hydro stations. The six thermal stations are Afam, Delta, Egbin and Ijora which run on gas, while Sapele power station runs on gas and steam, Oji River runs on coal and the rest like Kainji, Jebba and Shiroro run on hydro and they are run on water.

The paper will analyse the cost of power generation and provide reliable means of electricity power supply in Nigeria using the Methods of Determining Depreciation. Also, to determine the operational & maintenance cost, the fuel cost and the cost of establishing a power plant in Nigeria.

3. Aim of the Paper

The aim of this paper is to analyse the cost of selected power generation plant in Nigeria on the view to consider the best type of power generation plant.

4. Objectives of Paper

The following research objectives were formulated to guide the paper:

- To analyse the cost of thermal and hydro power plants, particularly the initial capital costs and the salvage cost.
- To collect numerical data from Nigeria bureau of statistics (NBS), Transmission company of Nigeria (TCN) and the maintenance department of the various selected power plants for the purpose for this paper.
- To analyse and compare the best power generation type to optimize for cost saving.

5. Scope of the Paper

The paper focus on the cost analysis regarding the generation of electricity at selected power plants in Nigeria

6. Justification of Paper

- It will help investors and planners for infrastructural development, expansion and investment opportunities in the Nigeria power sector
- It will ensure optimum service delivery from the power generation companies
- It will enhance efficient utilization of resources from the power generation companies

7. Review of Previous Papers

With the growth in industrialisation and population, there has been an increasing demand for electrical energy in Nigeria. Power generation in Nigeria is mainly from three hydro-electric power stations, steam and gas thermal stations (British Electricity International, 1991). Most of these facilities are being managed by the National Electric power Authority (NEPA), which as a result of unbundling and the power reform process, was renamed Power holding Company of Nigeria (PHCN) in 2005. PHCN is a government owned utility company that co-ordinates all activities of the power sector be it production, transmission, distribution, or marketing and sales. Growth in thermal plants in Nigeria started with the installation of steam thermal plants at Oji river (1956), 4 unit gas thermal plants in Ijora (1966/78), 20 units gas thermal plants in Delta (1966/90), 4 steam thermal plants at Sapele (1978/80), another 18 unit gas thermal plants were installed at

Afam (1982) and 6 steam thermal plants at Egbin (1985/87) [19]. A total of 6 power stations in all, consist of a total of 55 units capable of producing a total capacity of 5,988 MW of electricity. The poor performance of these thermal plants has contributed immensely to incessant power outages and economic loss. [19] in their report in 1994 revealed that only 15 out of the 55 units were available for power generation as at 1994. The then Minister of Power and Steel, Chief Agagu 2001 put the record at 20 out of 78 units (25.6%) were functional before 1999 and by 2001 the percentage had moved to 43.8% with the additional 2 units added while 17 units were under rehabilitation. For greatest economic benefit, the availability of the most efficient and modern plant must be high. [2] reported that Nigeria's economic losses from unreliable power generation and supply was put at a staggering N66 billion (equivalent to $0.55 billion).

8. Generating Stations

Bulk electric power is produced by special plants known as generating stations or power plants. A generating station essentially employs a prime mover coupled to an alternator for the production of electric power. The prime mover (e.g., steam turbine, water turbine etc.) converts energy from some other form into mechanical energy. The alternator converts mechanical energy of the prime mover into electrical energy. The electrical energy produced by the generating station is transmitted and distributed with the help of conductors to various consumers [18]. It may be emphasized here that apart from prime mover-alternator combination, a modern generating station employs several auxiliary equipment and instruments to ensure cheap, reliable and continuous service. Depending upon the form of energy converted into electrical energy, the generating stations are classified as under:
(i) Thermal (Steam) power stations (ii) Hydroelectric power stations (iii) Diesel power stations
(iv) Nuclear power stations

Power Plant	Installed Capacity (Mw) as at March 2012	Available Capacity (Mw) as at March 2012
Fgn Owned Plants (Phcn+Nipp)		
Hydro:		
Jebba	540	197
Kainji	760	225
Shiroro	600	100
Thermal:		
Egbin	1320	580
Afam Iv & V	726	60
Delta (Ughelli)	900	81
Geregu	414	153
Omotosho	755	0
Olorunshogo	304	136
State Govt Ipps:		
Aes (Lasg)	297	199
Ibom Power (Aksg)	190	56
Omoku-1 (Rvsg)	150	28
Trans-Amadi (Rvsg)	100	14
New Afam I & Ii (Rvsg)	360	0
Ipps Of The Oil & Gas Industry:		
Okpai (Naoc)	480	408
Afam Vi (Spdc)	650	421
Total	6643	653

Table 1: Installed Generation Capacity and Available Capacity in Nigeria as at March 2012

8.1. Thermal Power Plants/Station

A generating station which converts heat energy of coal combustion into electrical energy is known as a steam power station. A steam power station basically works on the Rankine cycle [6]. Steam is produced in the boiler by utilizing the heat of coal combustion. The steam is then expanded in the prime mover (i.e., steam turbine) and is condensed in a condenser to be fed into the boiler again.
The steam turbine drives the alternator which converts mechanical energy of the turbine into electrical energy [5]. This type of power station is suitable where coal and water are available in abundance and a large amount of electric power is to be generated.

8.2. Advantages

- The fuel (i.e., coal) used is quite cheap.
- Less initial cost as compared to other generating stations.
- It can be installed at any place irrespective of the existence of coal. The coal can be trans- ported to the site of the plant by rail or road.
- It requires less space as compared to the hydroelectric power station.
- The cost of generation is lesser than that of the diesel power station.

8.3. Disadvantages

- It pollutes the atmosphere due to the production of large amount of smoke and fumes.
- It is costlier in running cost as compared to hydroelectric plant.

8.4. Schematic Arrangement of Thermal Power Station

Although steam power station simply involves the conversion of heat of coal combustion into electrical energy, yet it embraces many arrangements for proper working and efficiency. The schematic arrangement of a steam power station is shown in Figure 2.1**.** The whole arrangement can be divided into the following stages for the sake of simplicity:

- Coal and ash handling arrangement
- Steam generating plant
- Steam turbine
- Alternator
- Feed water
- Cooling arrangement

