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Profitability Analysis of a Proposed Aku Dam-Toe Small Hydropower Project

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Abstract

The study seeks to address the profitability analysis of proposed Aku-dam toe small hydropower project. The economic metrics of the project with an investment cost of ₦ 820,788,529 proposed to be partly financed by a bank loan and an equity contribution of 30% showed a very high return on investment, with a project payback period or breakeven point of 7 years which is timely enough for an investor to re-coup his or her initial capital from the project that has a minimum life of 30 years and a maximum of 50 years. The net present value (NPV) of ₦238,800,732 shows that the project is capable of making profit after paying for its investment cost and running cost. The internal rate of return (IRR) of the project from calculation stood at 17.09%, above the hurdle rate of 12%. The benefit cost ratio of the project is 1.12 which is above unity, a good sign to show the profitability index of the project is favourable.

Keywords

Economic, Viability, Aku-Dam, Small Hydropower, Energy

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1. Introduction

Small hydro power scheme is defined as any hydro power installation rated between 100KW to 30 MW [4], however a common practice to refer to all hydro station with 30MW and below as Small Hydropower. There are many small rivers all over the country with potential sites fitting for SHP schemes, the progress of which will provide electricity to isolated communities; then, used as a substitute for commercial fuels, which effect reduces cost of fuelling and raises earning potential of the rural communities. However, the problem often encountered in SHP growth is how to determine the potential capacity of the proposed site because the hydropower potential is limited by the intermittent nature of rivers flows which have high water discharges during rainy season and very low discharges in dry season, which most of the countries lack specialisation to undertake feasibility studies, detailed studies that would include detailed design and costing of the schemes to make a meaningful impact on utilisation of small hydro sites [11], Coupled with the high cost of importing SHP equipment and the longer project cycle time had not been encouraging local investments in SHP Development [1].

[3] reported that the total hydroelectric power potential of the country was estimated to be about 8,824 MW with an annual electricity generation potential in excess of 36,000 GW h. This consists of 8,000 MW of large hydropower technology, while the remaining 824 MW is still small-scale hydropower

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technology. Presently, 24% and 4% of both large and small hydropower potentials, respectively, in the country have been exploited.

According to the World Bank, most of the world's poor people spend more than 12% of their total income on energy, which is more than four times of what a middle-income family in the developed world spends. The energy consumption *per capita* in Nigeria is very small - about one-sixth of the energy consumed in developed countries. Gross domestic product (GDP) and *per capita* income are indices that are used to measure the economic well-being of a country and its people. GDP is defined as the total market value of all final goods and services produced within a given country in a given period of time (usually a calendar year). The *per capita* income refers to how much each individual receives, in monetary terms, of the yearly income that is generated in his/her country through productive activities. That is what each citizen would receive if the yearly income generated by a country from its productive activities were divided equally between everyone [12]. According to [16], population is a major driver of energy demand, while its most important determinant is the level of economic activity and its structure measured by the total gross domestic product (GDP) alongside the various sectors and sub-sector*s* of the economy. Population projection of Nigeria was expected to grow from 115.22 million in 2000 to 281.81 million by 2030 at an average annual rate of 2.86% between 2000 and 2030. Where electric power supply is available and constant, the growth of cottage and small scale industries have resulted in improved life styles and economies of such communities [1]. Water resources for the development of SHP abound in all states of Nigeria, in fact flowing water bodies classified as "small" in Nigeria can generate between 100 – 200Kw [18]

This work will address the economic analysis of proposed Aku-Dam toe scheme SHP plant and its computation for financial investment decision, even though similar study was conducted on the run-off scheme economic viability of SHP plants that was fully financed without bank loans. The recent study differ from the one conducted in the past, in several ways like: type of scheme to be adopted (Dam-Toe), project duration above 2 years, Mode of funding (Loan), capacity of the plant, huge investment cost etc, hence different approach in tackling the profitability analysis to integrate these parameters, will be x-rayed in this work, using economic indicators like Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), to ascertain the breakeven point of the project, principal repayment, principal residual, interest on loan, cash flow, present and future value of project as well as the expected yearly revenue of the project is shown in advance within the economic life or span of the project.

