Nigerian Journal of Technology (NIJOTECH)
Vol. 42, No. 4, December, 2023, pp.478 - 485
www.nijotech.com

Print ISSN: 0331-8443
Electronic ISSN: 2467-8821
https://doi.org/10.4314/njt.v42i4.8

ASSESSMENT OF THE FEASIBILITY OF AKU SMALL HYDROPOWER PROJECT USING RETSCREEN ENERGY MODEL SOFTWARE

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ARTICLE HISTORY:
Received: 04 April, 2023.
Revised: 21 November, 2023.
Accepted: 24 October, 2023.
Published: 12 February, 2024

KEYWORDS:
Hydropower, Feasibility, RETScreen software, River Aku, Greenhouse gas.

ARTICLE INCLUDES:
Peer review

DATA AVAILABILITY:
On request from author(s)

EDITOR:
Chidozie Charles Nnaji

FUNDING:
None

Abstract
The RETScreen 4 software was used in this study to conduct the analysis to determine the viability of the river Aku hydropower plant in Uturu, Abia State. The study was carried out using data from Ivo river dam authority, previous studies and literatures. The result of the study showed that the Aku river could generate an annual energy of 6,434,000kWh and will be able to payback its project cost at 6.3 years. The estimated annual GHG reduction of the project stood at 4,310.7tCo2 an equivalent of 1,852,317 litres of gasoline not used. The sensitivity/risk analysis indicated that electricity export rate (electricity sales price), initial cost and debt interest rate impacted the project profitability the most in that order. The project NPV is sensitive to both the debt interest rate and the initial cost of the project as variation in cost above 30% will throw the project into a negative NPV. In the light of the available information, the project is feasible if implemented.

1.0 INTRODUCTION
Electricity is a crucial component for industrializing the economy and accelerating economic growth [1]. Inadequate electricity has been provided to families and businesses in Nigeria. Nigeria has an installed capacity of 12,500 MW [2], a generating capacity that is available of around 6,803 MW [3], and a distribution of roughly 4,000 MW in 2021 [4]. This is grossly inadequate for a country of over 195 million people [2], and far below 40,000 MW required to sustain economic growth and development of the populace [5]. The majority of electricity is produced using fossil fuels, with gas making up 86% of the capacity and hydropower making up the remaining portion [6]. Policy makers have advocated generation of electricity via other alternatives arising from environmental concerns and rising cost of fossil fuels.

Small hydropower (SHP) is a viable source of energy for electricity generation as it is an ecological and friendlier option in replacing conventional sources of energy, such as kerosene lamps, petrol generators, biomass stoves etc. Opportunities exist for the development of SHP schemes since there are potential sites with a combined estimated capacity of 3500 MW [7] and 278 untapped sites with a combined potential capacity of 734.2 MW [7].

For the purpose of evaluating the viability of small hydro projects, numerous studies have been carried

HOW TO CITE:
Chinyere, O., Sanusi, Y., and Kulla, D. "Assessment of the Feasibility of Aku Small Hydropower Project using Retscreen Energy Model Software", *Nigerian Journal of Technology*, 2023; 42(4), pp. 478 – 485; *https://doi.org/10.4314/njt.v42i4.8*

out. RETScreen was used by [8] to examine the potential of the Oshin River, Ifeolodun, L.G.A in the Nigerian state of Kwara. The study calculated the river's sub-basin 9 power potential at 363.36 kW, and its yearly generation capacity at 2,624,482.08kWh. RETScreen was used in a research by [9] to evaluate the hydropower potential of Ekiti State. The study's findings indicate that every river in Ekiti has the capacity to support a mini/pico hydropower project with a capacity of 42 to 190 kW. [10] utilized RETScreen tool to analyse the technical, economic, and environmental elements of a planned mini-hydropower plant on the Tuwan River. The impressive internal rate of return (IRR) for the project was 68.1%, and the project's net present value (NPV) was $568,178 USD (11% discount rate).

[1] investigated the Technical analysis of Aku river through field work. The result estimated a run-off power of 152kW could be generated from the river and recommended for a Dam-toe system to meet the power requirement of the locals which happens to be 639.013kW [1]. This work is aimed at using the RETScreen software to carry out a feasibility analysis of Aku river SHP project. Moreso the study will further provide the annual GHG emission analysis, sensitivity/risk analysis of the project that were not addressed in previous studies, owning to their relevance in terms of environmental concerns, carbon credit financing and to address the uncertainty that comes with project of this nature which can limit the success of the project.