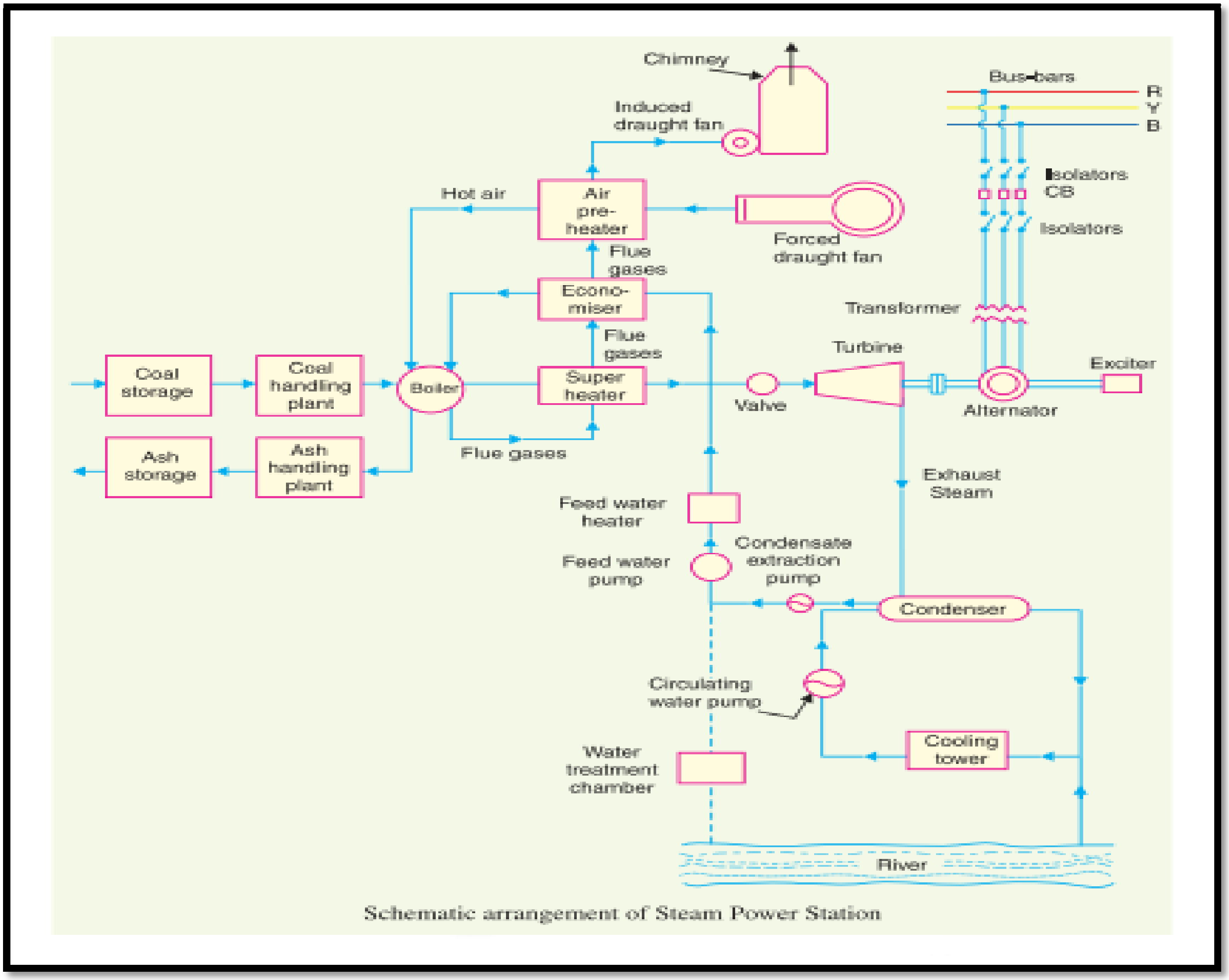

Figure 1: Schematic Arrangement of Thermal Power Station

8.5. Electrical Equipment

A modern power station contains numerous electrical equipments. However, the most important items are:

- Alternators. Each alternator is coupled to a steam turbine and converts mechanical energy of the turbine into electrical energy. The alternator may be hydrogen or air cooled.
- Transformers. A generating station has different types of transformers, viz.
- Main step-up transformers which step-up the generation voltage for transmission of power.
- Station transformers which are used for general service (e.g., lighting) in the power station.
- Auxiliary transformers which supply to individual unit-auxiliaries.
- Switchgear. It houses such equipment which locates the fault on the system and isolates the faulty part from the healthy section. It contains circuit breakers, relays, switches and other control devices.

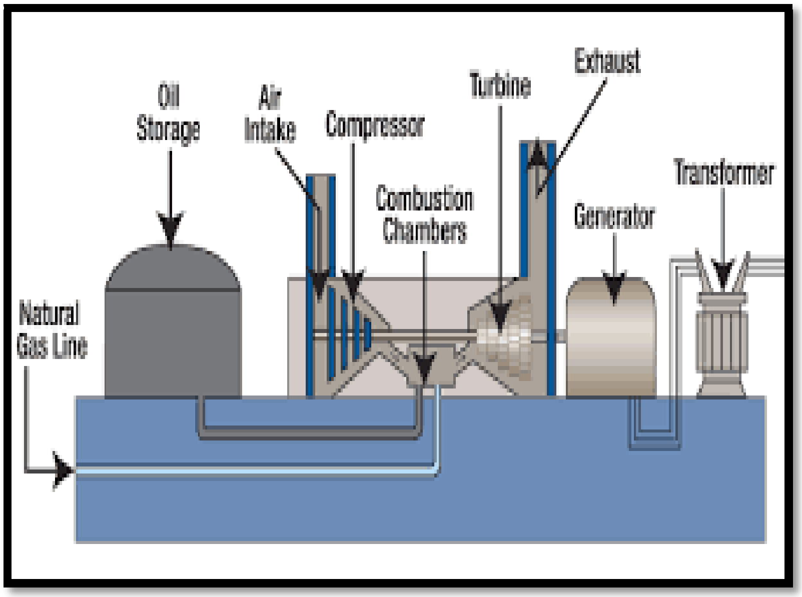

Figure 2: Combustion Turbine Power Plants

9. Materials and Methods

9.1. Research Design

The descriptive survey research design was used for the study. Surveys are used for obtaining information concerning facts, opinions and behaviors using interviews, observations and such related methods. As this study deals with cost analysis of selected power generation plants the choice of a survey is deemed fit for the paper.

9.2. Data Collection Method

The data for this research was obtained from the Nigeria bureau of statistics (NBS), Transmission company of Nigeria (TCN) and the maintenance department of the various selected power plants for the purpose of this research analysis under review.

9.3. Data Analysis

Analysis of power generation systems are of scientific interest and also essential for the efficient utilization of energy resources. The data of the power generating plants (Egbin, Afam, Ughelli thermal power plants and Jebba, Shiroro, Kainji Hydroelectric power plants) were analyzed using methods of determining depreciation: straight line, diminishing value, and sinking fund techniques with all the input variables fixed in the model equations.

9.4. Cost of Electrical Energy

The total cost of electrical energy generated can be divided into three parts, namely;

- Fixed cost
- Semi-fixed cost
- Running or operating cost

9.4.1. Fixed Cost

It includes Initial cost of the plant, Rate of interest, Depreciation cost, Taxes, and Insurance. It is the cost which is independent of maximum demand and units generated.

9.4.2. Semi-Fixed Cost

It is the cost which depends upon maximum demand but is independent of units generated. The semi-fixed cost is directly proportional to the maximum demand on power station and is on account of annual interest and depreciation on capital investment of building and equipment, taxes, salaries of management and clerical staff. The maximum demand on the power station determines its size and cost of installation.

9.4.3. Operating or Running Costs

Operating costs are expenses associated with the maintenance and administration of a business on a day to day basis. The operating cost is a component of operating income and is usually reflected on a company's income statement.

It includes Fuel cost, Operating labour cost, Maintenance cost, Supplies, Supervision, Operating taxes. It is the cost which depends only upon the number of units generated. The running cost is on account of annual cost of fuel, lubricating oil, maintenance, repairs and salaries of operating staff. Since these charges depend upon the energy output, the running cost is directly proportional to the number of units generated by the station. In other words, if the power station generates more units, it will have higher running cost and vice-versa.

9.5. Interest

The cost of use of money is known as interest. A power station is constructed by investing a huge capital. This money is generally borrowed from banks or other financial institutions and the supply company has to pay the annual interest on this amount. Even if company has spent out of its reserve funds, the interest must be still allowed for, since this amount could have earned interest if deposited in a bank. Therefore, while calculating the cost of production of electrical energy, the interest payable on the capital investment must be included. The rate of interest depends upon market position and other factors and may vary from 4% to 8% per annum.

9.6. Depreciation

The decrease in the value of the power plant equipment and building due to constant use is known as depreciation.

If the power station equipment were to last forever, then interest on the capital investment would have been the only charge to be made. However, in actual practice, every power station has a useful life ranging from fifty to sixty years. From the time the power station is installed, its equipment steadily deteriorates due to wear and tear so that there is a gradual reduction in the value of the plant. This reduction in the value of plant every year is known as annual depreciation. Due to depreciation, the plant has to be replaced by the new one after its useful life. Therefore, suitable amount must be set aside every year so that by the time the plant retires, the collected amount by way of depreciation equals the cost of replacement. It becomes obvious that while determining the cost of production, annual depreciation charges must be included. There are several methods of finding the annual depreciation charges and will be discussed below.

9.7. Methods of Determining Depreciation

There is reduction in the value of the equipment and other property of the plant every year due to depreciation. Therefore, a suitable amount (known as depreciation charge) must be set aside annually so that by the time the life span of the plant is over, the collected amount equals the cost of replacement of the plant.

The following are the commonly used methods for determining the annual depreciation charge: (i) Straight line technique; (ii) Diminishing value technique; (iii) Sinking fund technique.

9.8. Straight Line Technique

In this technique, a constant depreciation charge is made every year on the basis of total depreciation and the useful life of the property. Obviously, annual depreciation charge will be equal to the total depreciation divided by the useful life of the property.

$$ASLD_R = \frac{Initial \quad capital \quad \cos t - [1 - S_V]}{n} \qquad (1)$$

In general, the annual depreciation charge on the straight-line technique may be expressed as:

$$ASLD_R = \frac{I_{\cos t} - [1 - S_V]}{n} \qquad (2)$$

Where:

$ASLD_R$ = Annual straight-line depreciation reserve of power plant

I_{cost} = Initial cost of equipment

S_V = Scrap or salvage value after the useful life of the plant

n = Useful life of equipment in years

r = interest rate

9.9. Diminishing Value Technique

In this technique, depreciation charge is made every year at a fixed rate on the diminished value of the equipment. In other words, depreciation charge is first applied to the initial cost of equipment and then to its diminished value.