2. Materials and Methodology

2.1. Study Site

River Aku also known as EzeAku (Onuaku) is located in Uturu in Isuikwato Local Gorvernment Area of Abia State, Nigeria. It lies on coordinates 5°54'0" N and 7°33'0" E in DMS (Degrees Minutes Seconds) or 5.9 and 7.55 (in decimal degrees). The area is extensively a low-lying terrain of about 50 – 135m above sea level. The area is generally a level, gentle undulating plain with minor local topographic features of sand ridges and isolated intrusive of igneous origin. The Aku River is an all season river with the highest / full discharge during the rainy season. It flows south easterly and empties into Ivo River. Other rivers within the vicinity are Nwaomaiyi, Ikwa and Akwukwo which all empty into Ivo River[15].

2.2. Technical Details

The technical feasibility study was carried out by [15]. The summary of the data available from the feasibility analysis is provided in table 1

Table 1. Basic Summary of Data Gotten from the Feasibility Analysis for Aku Dam Toe SHP Project [15].

Project Name	Aku SHP Project
River discharge	2.75m^3/s
Gross head	7.9m
Estimated Run-off Power	152.1kW
Load demand of Aku and surrounding villages	639.013kW
Scheme type to be adopted	Dam
Depth of dam	21m
Free board of dam	2m
Area of Dam	3,142,500m^2
Required discharge from dam	5m^3/s approx.
Dam -toe Power	700kW approx.
Penstock length	127m
Annual Energy produced	4,670,748kWh
Turbine type	Two units of 350kW Kaplan turbine

2.3. Profitability Analysis

The profitability analysis is an evaluation of costs and benefits that will enable the investor to make an informed choice whether to proceed with the project or abandon it. The below are the tools and components for profitability Analysis

a) Present value (PV): In any Profitability analysis involving economic value, there are always two variables, money and time [6]. A certain amount of money paid or received at a point in time has a different value, if it is paid or received at another point in time. Money can be invested during a certain period of time, with the guarantee of a certain benefit. The term "present value", describes a monetary amount now, i.e.

at a point in time other than that at which it is paid or received. It is mathematically given as [2]

$$PV = \frac{1}{(1+r)^n} \tag{1}$$

Where: r = Discount rate (%)

n = time (years)

b) Discount rate; the discount rate is a concept related to the NPV method. The discount rate is used to convert costs and benefits to present values to reflect the principle of time preference [8]. As at May 2016, the prevailing discount rate published by the Central Bank of Nigeria, stood at twelve percentage (12%) [17]. There are some possible risk factors that may influence the discount rate. These comprise technical and political risk. The technical risk is associated to a probable malfunction and the necessity of replacement of components, but also the danger that the plant is not built properly, while the political risk entails the risks that the taxes for small hydropower plants are modified or that the government starts providing subsidies to this type of electricity generation. The higher the discount rate and the shorter the lifetime, the lower the NPV value will be.

c) Payback method (PBP); this is the ratio of the capital investment cost to the annual cash inflows. It determines the number of years required for the investment capital to be offset by resulting benefits. The required number of years is termed the Payback period, recovery or breakeven point. The measure is usually calculated on a before tax basis and without discounting, i.e. neglecting the opportunity cost of capital. The payback ratio should not exceed a maximum period of ten years (10) if the small hydro project is to be considered profitable [14]. However this method presents obvious drawbacks which prevent the ranking of projects. The method takes no account of the time value of money and neither does it take account of the earnings, after initial investment is recouped. Despite the above limitations, the payback method continues to be very popular and widely put to use, particularly where there is a high degree of uncertainty. It is mathematically given as [5].

$$\text{Payback Period} = \frac{\text{capital investment cost}}{\text{Annual Cash inflows}} \tag{2}$$

d) Net present value; Net Present Value (NPV) is the difference between the present value of cash inflows and the present value of cash outflows. A zero net present value means the project repays original investment plus the required rate of return, while a positive net present value indicates that the projected earnings generated by a project or investment exceeds the anticipated costs and a negative net present value means a worse return, than the return from zero net present value. The preferred option is that with the highest Net Present Value. A positive net present value means a better return. The NPV is viewed as the most reliable technique to support investment appraisal decisions. It is mathematically given as [9].