2.0 METHODOLOGY

2.1 Study Location

The location for this study is Aku community in Uturu-Isuikwato Local Government Area of Abia state, southeast of Nigeria. It is located on co-ordinates 5°54'0" N and 7°33'0" E in DMS (Degrees Minutes Seconds). The area has two distinct seasons; the rainy (wet) season and the dry season. The rainy season spans from April to October with a double maxima in July and September. The dry season spans from November to March. A mean rainfall range of 1750m-2000mm is experienced. The air temperature range between 26.2 – 28^{o}c, but lower temperature occur during harmattan periods of December and January and higher temperature in other times up to 30 – 32 ^{o}c. The relative humidity range between 60 – 80% which is high and evapotranspiration of about 1450mm. (IMWI, 1984). The higher the relative is experienced during the rainy season while the lower value occurs in the dry season. The study site was selected due to the availability of the Aku river and availability of a dam to be harnessed to solve the energy crises of the rural dwellers. An excepts from GIS imagery of the study area is shown in Figure 1.

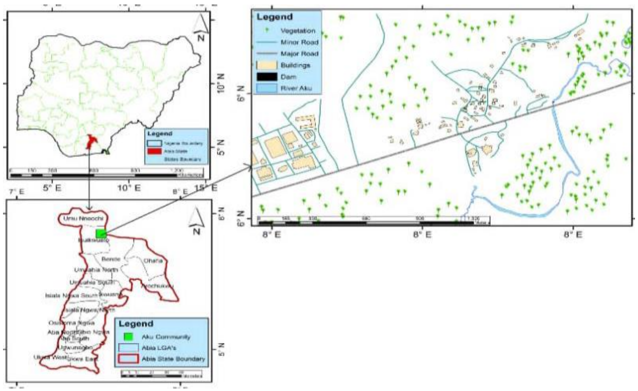

Figure 1: Summary of maps and satellite imagery of the study site

2.2 Data Collection

A summarize monthly flow duration data covering year (1999-2021) was gotten from Ivo river dam authority (IVORDA)

Table 1: Monthly flow data covering year (1999-2021) [3]

S/N	Percentage Exceedence (%)	Flow (m^3/s)
1	0	52.50
2	5	44.00
3	10	27.90
4	15	20.20
5	20	18.40
6	25	18.00
7	30	17.60
8	35	17.00
9	40	15.90
10	45	14.10
11	50	13.80
12	55	13.30
13	60	13.00
14	65	11.20
15	70	10.30
16	75	8.80
17	80	7.40
18	85	6.90
19	90	6.70
20	95	5.90
21	100	3.50

2.3 Mathematical Modeling

RETScreen calculates the annual energy, initial cost, financial analysis and emission analysis of the plant using the following model equations [11]:

2.3.1 Annual energy equations

The following model equations will be used to calculate the annual energy of the project.

i. Available flow

$$Q'_n = \max(Q_n - Q_r, 0) \quad (1)$$

Where; Q'_n is Available flow, Q_n is Actual flow = 5.9m^3/s at 95% availability [3], Q_r is Residual flow = 1.0m^3/s (15-20% of actual flow for environmental concerns. The study adopted a mid value of the range of approximately 17%) [11]

ii. Power available as a function of flow

$$P = pgQ[H_g - (h_{hydr} + h_{tail})]e_t e_g(I - I_{trans})(I - I_{para}) \quad (2)$$

Where h_{hydr} and h_{tail} are respectively the hydraulic losses and tailrace effect associated with the flow; e_t is the turbine efficiency at flow Q; e_g is the generator efficiency, I_{trans} is the transformer losses, and I_{para} is the parasitic electricity losses.

iii. Hydraulic losses

$$h_{hydro} = H_g I_{hydr,}\, max\frac{Q^2}{Qd^2} \quad (3)$$

Where; H_g is the gross head = 21m [1], $I_{hydr,}\, max$ is the maximum hydraulic losses = 8% [11], Q_d is the design flow = 5m^3/s [1].

iv. Maximum tailrace effect

$$h_{tail} = h_{tail,}\, max\frac{(Q-Q_{des})^2}{(Q_{max}-Q_{des})^2} \quad (4)$$

where $h_{tail,}\, max$ is the maximum tailwater effect, Q_{max} is the maximum river flow.