Suppose the annual unit depreciation is ADV_R.

Hence, $$ADV_R = 1 - \left(\frac{S_V}{I_{\cos t}}\right)^{\frac{1}{n}} \qquad (3)$$

Where,

ADV_R = Annual depreciation value reserve of power plant

Sv =salvage value
I_{cost} = initial capital cost
n = number of years

9.10. Sinking Fund Technique

In this technique, a fixed depreciation charge is made every year and interest compounded on it annually. The constant depreciation charge is such that total of annual installments plus the interest accumulations equal to the cost of replacement of equipment after its useful life.

$$ASF_R = [I_{Cost}(1 - Salvage \quad value)][\frac{r}{(1+r)^n - 1}] \quad (4)$$

Here,
ASF_R = Annual sinking fund depreciation reserve of power plant
I_{cost} = Initial capital cost
S_v = Salvage value (Scrap value)
r = Interest rate

$$ASF_R = [I_{Cost}(1 - S_V] \quad [\frac{r}{(1+r)^n - 1}] \quad (5)$$

Afam Thermal Power Plants
Initial capital cost = $ 13.2258 Billion
Conversion rate: $1=N350.6
Initial capital cost =N4.637 Trillion
Capacity = 776MW

- Case 1: Sinking Fund Reserve Technique

Design Parameters:

- Useful life (n) = 25years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Afam power plant (I_{cost}) = N4.637 Trillion

$$ASF_{RA} = [I_{COST}(1 - Sv] \quad [\frac{r}{(1+r)^n - 1}] \quad (6)$$

Where:
ASF_{RA} = Annual sinking fund reserve of Afam thermal power plant
Hence,

$$ASF_{RA} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RA} = [4.637 \times 10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$

= N [3.94145x 10^{12}] [0.013678779]
ASF_{RA} = N 5.3914 × 10^{10}

- Case 2: Straight Line Depreciation Reserve

The Annual Straight Line Depreciate Reserve of Afam power plant($ASLD_{RA}$) is given as

$$ASLD_{RA} = \frac{I_{\cos t} \quad - [1 - S_V]}{n} \quad (7)$$

$$ASLD_{RA} = \frac{4.637X10^{12} \quad - [1 - 0.15]}{25}$$

$$ASLD_{RA} = \frac{4.637X10^{12} \quad -[0.85]}{25}$$

$$ASLD_{RA} = \frac{4.637 \times 10^{12}}{25}$$

$ASLD_{RA}$= N1.8548 x10^{11}

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve (ADV_{RA}) is given as:

$$ADV_{RA} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{25}} \quad (8)$$

Since,
Sv =0.15 and n=25years
I_{cost}=4.637 x10^{12}

Thus, $ADV_{RA} = 1 - [\frac{0.15}{4.637 \times 10^{12}}]^{\frac{1}{25}}$

$$ADV_{RA} = 1 - [\frac{0.15}{4.637 \times 10^{12}}]^{0.04}$$

$$ADV_{RA} = 1 - [3.2349 \times 10^{-14}]^{0.04}$$

$$ADV_{RA} = 1 - [0.380534613]$$

$$ADV_{RA} = N0.619465386 \approx N0.6195$$

$$ADV_{RA} = N0.6195$$

Egbin Thermal Power Plants
Initial capital cost = $ 32.0992 Billion
Conversion rate: $1=N350.6
Initial capital cost =N11.254 Trillion
Capacity = 1320MW

- Case1: Sinking Fund Reserve Technique

Design Parameters:

- Useful life (n) = 25years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Egbin power plant (I_{cost}) = N11.254 Trillion
- $$ASF_{RE} = [I_{COST}(1 - S_V) \quad [\frac{r}{(1+r)^n - 1}] \quad (9)$$
- Where:
- ASF_{RE} = Annual sinking fund reserve of Egbin thermal power plant
- Hence,
- $$ASF_{RE} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$
- $$ASF_{RE} = [11.254X10^{12}\,(O.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$
- = N [9.5659x 10^{12}] [0.013678779]
-

- ASF_{RE} = N 1.30849832 X 10^{11}

- Case 2: Straight Line Depreciation Reserve

- The Annual Straight Line Depreciate Reserve ($ASLD_{RE}$) is given as

$$ASLD_{RE} = \frac{I_{\cos t} \quad -[1-S_V]}{n} \qquad (10)$$

$$ASLD_{RE} = \frac{11.254\times10^{12} \quad -[1-0.15]}{25}$$

$$ASLD_{RE} = \frac{11.254\times10^{12} \quad -[0.85]}{25}$$

$$ASLD_{RE} = \frac{11.254\times10^{12} \quad]}{25}$$

- $ASLD_{RE}$ = N4.5016 x10^{11}

- Case 3: Diminishing Value Technique

- The annual diminishing value depreciation reserve (ADV_{RE}) is given as:

$$ADV_{RE} = 1-[\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}} \qquad (11)$$

- Since,
- Sv =0.15 and n=25years
- I_{cost}=11.254 x10^{12}
- Thus, $ADV_{RU} = 1-[\frac{0.15}{11.254X10^{12}}]^{\frac{1}{25}}$

$$ADV_{RE} = 1-[\frac{0.15}{11.254\times10^{12}}]^{\frac{1}{25}}$$

$$ADV_{RE} = 1-[\frac{0.15}{11.254\times10^{12}}]^{0.04}$$

$$ADV_{RE} = 1-[1.332859428\times10^{-14}]^{0.04}$$

$$ADV_{RE} = 1-[0.278606583]$$

$$ADV_{RE} = N0.721393416 \approx N0,7214$$

$$ADV_{RE} = N0.7214$$

Ughelli Thermal Power Plants
Initial capital cost = $ 1.54590 Billion
Conversion rate: $1=N350.6
Initial capital cost = ₦5.42 Trillion
Capacity = 900MW

- Case1: Sinking Fund Reserve Technique

Design Parameters:

- Useful life (n) = 25years
- Salvage value (scrap value) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Ughelli power plant = N5.42 Trillion

$$ASF_{Ru} = [I_{COST}(1 - S_V) \quad [\frac{r}{(1+r)^n - 1}] \qquad (12)$$

Where:
ASF_{RU} = Annual sinking fund reserve of ughelli thermal power plant
Hence,

$$ASF_{RU} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RU} = [5.42X10^{12}\,(O.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$

= N [4.59 × 10^{12}] [0.013678779]
ASF_{RU} = N 6.278 X 10^{10}

- Case 2: Straight line depreciation reserve

The Annual Straight Line Depreciate Reserve of Ughelli power plant ($ASLD_{RU}$) is given as

$$ASLD_{RU} = \frac{I_{\cos t} \quad -[1 - S_V]}{n} \qquad (13)$$

$$ASLD_{RU} = \frac{5.42 \times 10^{12} \quad -[1 - 0.15]}{25}$$

$$ASLD_{RU} = \frac{5.42 \times 10^{12} \quad -[0.85]}{25}$$

$$ASLD_{RU} = \frac{5.42 \times 10^{12}}{25}$$

$ASLD_{RU}$ = 2.168 $\times 10^{11}$

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve (ADV_{RU}) is given as:

$$ADV_{RU} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}} \qquad (14)$$

Since,
Sv =0.15 and n=25years
I_{cost}=5.42$\times 10^{12}$

Thus, $ADV_{RU} = 1 - [\frac{0.15}{5.42 \times 10^{12}}]^{\frac{1}{25}}$

$$ADV_{RU} = 1 - [\frac{0.15}{5.42 \times 10^{12}}]^{\frac{1}{25}}$$

$$ADV_{RU} = 1 - [\frac{0.15}{5.42 \times 10^{12}}]^{0.04}$$

$$ADV_{RU} = 1 - [2.7675 \times 10^{-14}]^{0.04}$$

$$ADV_{RU} = 1 - [0.2868689245]$$

$$ADV_{RU} = N0.7131$$

Kainji Hydro Power Plants
Initial capital cost = $ 36.7598 Billion
Conversion rate: $1=N350.6
Initial capital cost =N12.888 Trillion
Capacity = 760MW