$$NPV = \sum_{j=4}^{36} \frac{(B_j - C_j)}{(1+i_s)^j} - \sum_{j=0}^{3} \frac{(I_j)}{(1+i_s)^j} \tag{3}$$

e) Internal rate of return; is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero. Internal rate of return is used to evaluate the attractiveness of a project or investment. In other words, the method calculates the rate of return an investment is expected to yield. The preferred option is that with the IRR greatest in excess of a specified rate of return or discount rate [19]. A process of trial and error, whereby the net cash flow is computed for various discount rates, until its value is reduced to zero, usually calculates the rate of return. It is worth noting that under certain circumstances, there may be either no rate of return solution or multiple solutions. Hence it is expected to choose from the IRR values that converge very close to zero, as the project IRR. It is mathematically given as [9]

$$NPV = \sum_{j=4}^{36} \frac{(B_j - C_j)}{(1+i_s)^j} - \sum_{j=0}^{3} \frac{(I_j)}{(1+i_s)^j} = 0 \tag{4}$$

f) Benefit cost ratio (BCR) or profitability index; the BCR or Profitability index, is calculated by dividing the total discounted value of the benefits by the total discounted value of the costs. The ratio is used to measure both the quantitative and the qualitative factors, since sometimes the benefits and the costs cannot be measured exclusively in financial terms. The preferred option is that with the ratio greatest in excess of one [10]. In any event, a project with a benefit cost ratio of less than one should generally be discarded. The advantage of this method is its simplicity, because it gives the investor an Idea of the benefit on every one naira invested in the project. It is mathematically given as [9].

$$B/C = \frac{\sum_{j=4}^{36} \frac{B_j}{(1+i_s)^j} - \sum_{j=0}^{3} \frac{I_j}{(1+i_s)^j}}{\sum_{j=4}^{36} \frac{C_j}{(1+i_s)^j} - \sum_{j=0}^{3} \frac{I_j}{(1+i_s)^j}} \tag{5}$$

g) Annual benefits: Small hydropower plant is a price taker, once the generation capacity has been fixed; optimal production is always at full capacity provided the price exceeds production cost. The annual benefits are the resulting net yearly revenues expected from selling the electricity produced, after deducting the operation and maintenance cost, at constant value money [2].

h) Principal repayment: this is the ratio of loan amount received by the repayment time.

$$\text{Principal repayment} = \frac{\text{Loan Amount}}{\text{Repayment time}} \quad (6)$$

i) Annual repayment (R): this is the amount of the loan repayable. Given by:

$$R = \frac{Lxi(1+i)^n}{(1+i)^n - 1} \quad (7)$$

Where R = Annual repayment

L = Loan amount

i = interest rate

n = number of years of repayment.

j) Capital cost: this is the sum of money invested in the project before it's fully put into use or operation, which is given by the budget estimate of a project design. It consist of direct expenditures (Civil, electrical, mechanical works), indirect expenditures (supervision, administrative legal etc.)

The computations were successfully carried out using anexcel based platform to show the different cash flow analysis of the respective indicators used.

3. Results and Discussion

3.1. Results of the Study

3.1.1. Project Cost and Funding

The Summary of the results of the investment cost of the project after a proper bill of engineering measurement and evaluation is estimated in table 2.

Table 2. Summary of the investment cost of Aku SHP.

Description	Cost (₦)
Direct Cost	
Reconnaissance Visit	120,500.00
Detailed Site Survey	526,380.00
Detailed Project Design	1,000,000.00
Environmental Impact Assessment	2,000,000.00
Renovation and expansion of existing dam and civil Structures	545,242,815.00
Turbine-Generator	222,482,241.00
Total Direct Cost Foreseen	771,371,936.00
Contingencies (unforeseen)- 5% of Total Direct Cost	38,568,596.8
Total Direct Cost Foreseen & Unforeseen	809,940,532.8
Indirect Cost	
Capacity Building for Local Technicians & Artisans	2,748,591.00
Admin & Others (1% of Direct & Contingencies)	8,099,405.33
Total indirect Cost	10,847,996.33
Investment Cost = Total Direct Cost + Total Indirect Cost	820,788,529.1