v. Plant capacity

$$P_{des} = pgQ_{des}[H_g(I - h_{hydr})]e_{t,des}e_g(I - I_{trans})\,(I - I_{para}) \quad (5)$$

Where P_{des} is the plant capacity and $e_{t,des}$ the turbine efficiency at design flow,

vi. Annual energy or renewable energy available

$$E_{avail} = \sum_{k=1}^{20}\left(\frac{P_{5(k-1)}+P_{5k}}{2}\right)\frac{5}{100} * 8760(1 - I_{dt}) \quad (6)$$

Where I_{dt} is the annual downtime losses [11].

2.3.2 Initial cost equations [11]

i. Engineering cost (EC)

The engineering cost of the project was modeled using:

$$EC = 0.37n^{0.1}E\left(\frac{MW}{H_g{}^{0.3}}\right)^{0.54} * 10^6 \quad (7)$$

ii. Energy equipment cost (EEC)

The Kaplan turbine type was selected for this project, owning to its advantage with low flow [1].

$$EEC\ for\ Kaplan\ turbine = 0.27 * n^{0.96} * J_t * K_t * d^{1.47} * (1.17 * H_g{}^{0.12} + 2) * 10^6 \quad (8)$$

iii. Installation of energy equipment cost (IEEC)

$$IEEC = 0.15(EEC\ for\ Kaplan\ turbine) \quad (9)$$

iv. Access road

$$Access\ road = 0.025 * T * A^2 * I_a{}^{0.9} * 10^6 \quad (10)$$

v. Transmission line

$$Transmission\ line = 0.0011 * D * P * (I_T{}^{0.95}) * V * 10^6 \quad (11)$$

vi. Substation & transformer cost (STC)

$$STC = 0.0025 * n^{0.95} + 0.002(n + 1) * \left(\frac{MW}{0.95}\right)^{0.9} * V^{0.3} * 10^6 \quad (12)$$

vii. Installation of substation & transformer

$$Installation\ of\ substation\ \&\ transformer = 0.15(STC) \quad (13)$$

viii. Civil works

$$Civil\ works = 3.54n^{-0.04} * CR * \left(\frac{MW}{H_g{}^{0.3}}\right)^{0.82} * (1 + 0.01I_b) * \left(1 + 0.005 * \frac{I_d}{H_g}\right) * 10^6 \quad (14)$$

ix. Penstock

$$Penstock = 20n_p{}^{0.95} * W^{0.88} \quad (15)$$

Where; W= Weight of penstock calculated model, n_p = No. of penstock = 2 [1]

x. Installation of penstock

$$Installation\ of\ penstock = 5W^{0.88} \quad (16)$$

xi. Canal

$$Canal = 20 * [(1.5 + 0.01S_s{}^{1.5})Q_d I_{cs}]^{0.9} + 100 * [(1.5 + 0.016S_r{}^2)Q_d I_{cr}]^{0.9} \quad (17)$$

xii. Tunnel

$$Tunnel = 400 * R_v{}^{0.88} + 4000C_v{}^{0.88} \quad (18)$$

$$\text{Where; } R_v = 0.185I_t{}^{1.375} * \left(\frac{Q_d{}^2}{KH_g}\right)^{0.375} \quad (19)$$

$$C_v = 0.306R_v \quad (20)$$

xiii. Development cost

$$Development\ Cost = 0.04\sum Eq(7\ to\ 20) \quad (21)$$

xiv. Miscellaneous cost

$$Miscellaneous = 0.25iQ_d{}^{0.35} * 1.1\sum(Eq.7)\ to\ (Eq.21) + 0.1\sum(Eq.7)\ to\ (Eq.21) \quad (22)$$

xv. Feasibility study

$$Feasibility\ study = 0.032\sum Eq(7\ to\ 22) \quad (23)$$

xvi. Initial Cost-Total

$$Initial\ Cost - Total = \sum(Eq.7)\ to\ (Eq.23) \quad (24)$$

2.3.3 Financial analysis [11]

i. Net present value (NPV)

$$\sum_{n=0}^{N}\frac{(\widetilde{C_n})}{(1+r)^n} \quad (25)$$

Where; r = the discount rate = 12% as at 2021 [12],

N = Project life in years = 35 years [13], $\tilde{C}_n$= is the after tax cash flow in year n.