- Case1: Sinking Fund Reserve Technique

Design Parameters**:**

- Useful life (n) = 25years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Kainji hydro power plant (I_{cost}) = N12.888 Trillion

$$ASF_{RK} = [I_{COST}(1-Sv] \quad [\frac{r}{(1+r)^n - 1}] \tag{15}$$

Where:

ASF_{RK} = Annual sinking fund reserve of Kainji hyro power plant

Hence,

$$ASF_{RK} = [I_{Cost}(1-0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RK} = [12.888\times10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RK} = [1.09548\times10^{13}] \quad [0.013678779]$$

ASF_{RK} =149848288189

ASF_{RK} = 149.8483×10^9

- Case 2: Straight Line Depreciation Reserve

The Annual Straight Line Depreciate Reserve of jebba hydro power plant ($ASLD_{RK}$) is given as:

$$ASLD_{RJ} = \frac{I_{\cos t} \quad -[1-S_V]}{n} \tag{16}$$

$$ASLD_{RJ} = \frac{12.888\times10^{12} \quad -[1-0.15]}{25}$$

$$ASLD_{RJ} = \frac{12.888\times10^{12} - \quad [0.85]}{25}$$

$$ASLD_{RJ} = \frac{12.888\times10^{12}}{25}$$

$ASLD_{RK}$= N515.520x10^9

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve (ADV_{RK}) is given as:

$$ADV_{RK} = 1-[\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}} \tag{17}$$

Since,

Sv =0.15 and n=25years

I_{cost}=12.888 x10^{12}

Thus, $ADV_{RK} = 1-[\frac{0.15}{12.888\times10^{12}}]^{\frac{1}{25}}$

$$ADV_{RK} = 1-[\frac{0.15}{12.888\times10^{12}}]^{0.04}$$

$$ADV_{RK} = 1-[1.163873\times10^{-14}]^{0.04}$$

$$ADV_{RK} = 1 - [0.2770998073]$$
$$ADV_{RK} = N0.722900193 \approx N0.7229$$
$$ADV_{RK} = N0.7229$$

Jebba Hydro Power Plants
Initial capital cost = $ 26.4517 Billion
Conversion rate: $1=N350.6
Initial capital cost =N9.274 Trillion
Capacity = 540MW

- Case1: Sinking Fund Reserve Technique

Design Parameters:

- Useful life (n) = 25years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Jebba hydro power plant (I_{cost}) = N9.274X10^{12}

$$ASF_{RJ} = [I_{COST}(1 - Sv] \quad [\frac{r}{(1+r)^n - 1}] \quad (18)$$

Where:
ASF_{RK} = Annual sinking fund reserve of Jebba hyropower plant
Hence,

$$ASF_{RJ} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$
$$ASF_{RJ} = [9.274 \times 10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$
$$ASF_{RJ} = [7.8829 \times 10^{12}] \quad [0.013678779]$$

ASF_{RJ} =107828446979 ≈ 107.8285X10^9
ASF_{RJ} = 107.8285×10^9

- Case 2: Straight Line Depreciation Reserve

The Annual Straight Line Depreciate Reserve of Jebba hydro power ($ASLD_{RJ}$) is given as

$$ASLD_{RJ} = \frac{I_{\cos t} \quad -[1 - S_V]}{n} \quad (19)$$
$$ASLD_{RJ} = \frac{9.274 \times 10^{12} \quad -[1 - 0.15]}{25}$$
$$ASLD_{RJ} = \frac{9.274 \times 10^{12} \quad -[0.85]}{25}$$
$$ASLD_{RJ} = \frac{9.274 \times 10^{12}}{25}$$

$ASLD_{RJ}$= N370.96x10^9

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve of Jebba hydro power plant (ADV_{RJ}) is given as:

$$ADV_{RJ} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}} \quad (20)$$

Since,

Sv =0.15 and n=25years
I_{cost}=9.274 x10^{12}

Thus, $ADV_{RJ} = 1 - [\frac{0.15}{9.274 \times 10^{12}}]^{\frac{1}{25}}$

$$ADV_{RJ} = 1 - [\frac{0.15}{9.274 \times 10^{12}}]^{0.04}$$

$$ADV_{RJ} = 1 - [1.617425 \times 10^{-14}]^{0.04}$$

$$ADV_{RJ} = 1 - [0.2807714637]$$

$$ADV_{RJ} = N0.719228536 \approx N0.7192$$

$$ADV_{RJ} = N0.7192$$

Shiroro Hydro Power Plants
Initial capital cost = $ 30.638 Billion
Conversion rate: $1=N350.6
Initial capital cost =N10.742x10^{12}
Capacity = 600MW

- Case1: Sinking Fund Reserve Technique

Design Parameters:

- Useful life (n) = 25years
- Salvage value (scrap value) =15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Kainji hydro power plant (I_{cost}) = N10.742x10^{12}

$$ASF_{RS} = [I_{COST}(1 - Sv) \quad [\frac{r}{(1+r)^n - 1}] \tag{21}$$

Where:
ASF_{RS}= Annual sinking fund reserve of Shiroro hydro power plant
Hence,

$$ASF_{RS} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RS} = [10.742 \times 10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^{25} - 1}]$$

$$ASF_{RS} = [9.1307 \times 10^{12}] \quad [0.013678779]$$

ASF_{RS} =124896827415 ≈≈ 124.8968×10^9
ASF_{RS} = 124.8968×10^9

- Case 2: Straight Line Depreciation Reserve

The Annual Straight Line Depreciate Reserve ($ASLD_{RS}$) is given as

$$ASLD_{RS} = \frac{I_{\cos t} \quad - [1 - S_V]}{n} \tag{22}$$

$$ASLD_{RS} = \frac{10.742 \times 10^{12} \quad - [1 - 0.15 \ ]}{25}$$

$$ASLD_{RS} = \frac{10.742 \times 10^{12} \quad - [0.85 \ ]}{25}$$

$$ASLD_{RS} = \frac{10.742\times10^{12}}{25}$$

$ASLD_{RS}$ =429680000000 ≈ 429.68X10^9
$ASLD_{RS}$= N429.68x10^9

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve of Sshiroro hydro power plant (ADV_{RS}) is given as:

$$ADV_{RS} = 1-[\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}} \quad (23)$$

Since,
Sv =0.15 and n=25years
I_{cost}=10.742 x10^{12}

Thus, $ADV_{RS} = 1-[\frac{0.15}{10.742\times10^{12}}]^{\frac{1}{25}}$

$$ADV_{RS} = 1-[\frac{0.15}{10.742\times10^{12}}]^{0.04}$$

$$ADV_{RS} = 1-[1.396388\times10^{-14}]^{0.04}$$

$$ADV_{RS} = 1-[0.2791259694]$$

$$ADV_{RS} = N0.720874031 \approx N0.7209$$

$$ADV_{RS} = N0.7209$$

The $ASLD_R$, ADV_R and ASF_R values for 2011 were obtained through mathematically but the values from 2012 to 2035 were generated via excel software which are presented in table 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9 respectively.

Afam Thermal Power Plant 2016 Real Cost
Initial capital cost = $ 16.1580 Billion
Conversion rate: $1=N350.6
Initial capital cost =N5.665 Trillion

- Case 1: Sinking Fund Reserve Technique

Design Parameters:
- Useful life (n) = 5years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- (I_{cost}) = N5.665 Trillion

From equation 6, $ASF_{RA} = [I_{COST}(1-Sv] \quad [\frac{r}{(1+r)^n-1}]$ $\qquad ASF_{2016} = [5.665(1-0.15)] \quad [\frac{0.08}{(1+0.08)^5-1}]$

$$ASF_{2016} = [5.665\times10^{12}(O.85) \quad][\frac{0.08}{(1+0.08)^5-1}]$$

= N [5.665 × 10^{12} (0.85)] [0.1705]
ASF_{2016}= N 0.8207

- Case 2: Straight Line Depreciation Reserve

From equation 7

$$ASLD_{RA} = \frac{I_{\cos t} \quad -[1-S_V]}{n}$$

$$ASLD_{2016} = \frac{5.665 \times 10^{12} \quad -[1-0.15]}{5}$$

$$ASLD_{2016} = \frac{5.665 \times 10^{12} \quad -[0.85]}{5}$$

$ASLD_{RA}$= N1.133 x10^{12}

- Case 3: Diminishing Value Technique

From equation 8, $ADV_{RA} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}}$