Hence we have:

Investment cost= ₦820, 788,529.1

Equity contribution = ₦246, 236, 558

Bank Loan=₦574,551,971

Interest rate= 13% - (Negotiable between 10-13%)

3.1.2. Principal Repayment

From equation 6, the principal repayment is calculated

$$\text{Principal repayment} = \frac{\text{Loan Amount}}{\text{Repayment time}}$$

$$= \frac{574{,}551{,}971}{12}$$

Principal repayment = ₦ 47,879,330.92

3.1.3. Expected Revenue

Expected revenue = Energy produced * tariff rate

N/b: the present Commercial/domestic Electricity tariff rate of 27.13kWh were used

Expected Revenue = 4,670,748 x 27.13

Expected Revenue =₦126,717,393.2

But with 2% energy escalation or annual growth rate

3.1.4. Operation and Maintenance Cost

From literature this cost ranges between 1-3percent depending on scheme size. Thus the bigger the scheme the smaller the O&M cost. Hence for this work we adopt a 2% O& M cost of the investment cost.

O&M Cost = 820,788,529.1 x 0.2

= ₦16, 415,770.58

= ₦16, 415,771 approx.

3.1.5. Payback Period

From equation 2, the Payback period is calculated

$$\text{Payback Period} = \frac{\text{capital investment cost}}{\text{Annual Cash inflows}} = \frac{820{,}788{,}529.1}{126{,}110{,}196}$$

Payback Period =6.5years

=7 years approx.

3.1.6. Net Present Value

From equation 3, the NPV of the project is calculated.

Table 3. below shows that the cash flow analysis gave an NPV of ₦238, 800,732.05 at the 35 years life span of the project base on the following Projections.

i) 12% discount rate [17]

ii) Project life Span of 35years [6]

iii) 2% of energy escalation on annual benefits [13]

Table 3. Cash Flow Analysis for Project NPV: from equation 4.