ii. Internal rate of return (IRR)

$$0 = \sum_{n=0}^{N} \frac{(C_n)}{(1+IRR)^n} \quad (26)$$

Where; C_n = cash flow for year n

iii. Benefit cost ratio (BCR)

$$B - C = \frac{NPV + (1-f_d)C}{(1-f_d)C} \quad (27)$$

Where; C = total initial cost of the project, f_d = debt ratio = 70% [12]

2.3.4 Annual Green House Gas (GHG) emission reduction equation

i. GHG emission reduction for electricity generating technology model

$$\Delta_{GHG} = (e_{base} - e_{propose}).E_{propose}(1 - \lambda_{propose})(1 - e_{\sigma}) \quad (28)$$

Where; e_{base} = base case GHG emission factor = 0.744[11], $e_{propose}$ = proposed case GHG emission factor, $E_{propose}$ = proposed case annual electricity produced, $\lambda_{propose}$ = fraction of electricity lost in transmission and distribution (T&D) for the proposed case, e_{σ} = GHG emission reduction credit transaction fee = 10₦/tCo₂[14].

ii. GHG emission factor-base case electricity system

$$e_{base} = (e_{Co_2}GWP_{Co_2} + e_{CH_4}GWP_{CH_4} + e_{N_2o}GWP_{N_2o})\frac{1}{\eta}\frac{1}{1-\lambda} \quad (29)$$

Where; e_{Co_2}, e_{CH_4}, e_{N_2o} are respectively the Co_2, CH_4, N_2o emission factors for the fuel/source considered, GWP_{CO_2}, GWP_{CH_4}, GWP_{N_2o} are the global warming potentials of CO_2 CH_4, N_2O, ŋ is the fuel conversion efficiency and λ is the fraction of electricity lost in T&D losses usually 10% [11]

iii. GHG emission factor-proposed case electricity system

$$e_{propose} = (e_{Co_2}GWP_{Co_2} + e_{CH_4}GWP_{CH_4} + e_{N_2o}GWP_{N_2o})\frac{1}{\eta}\frac{1}{1-\lambda} \quad (30)$$

Where; λ = zero for the proposed case T&D losses off-grid system

iv. Annual GHG reduction

Annual green house gas emission reduction (t_{co2}) = [base case emission factor (t_{co2}/MWh) – proposed case GHG emission factor (t_{co2}/MWh)] x End use Annual energy delivered (MWh).

2.4 RETScreen 4 Overview

The Natural Resources Canada (NRC)-developed Renewable Energy Technologies Screening Software (RETScreen) version 4 was used to assess the viability of this study. The benefit influences how people choose to use the software i.e is user friendly, flexible without compromising on the technical details, ability to computing project cost etc [15]. Utilizing a five-step analytical process that includes an energy analysis, cost analysis, emission analysis, financial analysis, and sensitivity/risk analysis. The software enables users to simulate sustainable energy projects [11].

2.4.1 Simulation guide

The project type is power generation (Isolated-grid) and method 2 was considered as the simulation method. Method 2 was used owning to a considerable availability of technical data, which provides better outcome than method 1. Lower heating value was used because the study area lies in a hot region [11]. The Nigerian naira (NGN) was chosen from the currency database and adopted for this project. One Canadian dollar exchanged at an official rate on second Feburary 2021 at 297 Nigerian naira [17].

3.0 RESULTS AND DISCUSION

3.1 Annual Energy Generated

Table 2: Power output summary

S/N	Parameters	Values
1	Power Capacity	761kW
2	Capacity factor	96.6%
3	Annual Energy	6, 434,000kW/h

Table 2 shows the reliable power at a capacity factor of 96.6% of the time is around 761kW, which surpasses the load requirement of the site which stood at 639.013kW [1] at a span of 20 years future load forecast. Hence the annual energy as calculated by the model stood at 6,434,000kWh. The capacity factor which represents the ratio of the average power produced by the hydro plant over a year to its rated power capacity, that is the power produced at a certain percentage of the total capacity of the plant.