Thus, $ADV_{2016} = 1 - [\frac{0.15}{5.665 \times 10^{12}}]^{\frac{1}{5}}$

$$ADV_{2016} = 1 - [\frac{0.15}{5.665 \times 10^{12}}]^{.0.2}$$

$$ADV_{2016} = N0.5163$$

Egbin Thermal Power Plant
Initial capital cost = \$ 33.970 Billion
Conversion rate: \$1=N350.6
Initial capital cost =N11.91 Trillion

- Case1: Sinking Fund Reserve Technique

From equation 9, $ASF_{RE} = [I_{COST}(1-S_V) \quad [\frac{r}{(1+r)^n - 1}]$ $\quad ASF_{2016} = [I_{COST}(1-0.15)] \quad [\frac{0.08}{(1+0.08)^5 - 1}]$

$$ASF_{2016} = [11.91 \times 10^{12} (0.85) \quad][\frac{0.08}{(1+0.08)^5 - 1}]$$

ASF_R = 0.0820

- Case 2: Straight Line Depreciation Reserve

From equation 10, $ASLD_{RE} = \frac{I_{\cos t} \quad -[1-S_V]}{n}$

$$ASLD_{2016} = \frac{11.91 \times 10^{12} \quad -[1-0.15]}{5}$$

$ASLD_{2016}$ = N2.382 $\times 10^{12}$

- Case 3: Diminishing Value Technique

The annual diminishing value depreciation reserve (ADV_{RE}) is given as:

From equation 11, $ADV_{RE} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}}$

Thus, $ADV_{2016} = 1 - [\frac{0.15}{11.91 \times 10^{12}}]^{\frac{1}{5}}$

$$ADV_{2016} = 1 - [\frac{0.15}{11.91 \times 10^{12}}]^{0.2}$$

$$ADV_{2016} = N0.9983$$

Ughelli Thermal Power Plant
Initial capital cost = \$ 1.7798 Billion
Conversion rate: \$1=N350.6

Initial capital cost =N6.24 Trillion

- Case1: Sinking Fund Reserve Technique
- Useful life (n) = 5years
- Salvage value (scrap value) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- Icost = N6.24 Trillion

From equation 12,

$$ASF_{Ru} = [I_{COST}(1 - S_V) \quad [\frac{r}{(1+r)^n - 1}]$$

$$ASF_{2016} = [I_{COST}(1 - 0.15)] \quad [\frac{0.08}{(1+0.08)^5 - 1}]$$

$$ASF_{2016} = [6.24X10^{12}(O.85) \quad][\frac{0.08}{(1+0.08)^5 - 1}]$$

ASF_{2016} = N 90.410 X 10^{12}

- Case 2: Straight Line Depreciation Reserve

From equation 13, $ASLD_{RU} = \frac{I_{\cos t} \quad -[1 - S_V]}{n}$

$$ASLD_{2016} = \frac{6.24 \times 10^{12} \quad -[1 - 0.15]}{5}$$

$ASLD_{2016}$ = 1,248x10^{12}

- Case 3: Diminishing Value Technique

From equation 14, $ADV_{RU} = 1 - [\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}}$

Thus,

$$ADV_{2016} = 1 - [\frac{0.15}{6.24 \times 10^{12}}]^{0.2}$$

$$ADV_{RU} = 1 - [0.001888]$$

$$ADV_{2016} = N0.9981$$

Kainji Hydro Power Plant
Initial capital cost = \$ 42.4985 Billion
Conversion rate: \$1=N350.6
Initial capital cost =N14.9Trillion

- Case1: Sinking Fund Reserve Technique
- Useful life (n) = 5years
- Salvage value (Sv) = 15% = 0.15
- Interest rate (r) = 8% = 0.08
- (I_{cost}) = N14.9 Trillion

From equation 15, $ASF_{RK} = [I_{COST}(1 - Sv] \quad [\frac{r}{(1+r)^n - 1}]$

Hence,

$$ASF_{2016} = [14.9 \times 10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^5 - 1}]$$

$$ASF_{2016} = [1.4.9 \times 10^{12}](0.85) \quad [0.1705]$$

ASF_{2016} = 2.1593×10^{12}

- Case 2: Straight Line Depreciation Reserve

From equation 16, $ASLD_{RK} = \frac{I_{\cos t} \quad -[1 - S_V]}{n}$ $\qquad ASLD_{2016} = \frac{14.9 \times 10^{12} - \quad [0.85]}{5}$

$ASLD_{2016}$= N2.98x10^{12}

- Case 3: Diminishing Value Technique

From equation 17, $ADV_{RK} = 1-[\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}}$ Thus, $ADV_{2016} = 1-[\frac{0.15}{14.9\times10^{12}}]^{\frac{1}{5}}$

$$ADV_{2016} = 1-[\frac{0.15}{14.9\times10^{12}}]^{0.2}$$

$$ADV_{2016} = 1-[0.001587]$$

$$ADV_{2016} = N0.9984$$

Jebba Hydro Power Plant
Initial capital cost = \$ 33.3713 Billion
Conversion rate: \$1=N350.6
Initial capital cost =N11.7Trillion

- Case1: Sinking Fund Reserve Technique

Design Parameters:
- Useful life (n) = 5years
- Salvage value (Sv) =15% = 0.15
- Interest rate (r) = 8% = 0.08
- Capital cost of installation of Jebba hydro power plant (I_{cost}) = N11.7×10^12^

From equation 18,

$$ASF_{RJ} = [I_{COST}(1-Sv] \quad [\frac{r}{(1+r)^n - 1}]$$

Hence,

$$ASF_{2016} = [11.7\times10^{12}(0.85) \quad][\frac{0.08}{(1+0.08)^5 - 1}]$$

ASF_{2016} = 1.6956×10^{12}

- Case 2: Straight Line Depreciation Reserve

From equation 19,

$$ASLD_{RJ} = \frac{I_{\cos t} \quad -[1-S_V]}{n}$$

$$ASLD_{2016} = \frac{11.7\times10^{12} \quad -[1-0.15]}{5}$$

$$ASLD_{2016} = \frac{11.7\times10^{12} \quad -[0.85]}{5}$$

$ASLD_{RJ}$= N2.340×10^{12}

- Case 3: Diminishing Value Technique

From equation 20, $ADV_{RJ} = 1-[\frac{S_V}{I_{\cos t}}]^{\frac{1}{n}}$

Thus, $ADV_{2016} = 1-[\frac{0.15}{11.7\times10^{12}}]^{\frac{1}{5}}$

$$ADV_{2016} = N0.9981$$

Shiroro Hydro Power Plants
Initial capital cost = \$ 31.3747 Billion
Conversion rate: \$1=N350.6
Initial capital cost =N11×10^{12}

- Case1: Sinking Fund Reserve Technique

Design Parameters**:**

- Useful life (n) = 5years
- Salvage value (scrap value) = 15% = 0.15
- Interest rate (r) = 8% = 0.08

9. Results

The results obtain below are through applications of the methods of determining depreciation on thermal and hydroelectric power plants

S/N	Power Plants	Capacity (Mw)	Useful Life (N)	Salvage Value (Sv) 15%	Interest Rate (R) 8%	Initial Capital Cost ($)	Conversion Rate	Naira Value (N)
Thermal Power Plants								
1	Afam	776	25	0.15	0.08	13.226×10^9	350.6	4.637×10^{12}
2	Egbin	1320	25	0.15	0.08	32.0992×10^9	350.6	11.254×10^{12}
3	Ughelli	900	25	0.15	0.08	15.4590×10^9	350.6	5.42×10^{12}
Hydro Power Plants								
4	Kainji	760	25	0.15	0.08	36.7598×10^9	350.6	12.888×10^{12}
5	Jebba	540	25	0.15	0.08	26.4517×10^9	350.6	9.274×10^{12}
6	Shiroro	600	25	0.15	0.08	$30,6380 \times 10^9$	350.6	10.742×10^{12}

Table 2: Thermal and Hydro Power Plants Initial Capital and Mode of Conversion

Power plants	$ASLD_R$	ADV_R	ASF_R
Afam	185,480,000,000	0.6195	53,914,223,700
Egbin	450,160,000,000	0.7214	130,849,800,000
Ughelli	216,800,000,000	0.7131	62,780,000,000
Kainji	515,520,000,0000	0.7229	149,848,300.000
Jebba	370,690,000,000	0.7192	107,828,500,000
Shiroro	429,680,000,000	0.7209	124,896,800,000