Interest on Loan (13%)	Revenues (2%)	Operation & Maintenance (2%)	Cash Flow	Cumulated Cash Flow	PV Factor (r=12%)	Present Value of Cash
			-121,730,010.00	-121,730,010.00		-121,730,010.00
			-125,063,548.00	-246,793,558.00		-125,063,548.00
			0	-246,793,558.00		0
-34,761,543.31			-34761543.31	-281,555,101.31		-34,761,543.31
-74,691,756.23	126,717,393.20	-16,415,770.58	35609866.39	-245,945,234.92		35,609,866.39
-74,691,756.23	129,251,741.06	-16744085.99	-10063432.08	-256,008,667.00	0.892857143	-8985207.212
-68,467,443.21	131,836,775.89	-17078967.71	-1588965.957	-257,597,632.95	0.797193878	-1266713.932
-62,243,130.19	134,473,511.40	-17420547.07	6930503.227	-250,667,129.73	0.711780248	4932995.304
-56,018,817.17	137,162,981.63	-17768958.01	15495875.53	-235,171,254.19	0.635518078	9847909.042
-49,794,504.15	139,906,241.26	-18124337.17	24108069.02	-211,063,185.17	0.567426856	13679565.8
-43,570,191.13	142,704,366.09	-18486823.91	32768020.13	-178,295,165.04	0.506631121	16601298.78
-37,345,878.11	145,558,453.41	-18856560.39	41476683.99	-136,818,481.05	0.452349215	18761945.46
-31,121,565.09	148,469,622.48	-19233691.6	50235034.87	-86,583,446.18	0.403883228	20289088.04
-24,897,252.07	151,439,014.93	-19618365.43	59044066.51	-27,539,379.68	0.360610025	21291882.3
-18,672,939.05	154,467,795.23	-20010732.74	67904792.52	40,365,412.84	0.321973237	21863525.83
-12,448,626.03	157,557,151.13	-20410947.39	76818246.79	117,183,659.63	0.287476104	22083410.31
-6,224,313.01	160,708,294.15	-20819166.34	85785483.88	202,969,143.51	0.256675093	22018997.05
	163,922,460.04	-21235549.67	142686910.4	345,656,053.88	0.22917419	32700157.13
	167,200,909.24	-21660260.66	145540648.6	491,196,702.46	0.204619813	29780500.24
	170,544,927.42	-22093465.87	148451461.6	639,648,164.01	0.182696261	27121527
	173,955,825.97	-22535335.19	151420490.8	791,068,654.79	0.163121662	24699962.09
	177,434,942.49	-22986041.89	154448900.6	945,517,555.38	0.145644341	22494608.33
	180,983,641.34	-23445762.73	157537878.6	1,103,055,433.99	0.13003959	20486161.16
	184,603,314.17	-23914677.99	160688636.2	1,263,744,070.17	0.116106777	18657039.63
	188,295,380.45	-24392971.55	163902408.9	1,427,646,479.08	0.103666765	16991232.52
	192,061,288.06	-24880830.98	167180457.1	1,594,826,936.16	0.092559612	15474158.19
	195,902,513.82	-25378447.6	170524066.2	1,765,351,002.38	0.08264251	14092536.92
	199,820,564.10	-25886016.55	173934547.5	1,939,285,549.93	0.073787956	12834274.7
	203,816,975.38	-26403736.88	177413238.5	2,116,698,788.43	0.065882103	11688357.31
	207,893,314.89	-26931811.62	180961503.3	2,297,660,291.70	0.058823307	10644753.98
	212,051,181.18	-27470447.85	184580733.3	2,482,241,025.04	0.052520809	9694329.518
	216,292,204.81	-28019856.81	188272348	2,670,513,373.04	0.04689358	8828764.383
	220,618,048.90	-28580253.94	192037795	2,862,551,168.00	0.041869268	8040481.849
	225,030,409.88	-29151859.02	195878550.9	3,058,429,718.86	0.037383275	7322581.684
	229,531,018.08	-29734896.2	199796121.9	3,258,225,840.74	0.033377924	6668779.748
	234,121,638.44	-30329594.13	203792044.3	3,462,017,885.05	0.029801718	6073352.984
	238,804,071.21	-30936186.01	207867885.2	3,669,885,770.26	0.026608677	5531089.325
	243,580,152.63	-31554909.73	212025242.9	3,881,911,013.16	0.023757747	5037242.064
	248,451,755.69	-32186007.92	216265747.8	4,098,176,760.93	0.021212274	4587488.308
	253,420,790.80	-32829728.08	220591062.7	4,318,767,823.65	0.01893953	4177891.138
					NPV =	238,800,732.05

3.1.7. Internal Rate of Return

From equation 4, the IRR of the project is calculated.

The IRR is an indicator to measure the financial return on investment of an income generating project and is used in investment decision. In general the decision rule is that as long as the IRR of the project is greater than discount rate or the hurdle rate, then you accept the project.

Table 4. shows that the upper and lower limit of discount gotten by Trial and error method are 12% - 17.1%, Hence we calculate by interpolation of the discount rate that makes the NPV to be zero or very close to zero.

Table 4. Cash Flow Analysis for Project IRR: from equation 4.