3.2 Initial Cost of the Project

Table 3: Summary of the project Initial cost

S/N	Initial costs (credits)	Amount (₦)	Relative costs
1	Feasibilty study	28,042,000	3.1%
2	Development	33,704,00	3.7%
3	Engineering cost	47,956,000	5.3%
4	**Power System**		
5	Hydro turbine	512,684,000	56.7%
6	Substation	2,369,000	0.3%
	Balance of systems & miscellaneous		
7	Penstock	60,814,000	6.7%
8	Other costs	218,773,000	24.2%
9	**Total initial cost**	**904,342,000**	**100%**

From Table 3 the cost distribution by the model shows that the hydro turbine equipment and accessories has the highest cost of 56.7% of the estimated total initial cost of the project. This was followed by other costs (which comprises of direct and indirect cost on labour, renovation of the dam, compensation, equipment, miscellaneous cost, civil works, simple weir, stopslogs , gates etc.) having 24.2%. The turbine cost is higher, owing to the high-tech and sophistication of the Kaplan blade design that enjoys the advantage of maintaining efficiency, even at varying loads especially in the dry period of its operation. The penstock cost is 6.7% which shows that the penstock is one key and expensive component in the design of the SHP. The feasibility study having the lowest cost of the project in line with best practices and falls within 1-5% of the project cost in line with ESHA standard [13].

3.3 Financial Analysis

Table 4, Table 5, Figure 2, shows the project's cost and savings/income summary, financial viability summary and cumulative cash flow graph, respectively.

3.3.1 Project costs and savings/income summary

From Table 4 a total annual cost of ₦ 125,061,690 that comprises of the recurrent operational cost of the Operation & Maintenance (O&M) for the smooth running of the operation, maintenance of the plant at regular intervals and debt repayment. The annual savings and income from the sales of electricity to consumers at the first year stood at ₦160,847,408 using the Multi Year Tarrif Order (MYTO) electricity sales price of 46.14kWh as at 2021.

Table 4: Projects costs and savings/income summary

S/N	Parameters	Amount (₦)
1	Total initial cost	904,342,000
2	Annual costs and debt payment	
3	O&M (2% of Initial cost) [16]	18,086,840
4	Debt Payments-12 yrs	106,974,850
5	Total annual cost	125,061,690
6	Annual savings and income	
7	Fuel cost-base case	0
8	Electricity export income	160,847,408
9	Total annual savings and income	160,847,408

3.3.2 Financial analysis

In line with Table 5, the IRR on equity of 17.6% represents the original interest by the project equity over a period of 35years before income tax. An investor will have time to recover his initial investment from the income or savings it created owing to the simple payback period (PBP) of 6.3 years. This implies that the annual savings generated is higher than the costs incurred in the smooth operation of the project. The resulting NPV of the project from Table 5 is positive at ₦203, 565,758; this implies that the project will get the required return at the life span of the project. Hence since the project has a positive NPV the project is economically and financially viable and accepted even at a higher discount rate as high as 17.6% which is above the initial discount rate or hurdle rate of 12% as shown in Table 5. The Aku SHP is viable considering the outcome of the RETScreen model which shows a positive NPV and IRR value, together with a BCR cost of 1.75 above unity as shown in Table 5.

Table 5: Financial analysis summary

S/N	Financial indicators	Output
1	Internal Rate Return	17.6%
2	Simple payback	6.3 yr
3	Equity payback	8.0yr
4	Net Present Value (NPV)	₦ 203,565,758
5	Annual life cycle savings	₦/yr 24,899,475
6	Benefit-Cost (B-C) ratio	1.75

3.4 GHG Analysis

Table 6 shows the outcome of the GHG analysis. The gross annual GHG emission reduction of 4,310.7tCo_2 is calculated by subtracting the propose case GHG emission of 479tCo_2 from the base case GHG emission of 4,789.7tCo_2. The annual GHG emission reduction of 4310.7tCo_2 is an equivalent of 1,852,317 litres of gasoline not consumed or 10,026 barrells of crude oil not used as shown in Table 7. GHG analysis seeks to calculate the emission offsets implementing the renewable energy project (propose case) that emits little or no emission, would bring to the host environment instead of the conventional fossil fuel (base case) with a lot of GHG emission. The baseline energy is the fossil fuel or the conventional energy source that would have been used, if this project is not implemented. The RETScreen software from its data base generates a transmission and distribution (T&D) losses of 10% [11] and GHG emission factor of 0.744 tCo_2 [11] for Nigeria sources of conventional fuel used in analyzing the GHG. Moreso implementing projects of this kind and nature will help reduce pollution and deforestation.