Table 3: Actual Cost Power Plants Design Parameters Results for 2011

Year	$ASLD_R$	ADV_R	ASF_R
2011	185,480,000,000.00	0.6195	53,914,223,700.00
2012	370,960,000,000.00	1.239	107,828,447,400.00
2013	556,440,000,000.00	1.8585	161,742,671,100.00
2014	741,920,000,000.00	2.478	215,656,894,800.00
2015	927,400,000,000.00	3.0975	269,571,118,500.00
2016	1,112,880,000,000.00	3.0975	323,485,342,200.00
2017	1,298,360,000,000.00	4.3365	377,399,565,900.00
2018	1,483,840,000,000.00	4.956	431,313,789,600.00
2019	1,669,320,000,000.00	5.5755	485,228,013,300.00
2020	1,854,800,000,000.00	6.195	862,627,579,200.00
2021	2,040,280,000,000.00	6.8145	593,056,460,700.00
2022	2,225,760,000,000.00	7.434	646,970,684,400.00
2023	2,411,240,000,000.00	8.0535	700,884,908,100.00
2024	2,596,720,000,000.00	8.673	1,078,284,474,000.00
2025	2,782,200,000,000.00	9.2925	808,713,355,500.00
2026	2,967,680,000,000.00	9.912	862,627,579,200.00
2027	3,153,160,000,000.00	10.5315	916,541,802,900.00
2028	3,338,640,000,000.00	11.151	970,456,026,600.00
2029	3,524,120,000,000.00	11.7705	1,024,370,250,300.00
2030	3,709,600,000,000.00	12.39	1,078,284,474,000.00
2031	3,895,080,000,000.00	13.0095	1,132,198,697,700.00
2032	4,080,560,000,000.00	13.629	1,186,112,921,400.00
2033	4,266,040,000,000.00	14.2485	1,240,027,145,100.00
2034	4,451,520,000,000.00	14.868	1,293,941,368,800.00
2035	4,637,000,000,000.00	15.4875	1,347,855,592,500.00

Table 4: Afam Thermal Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

YEAR	$ASLD_R$	ADV_R	ASF_R
2011	450,160,000,000.00	0.7214	130,849,800,000.00
2012	900,320,000,000.00	1.4428	261,699,600,000.00
2013	1,350,480,000,000.00	2.1642	392,549,400,000.00
2014	1,800,640,000,000.00	2.8856	523,399,200,000.00
2015	2,250,800,000,000.00	3.607	654,249,000,000.00
2016	2,700,960,000,000.00	3.607	785,098,800,000.00
2017	3,151,120,000,000.00	5.0498	915,948,600,000.00
2018	3,601,280,000,000.00	5.7712	1,046,798,400,000.00
2019	4,051,440,000,000.00	6.4926	1,177,648,200,000.00
2020	4,501,600,000,000.00	7.214	2,093,596,800,000.00
2021	4,951,760,000,000.00	7.9354	1,439,347,800,000.00
2022	5,401,920,000,000.00	8.6568	1,570,197,600,000.00
2023	5,852,080,000,000.00	9.3782	1,701,047,400,000.00
2024	6,302,240,000,000.00	10.0996	2,616,996,000,000.00
2025	6,752,400,000,000.00	10.821	1,962,747,000,000.00
2026	7,202,560,000,000.00	11.5424	2,093,596,800,000.00
2027	7,652,720,000,000.00	12.2638	2,224,446,600,000.00
2028	8,102,880,000,000.00	12.9852	2,355,296,400,000.00
2029	8,553,040,000,000.00	13.7066	2,486,146,200,000.00
2030	9,003,200,000,000.00	14.428	2,616,996,000,000.00
2031	9,453,360,000,000.00	15.1494	2,747,845,800,000.00
2032	9,903,520,000,000.00	15.8708	2,878,695,600,000.00
2033	10,353,680,000,000.00	16.5922	3,009,545,400,000.00
2034	10,803,840,000,000.00	17.3136	3,140,395,200,000.00
2035	11,254,000,000,000.00	18.035	3,271,245,000,000.00

Table 5: Egbin Thermal Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

Year	$ASLD_R$	ADV_R	ASF_R
2011	216,800,000,000.00	0.7131	62,780,000,000.00
2012	433,600,000,000.00	1.4262	125,560,000,000.00
2013	650,400,000,000.00	2.1393	188,340,000,000.00
2014	867,200,000,000.00	2.8524	251,120,000,000.00
2015	1,084,000,000,000.00	3.5655	313,900,000,000.00
2016	1,300,800,000,000.00	3.5655	376,680,000,000.00
2017	1,517,600,000,000.00	4.9917	439,460,000,000.00
2018	1,734,400,000,000.00	5.7048	502,240,000,000.00
2019	1,951,200,000,000.00	6.4179	565,020,000,000.00
2020	2,168,000,000,000.00	7.131	1,004,480,000,000.00
2021	2,384,800,000,000.00	7.8441	690,580,000,000.00
2022	2,601,600,000,000.00	8.5572	753,360,000,000.00
2023	2,818,400,000,000.00	9.2703	816,140,000,000.00
2024	3,035,200,000,000.00	9.9834	1,255,600,000,000.00
2025	3,252,000,000,000.00	10.6965	941,700,000,000.00
2026	3,468,800,000,000.00	11.4096	1,004,480,000,000.00
2027	3,685,600,000,000.00	12.1227	1,067,260,000,000.00
2028	3,902,400,000,000.00	12.8358	1,130,040,000,000.00
2029	4,119,200,000,000.00	13.5489	1,192,820,000,000.00
2030	4,336,000,000,000.00	14.262	1,255,600,000,000.00
2031	4,552,800,000,000.00	14.9751	1,318,380,000,000.00
2032	4,769,600,000,000.00	15.6882	1,381,160,000,000.00
2033	4,986,400,000,000.00	16.4013	1,443,940,000,000.00
2034	5,203,200,000,000.00	17.1144	1,506,720,000,000.00
2035	5,420,000,000,000.00	17.8275	1,569,500,000,000.00

Table 6: Ughelli Thermal Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

YEAR	$ASLD_R$	ADV_R	ASF_R
2011	5,155,200,000,000.00	0.7229	149,848,300.00
2012	10,310,400,000,000.00	1.4458	299,696,600.00
2013	15,465,600,000,000.00	2.1687	449,544,900.00
2014	20,620,800,000,000.00	2.8916	599,393,200.00
2015	25,776,000,000,000.00	3.6145	749,241,500.00
2016	30,931,200,000,000.00	3.6145	899,089,800.00
2017	36,086,400,000,000.00	5.0603	1,048,938,100.00
2018	41,241,600,000,000.00	5.7832	1,198,786,400.00
2019	46,396,800,000,000.00	6.5061	1,348,634,700.00
2020	51,552,000,000,000.00	7.229	2,397,572,800.00
2021	56,707,200,000,000.00	7.9519	1,648,331,300.00
2022	61,862,400,000,000.00	8.6748	1,798,179,600.00
2023	67,017,600,000,000.00	9.3977	1,948,027,900.00
2024	72,172,800,000,000.00	10.1206	2,996,966,000.00
2025	77,328,000,000,000.00	10.8435	2,247,724,500.00
2026	82,483,200,000,000.00	11.5664	2,397,572,800.00
2027	87,638,400,000,000.00	12.2893	2,547,421,100.00
2028	92,793,600,000,000.00	13.0122	2,697,269,400.00
2029	97,948,800,000,000.00	13.7351	2,847,117,700.00
2030	103,104,000,000,000.00	14.458	2,996,966,000.00
2031	108,259,200,000,000.00	15.1809	3,146,814,300.00
2032	113,414,400,000,000.00	15.9038	3,296,662,600.00
2033	118,569,600,000,000.00	16.6267	3,446,510,900.00
2034	123,724,800,000,000.00	17.3496	3,596,359,200.00
2035	128,880,000,000,000.00	18.0725	3,746,207,500.00