Year	Investment	Cash Flow	PV Factor (r=12%)	Present Value of Cash	PV Factor for IRR (17.1%)	Present value for IRR
-4	-121,730,010	-121,730,010.00		-121,730,010.00		-121,730,010.00
-3	-125,063,548	-125,063,548.00		-125,063,548.00		-125,063,548.00
-2	-267,396,487	0		0		0
-1	-307,155,484	-34761543.31		-34,761,543.31		-34,761,543.31
0		35609866.39		35,609,866.39		35,609,866.39
1		-10063432.08	0.892857143	-8985207.212	0.853970965	-8593878.802
2		-1588965.957	0.797193878	-1266713.932	0.729266409	-1158779.497
3		6930503.227	0.711780248	4932995.304	0.622772339	4316125.705
4		15495875.53	0.635518078	9847909.042	0.531829495	8241163.665
5		24108069.02	0.567426856	13679565.8	0.454166947	10949088.12
6		32768020.13	0.506631121	16601298.78	0.387845386	12708925.42
7		41476683.99	0.452349215	18761945.46	0.331208699	13737438.53
8		50235034.87	0.403883228	20289088.04	0.282842612	14208608.48
9		59044066.51	0.360610025	21291882.3	0.241539378	14261467.12
10		67904792.52	0.321973237	21863525.83	0.206267616	14006559.67
11		76818246.79	0.287476104	22083410.31	0.176146555	13531269.54
12		85785483.88	0.256675093	22018997.05	0.150424044	12904199.37
13		142686910.4	0.22917419	32700157.13	0.128457766	18329241.71
14		145540648.6	0.204619813	29780500.24	0.109699202	15965693.03
15		148451461.6	0.182696261	27121527	0.093679934	13906923.05
16		151420490.8	0.163121662	24699962.09	0.079999943	12113630.67
17		154448900.6	0.145644341	22494608.33	0.068317629	10551582.65
18		157537878.6	0.13003959	20486161.16	0.058341271	9190960.12
19		160688636.2	0.116106777	18657039.63	0.049821752	8005789.345
20		163902408.9	0.103666765	16991232.52	0.042546329	6973445.885
21		167180457.1	0.092559612	15474158.19	0.03633333	6074222.718
22		170524066.2	0.08264251	14092536.92	0.031027609	5290954.033
23		173934547.5	0.073787956	12834274.7	0.026496677	4608687.544
24		177413238.5	0.065882103	11688357.31	0.022627393	4014399.056
25		180961503.3	0.058823307	10644753.98	0.019323137	3496743.84
26		184580733.3	0.052520809	9694329.518	0.016501398	3045840.066
27		188272348	0.04689358	8828764.383	0.014091714	2653080.16
28		192037795	0.041869268	8040481.849	0.012033915	2310966.493
29		195878550.9	0.037383275	7322581.684	0.010276614	2012968.252
30		199796121.9	0.033377924	6668779.748	0.00877593	1753396.769
31		203792044.3	0.029801718	6073352.984	0.007494389	1527296.93
32		207867885.2	0.026608677	5531089.325	0.006399991	1330352.577
33		212025242.9	0.023757747	5037242.064	0.005465406	1158804.124
34		216265747.8	0.021212274	4587488.308	0.004667298	1009376.777
35		220591062.7	0.01893953	4177891.138	0.003985737	879218.0298
						-629,473.76
			NPV =	238,800,732.05		

$$\text{Lower Discount Rate} + \text{Diff of two discount rate}\left[\frac{\text{NPV at lower disc rate}}{\text{Sum of NPV at two disc rate}}\right]$$

But lower rate = 12%

Difference of two disc rate = 17.1% -12 = 5.1%

NPV at hurdle discount rate of 12% = ₦238, 800,732.05

NPV at upper discount rate = ₦ -629,473.76

we have

$$\text{IRR} = 12 + 5.1\left[\frac{238{,}800{,}732.05}{238{,}800{,}732.5 + 629{,}473.76}\right]$$

= 12 + 5.08%

IRR = 17.09%

Therefore with an IRR of 17.09%, the project NPV becomes zero.

3.1.8. Benefit Cost Ratio

From equation 5, BCR of the project is calculated.

The benefit cost ratio of the project from discounted O& M cost, discounted investment cost and the discounted Annual benefit in Table 5 is given as:

Total Discounted Cost = 1, 046,686,103+177, 514,478.2

= ₦ 1, 224,200,581

Discounted benefit= ₦ 1, 370,278,162

Hence b/c ratio $= \frac{1{,}370{,}278{,}162}{1{,}224{,}200{,}581} = 1.12$

Table 5. Cash Flow Analysis for Project BCR: from equation 5.