Table 7: Kainji Hydro Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

Year	$ASLD_R$	ADV_R	ASF_R
2011	370,690,000,000.00	0.7192	107,828,500,000.00
2012	741,380,000,000.00	1.4384	215,657,000,000.00
2013	1,112,070,000,000.00	2.1576	323,485,500,000.00
2014	1,482,760,000,000.00	2.8768	431,314,000,000.00
2015	1,853,450,000,000.00	3.596	539,142,500,000.00
2016	2,224,140,000,000.00	3.596	646,971,000,000.00
2017	2,594,830,000,000.00	5.0344	754,799,500,000.00
2018	2,965,520,000,000.00	5.7536	862,628,000,000.00
2019	3,336,210,000,000.00	6.4728	970,456,500,000.00
2020	3,706,900,000,000.00	7.192	1,725,256,000,000.00
2021	4,077,590,000,000.00	7.9112	1,186,113,500,000.00
2022	4,448,280,000,000.00	8.6304	1,293,942,000,000.00
2023	4,818,970,000,000.00	9.3496	1,401,770,500,000.00
2024	5,189,660,000,000.00	10.0688	2,156,570,000,000.00
2025	5,560,350,000,000.00	10.788	1,617,427,500,000.00
2026	5,931,040,000,000.00	11.5072	1,725,256,000,000.00
2027	6,301,730,000,000.00	12.2264	1,833,084,500,000.00
2028	6,672,420,000,000.00	12.9456	1,940,913,000,000.00
2029	7,043,110,000,000.00	13.6648	2,048,741,500,000.00
2030	7,413,800,000,000.00	14.384	2,156,570,000,000.00
2031	7,784,490,000,000.00	15.1032	2,264,398,500,000.00
2032	8,155,180,000,000.00	15.8224	2,372,227,000,000.00
2033	8,525,870,000,000.00	16.5416	2,480,055,500,000.00
2034	8,896,560,000,000.00	17.2608	2,587,884,000,000.00
2035	9,267,250,000,000.00	17.98	2,695,712,500,000.00

Table 8: Jebba Hydro Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

Year	$ASLD_R$	ADV_R	ASF_R
2011	429,680,000,000.00	0.7209	124,896,800,000.00
2012	859,360,000,000.00	1.4418	249,793,600,000.00
2013	1,289,040,000,000.00	2.1627	374,690,400,000.00
2014	1,718,720,000,000.00	2.8836	499,587,200,000.00
2015	2,148,400,000,000.00	3.6045	624,484,000,000.00
2016	2,578,080,000,000.00	3.6045	749,380,800,000.00
2017	3,007,760,000,000.00	5.0463	874,277,600,000.00
2018	3,437,440,000,000.00	5.7672	999,174,400,000.00
2019	3,867,120,000,000.00	6.4881	1,124,071,200,000.00
2020	4,296,800,000,000.00	7.209	1,998,348,800,000.00
2021	4,726,480,000,000.00	7.9299	1,373,864,800,000.00
2022	5,156,160,000,000.00	8.6508	1,498,761,600,000.00
2023	5,585,840,000,000.00	9.3717	1,623,658,400,000.00
2024	6,015,520,000,000.00	10.0926	2,497,936,000,000.00
2025	6,445,200,000,000.00	10.8135	1,873,452,000,000.00
2026	6,874,880,000,000.00	11.5344	1,998,348,800,000.00
2027	7,304,560,000,000.00	12.2553	2,123,245,600,000.00
2028	7,734,240,000,000.00	12.9762	2,248,142,400,000.00
2029	8,163,920,000,000.00	13.6971	2,373,039,200,000.00
2030	8,593,600,000,000.00	14.418	2,497,936,000,000.00
2031	9,023,280,000,000.00	15.1389	2,622,832,800,000.00
2032	9,452,960,000,000.00	15.8598	2,747,729,600,000.00
2033	9,882,640,000,000.00	16.5807	2,872,626,400,000.00
2034	10,312,320,000,000.00	17.3016	2,997,523,200,000.00
2035	10,742,000,000,000.00	18.0225	3,122,420,000,000.00

Table 9: Shiroro Hydro Power Plant Annual Straight Line, Sinking Fund and Diminishing Reserve Values

Power Plants	$ASLD_R$	ADV_R	ASF_R
Afam	1,133,000,000,000	0.5163	0.8207
Egbin	2,382,000,000,000	0.9983	0.0820
Ughelli	1,248,000,000,000	0.9981	90,410,000,000,000
Kainji	29,800,000,000,000	0.9984	2,159,300,000,000
Jebba	2,340,000,000,000	0.9981	1,695,600,000,000
Shiroro	2,340,000,000,000	0.9983	1.6956