Cash Flow	Cumulated Cash Flow	PV Factor (r=12%)	Present Value of Cash	PV Factor	Discounted Cost	Discounted O&M	Discounted Benefit
-121,730,010.00	-121,730,010.00		-121,730,010.00	1.57351936	-191544527.4		
-125,063,548.00	-246,793,558.00		-125,063,548.00	1.404928	-175705280.4		
0	-246,793,558.00		0	1.2544	-335422153.3		
-34761543.31	-281,555,101.31		-34,761,543.31	1.12	-344014142.1		
35609866.39	-245,945,234.92		35,609,866.39	1	0	-16415770.58	126717393.2
-10063432.08	-256,008,667.00	0.892857143	-8985207.212	0.892857143	0	-14950076.78	115403340.2
-1588965.957	-257,597,632.95	0.797193878	-1266713.932	0.797193878	0	-13615248.49	105099470.6
6930503.227	-250,667,129.73	0.711780248	4932995.304	0.711780248	0	-12399601.31	95715589.27
15495875.53	-235,171,254.19	0.635518078	9847909.042	0.635518078	0	-11292494.05	87169554.51
24108069.02	-211,063,185.17	0.567426856	13679565.8	0.567426856	0	-10284235.65	79386558.58
32768020.13	-178,295,165.04	0.506631121	16601298.78	0.506631121	0	-9366000.325	72298472.99
41476683.99	-136,818,481.05	0.452349215	18761945.46	0.452349215	0	-8529750.296	65843252.19
50235034.87	-86,583,446.18	0.403883228	20289088.04	0.403883228	0	-7768165.448	59964390.38
59044066.51	-27,539,379.68	0.360610025	21291882.3	0.360610025	0	-7074579.247	54610426.96
67904792.52	40,365,412.84	0.321973237	21863525.83	0.321973237	0	-6442920.386	49734495.98
76818246.79	117,183,659.63	0.287476104	22083410.31	0.287476104	0	-5867659.637	45293915.98
85785483.88	202,969,143.51	0.256675093	22018997.05	0.256675093	0	-5343761.455	41249816.34
142686910.4	345,656,053.88	0.22917419	32700157.13	0.22917419	0	-4866639.897	37566797.02
145540648.6	491,196,702.46	0.204619813	29780500.24	0.204619813	0	-4432118.477	34212618.72
148451461.6	639,648,164.01	0.182696261	27121527	0.182696261	0	-4036393.613	31157920.62
151420490.8	791,068,654.79	0.163121662	24699962.09	0.163121662	0	-3676001.326	28375963.42
154448900.6	945,517,555.38	0.145644341	22494608.33	0.145644341	0	-3347786.922	25842395.26
157537878.6	1,103,055,433.99	0.13003959	20486161.16	0.13003959	0	-3048877.376	23535038.54
160688636.2	1,263,744,070.17	0.116106777	18657039.63	0.116106777	0	-2776656.181	21433695.81
163902408.9	1,427,646,479.08	0.103666765	16991232.52	0.103666765	0	-2528740.451	19519972.97
167180457.1	1,594,826,936.16	0.092559612	15474158.19	0.092559612	0	-2302960.054	17777118.24
170524066.2	1,765,351,002.38	0.08264251	14092536.92	0.08264251	0	-2097338.62	16189875.54
173934547.5	1,939,285,549.93	0.073787956	12834274.7	0.073787956	0	-1910076.243	14744350.94
177413238.5	2,116,698,788.43	0.065882103	11688357.31	0.065882103	0	-1739533.722	13427891.03
180961503.3	2,297,660,291.70	0.058823307	10644753.98	0.058823307	0	-1584218.211	12228972.19
184580733.3	2,482,241,025.04	0.052520809	9694329.518	0.052520809	0	-1442770.156	11137099.67
188272348	2,670,513,373.04	0.04689358	8828764.383	0.04689358	0	-1313951.392	10142715.78
192037795	2,862,551,168.00	0.041869268	8040481.849	0.041869268	0	-1196634.304	9237116.152
195878550.9	3,058,429,718.86	0.037383275	7322581.684	0.037383275	0	-1089791.955	8412373.639
199796121.9	3,258,225,840.74	0.033377924	6668779.748	0.033377924	0	-992489.102	7661268.85
203792044.3	3,462,017,885.05	0.029801718	6073352.984	0.029801718	0	-903874.0036	6977226.988
207867885.2	3,669,885,770.26	0.026608677	5531089.325	0.026608677	0	-823170.9676	6354260.293
212025242.9	3,881,911,013.16	0.023757747	5037242.064	0.023757747	0	-749673.5598	5786915.624
216265747.8	4,098,176,760.93	0.021212274	4587488.308	0.021212274	0	-682738.4205	5270226.729
220591062.7	4,318,767,823.65	0.01893953	4177891.138	0.01893953	0	-621779.633	4799670.771
					-1046686103	-177514478.2	1370278162
		NPV =	238,800,732.05				