Table 10: Real Cost Power Plants Design Parameters Results for 2016

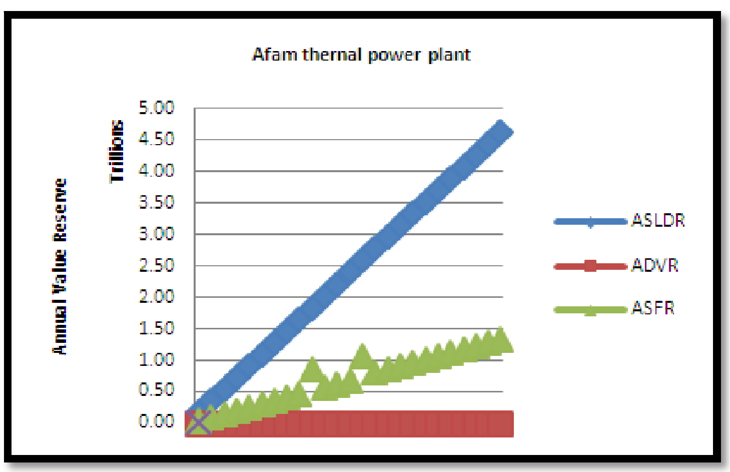

Figure 3: Afam Thermal Power Plant Showing $ASLD_R$, ADV_R and ASF_R

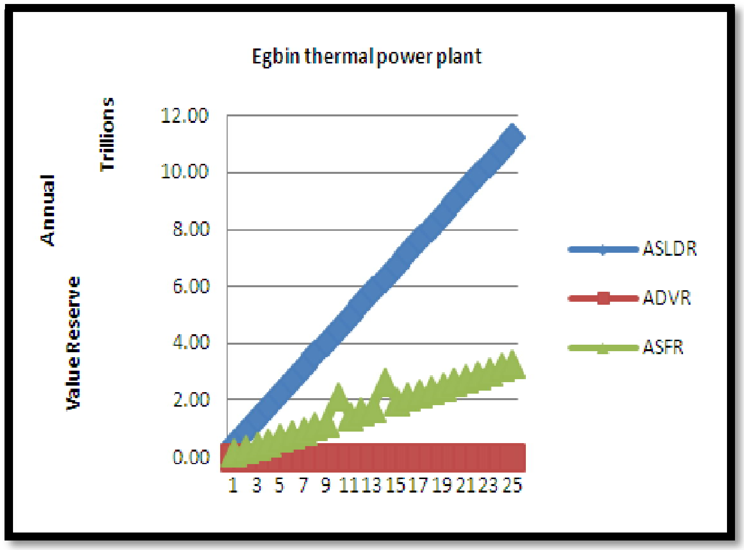

Figure 4: Egbin Thermal Power Plant Showing $ASLD_R$, ADV_R And ASF_R

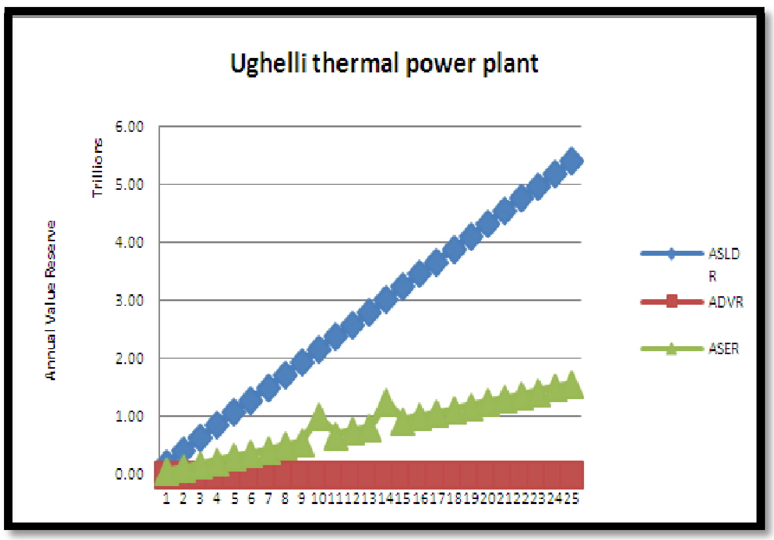

Figure 5: Ughelli Thermal Power Plant Showing $ASLD_R$, ADV_R and ASF_R

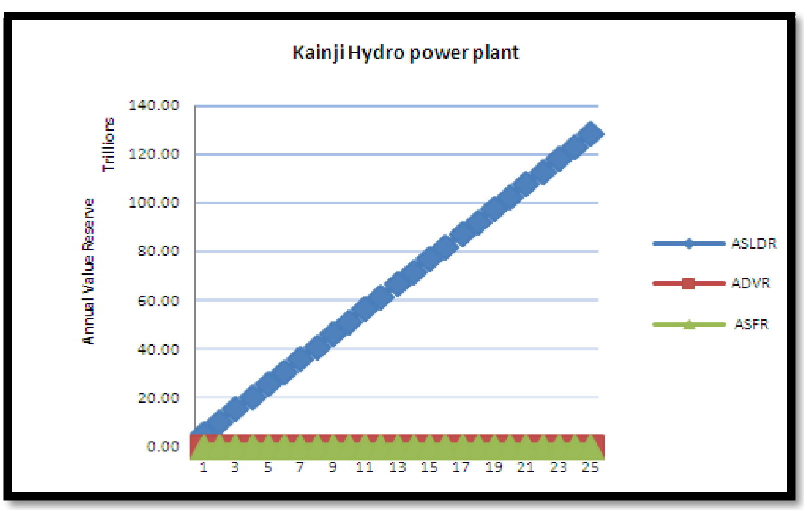

Figure 6: Kainji Hydro Power Plant Showing $ASLD_R$, ADV_R and ASF_R

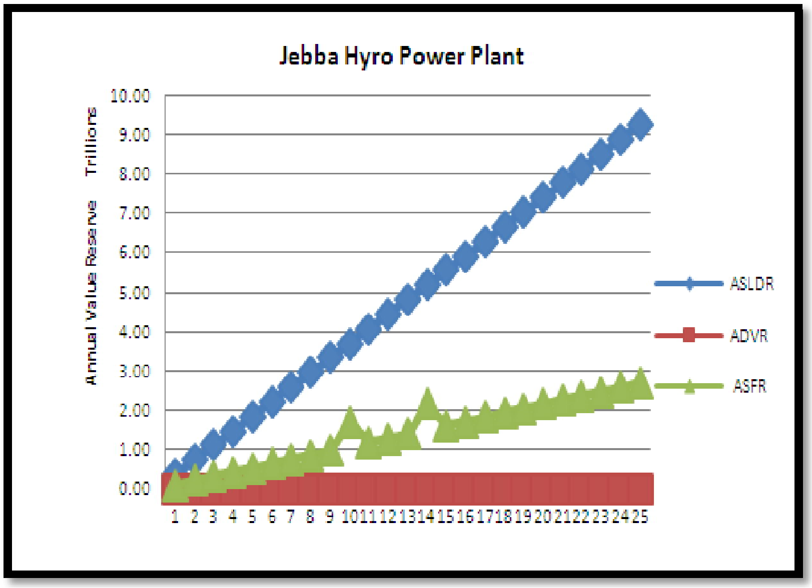

Figure 7: Jebba Hydro Power Plant Showing $ASLD_R$, ADV_R and ASF_R

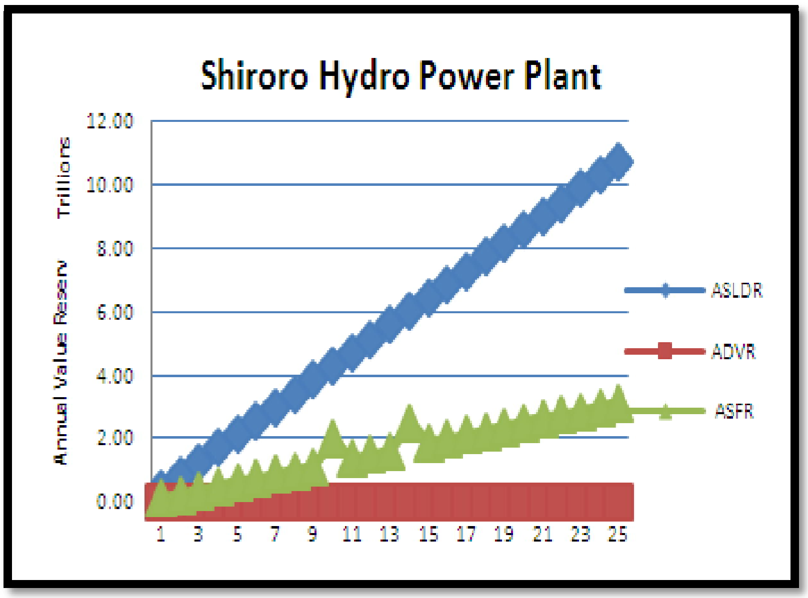

Figure 8: Shiroro Hydro Power Plant Showing $ASLD_R$, ADV_R and ASF_R

10. Discussion

The straight-line technique is extremely simple and is easy to apply as the annual depreciation charge can be readily calculated from the total depreciation and useful life of the equipment.

The diminishing technique has two drawbacks. Firstly, low depreciation charges are made in the late years when the maintenance and repair charges are quite heavy. Secondly, the depreciation charge is independent of the rate of interest which it may draw during accumulation. Such interest moneys, if earned, are to be treated as income.

During the manual calculations in chapter three of all the diminishing values of both the thermal and hydro power plants we observed that the overall costs AVD_R are on zero-point bases (i.e. 0.6195, 0.7214, 0.7131, 0.7229, 0.7192 and 0.7209) respectively. From the figures (4.1, 4.2, 4.3, 4.4, 4.5 and 4.6 above shows the graph analysis of $ASLD_R$, AVD_R and ASF_R and we observed that $ASLD_R$ gives a consistent trend of the period of 2011 – 2035 (25 years) over the other two techniques and can enhance better approach in future installation of power plant. Therefore, a careful study has to be made to calculate and analyse the cost of any power plant to avoid waste of finance.

Also, in 2016 when the real cost of each of the power plants were calculate the ASLDR shows close range to the actual value gotten in 2011 while the ADV_R remains on the zero basis (i.e. 0.5163, 0.9983, 0.9981, 0.9984, 0.9981, 0.9983). Based on all the indications, we opt that ASLDR should be adopted in all Nigeria power generation plants to avoid wastage in finance.

11. Conclusion and Recommendation

11.1. Conclusion

The combined installed capacity of power plants in Nigeria is far below the country's electricity demand, resulting in epileptic supply of electricity. The situation is compounded by the failure of the existing power plants to operate at its installed capacity. The inability of the hydro and thermal power plants to operate at installed capacity is because of low level of maintenance, vandalization, improper cost analysis and inadequate provision of materials.

In this project we estimated hydro and thermal power generation using the methods of determining depreciation via straight line, diminishing value and sinking fund methods or techniques. However, hydro power generation is the cheapest and does not pose threat to the environment unlike the thermal power station. When all the techniques were adhesively applied the annual straight-line depreciation reserve ($ASLD_R$) has the best advantage over the other two annual reserves i.e. the annual diminishing value reserve (ADV_R) and the annual sinking fund reserve (ASF_R).

Finally, while designing and building a power plants, efforts should be made to achieve overall economy so that the per unit cost of the plant will be as low as possible since the aim of this work is to reduce cost and maximize profit in any power plant.

11.1.1. Contribution to Knowledge

Significantly, this dissertation has immensely contributed to knowledge especially in the bits for generating expansion planning areas. It has also seriously beautified and considered the simple techniques, Annual Straight-Line Depreciation Reserve ($ASLD_R$) that actually captured a consistent planning trend over a look-ahead period of long-planning with the aim of minimizing cost and maximizing profit.

11.2. Recommendation

- The planning horizon for thermal and hydro power plants programs should extend beyond the agency's current planning horizon of 2030.
- During planning for thermal and hydro power plant installation, it is a necessity to consider the appropriate approach or technique that will enhance the true value of the power plant.
- Maintenance should be treated seriously at board level, or even by local management
- Maintenance technicians and even team leaders should undergo more training that will enhance their skills.
- Separate budget should be set aside for the rehabilitation of Nigeria existing power plants
- The transmission and distribution aspect of this project should be handled using the methods of determining depreciation to enhance adequate supply of power in Nigeria.

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