3.2. Discussions

I have evaluated the profitability of this project based on the following assumptions outlined, as well as the prevailing economic realities of the country. The project is jointly funded, with Aku development union, contributing equity portion of 30% of total investment cost and a bank loan to fund the remaining 70%. Below are brief discussion on the Project costs and Economic/profitability analysis (PBP, NPV, IRR, BCR and Generation profit)

a) Project Costs and funding

The summary of the project cost was done by the assistance from Green Energy limited an independent consultant firm on small hydropower feasibility studies and installations after proper consultations within and internationally on modern price trends on equipment required. It is assumed that the project will be developed in four years, going by the ESHA Standard of plants with construction or rehabilitation of dams. Adopting [7] model, the feasibility study, project design, and licensing process will be done in the first year. This will result in nearly one-sixth of the investment costs being spent by the end of the first year. Similarly, costs incurred in the second year will amount to a further one-sixth of total costs. In the third year, about one-third of total costs are assumed to be due. At the end of the fourth year the whole development is finished and paid. In the first two years, only interest payments of 13% are made to the bank; principal repayments on the bank loan of ₦47,879,330.92starts in year three. An equity contribution of 30% (₦246, 236,558) of total loan amount of ₦820, 788,529.1 with a first installment of 46.54% of the loan amount Released, with a grace period of 2years and a repayment period of 12 years. As reported by already existing plants, operation and maintenance costs per year are estimated at 2% of the total investment, which amounts to ₦16, 415,771. This costs is intended to grow at an annually at energy escalation rate of 2%, which will be reflected on the cash flow analysis. The expected revenue resulting from the sale of electricity at a commercial/residential tariff rate of 27.13kWh gave yearly revenue of ₦126,717,393.2.

b) Payback Period or Breakeven point

The method is used to calculate the number of years taken for the savings obtained from SHP project to offset the invested capital amount and the accumulated O&M costs. From calculation the project would be completely paid for in 7 years, this implies that an investor will break even within a Seven years period, if the project is implemented and put into full operation. The PBP method is the fastest and most used method to show the economic metrics of a project. The shorter time for the project to pay back its initial investment, the better and seven years is considerable short a period for an investment that spans over 30 years minimum and 50 years and above, to yield.

c) Net Present Value

The NPV indicates the financial viability of SHPs considering the time value of money. Table 3 shows that the project net present value was estimated at ₦238,800,732.05, a signal to the investor that the project is indeed profitable and has the ability to pay for all its cost and able to withstand variations and fluctuations in price indices. The NPV is the most reliable technique to support appraisal decisions, as compared to the IRR and BCR.

d) Internal Rate of Return

The IRR is the rate at which the NPV of a project, at the end of its lifetime, equal zero. From table 4, the IRR of the project is 17.09% higher than the nominal current interest rate or hurdle rate of 12%. Generally speaking, the higher the IRR the more attractive is the project, since it is expressed as the return that investor will receive on their equity. The result of the IRR obtained, also shows that even at a discount rate above 12% that may be caused by inflation, the project will still break-even at 17.09%.

e) Benefit Cost Ratio or the profitability index

Table 5 shows that the BCR or profitability index of the project is 1.12, above unity, a signal that the project is viable and brings a benefit of 0.12 on every one naira spent.

4. Conclusion

An investment cost of ₦820, 788, 529.1 and a commercial/residential tariff rate of 27.13kWh yielding an annual revenue of ₦126,717,393.2 before tax for the first year of operation shows a healthy return on investment of the project. Also the project PBP of seven years is timely enough for the client or investor to recover its initial investment made on a project that spans over fifty years, having NPV of ₦238, 800,732.05 and an IRR of 17.09% is highly viable according to our decision rule. The benefit cost ratio of 1.12 above unity shows additional insurance or backup that the project is viable if pursued.

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