Table 6: Annual GHG emission reduction

S/N	Parameters	Unit	Outcomes
1	Base case	tCo_2	4789.7
2	Proposed case	tCo_2	479
3	Annual GHG emmision	tCo_2	4310.7

Table 7: GHG offsets or equivalent

S/N	Net annual GHG emission reduction of 4,311 tCO_2 equivalent
1	Is equivalent to removing or not using 790 cars and light trucks
2	Is equivalent to 396 Hectares of forest absorbing carbon not cut down during the span of the project life if implemented,
3	Is equivalent to 980 Acres of forest absorbing carbon not cut down during the span of the project life if implemented,
4	Is equivalent to 1,487 tonnes of waste recycled
5	Is equivalent to 4,311 people reducing energy use by 20%
6	Is equivalent to 1,852,317 litres of gasoline not consumed
7	Is equivalent to 10,026 barrells of crude oil not consumed

3.5 Impact of GHG Reduction on the Profitability of the Project.

Table 8 shows the outcome of the additional revenue (GHG reduction revenue of ₦15,518,520) that will accrue from possible sales of GHG emission reduction credits, at a least market value of Verified Emission Reduction (VER) rate of \$10/tCo_2 [14] over a 35 year span of the project. The dollar to naira official exchange rate as at the first quarter of 2021 stood at ₦ 360 per dollar [17] as shown in Table 8. Also from Table 8, it is shown that when income from the sales of GHG reduction credits was incorporated into the project, the simple payback value was reduced from 6.3 years to 5.7 years, with an IRR and BCR ratio of 21.8% and 2.22 respectively higher than the IRR (17.6%) and BCR (1.75) prior to addition of GHG emission reduction revenue. This implies that customers can pay as low as ₦38.24/kWh of electricity to break even at 5.7 years at a minimum tradable rate of \$10/tCo2, as against 46.14kwh of electricity to break even at 6.3 years without the green emission income as shown in Table 8.

Table 8: GHG reduction income/ Impact GHG reduction income on performance indicators.

S/N	Parameters	Unit	Outcomes
1	Annual GHG emmision	tCo_2	4310.7
2	Annual GHG emission for 35 years or VERs crediting period	tCo_2	35 * 4310.7 = 150,874.5
3	GHG credit rate	\$ /tCo_2	10
4	GHG credit rate	₦/tCo_2	10 * 360 =3600
5	GHG reduction revenue	₦	3600 * 4310.7=15518520
6	Internal rate return	%	21.8
7	Simple payback	yr	5.7
8	Net present value	₦	330,437,790
9	Benefit-cost ratio		2.22
10	Electricity export rate (electricity sales price)	kWh	38.24kWh

3.6 Sensitivity and Risk Analysis done for the NPV

RETScreen Sensitivity and Risk Analysis - Power project

Sensitivity analysis

Perform analysis on	Net Present Value (NPV)
Sensitivity range	30%
Threshold	0 NGN

Debt interest rate		Initial costs				NGN
		633,039,400	768,690,700	904,342,000	1,039,993,300	1,175,644,600
%		-30%	-15%	0%	15%	30%
9.10%	-30%	562,338,755	439,087,643	315,836,531	192,585,419	69,334,308
11.05%	-15%	523,802,028	392,293,046	260,784,064	129,275,082	-2,233,900
13.00%	0%	483,749,214	343,657,486	**203,565,758**	63,474,031	-76,617,697
14.95%	15%	442,298,063	293,323,945	144,349,828	-4,624,289	-153,598,407
16.90%	30%	399,565,083	241,433,899	83,302,715	-74,828,469	-232,959,653

O&M		Initial costs				NGN
		633,039,400	768,690,700	904,342,000	1,039,993,300	1,175,644,600
NGN		-30%	-15%	0%	15%	30%
12,660,788	-30%	536,998,616	396,906,888	256,815,160	116,723,432	-23,368,295
15,373,814	-15%	510,373,915	370,282,187	230,190,459	90,098,732	-49,992,996
18,086,840	0%	483,749,214	343,657,486	**203,565,758**	63,474,031	-76,617,697
20,799,866	15%	457,124,513	317,032,785	176,941,057	36,849,330	-103,242,398
23,512,892	30%	430,499,812	290,408,084	150,316,356	10,224,629	-129,867,099

Figure 3: Sensitivity analysis result for NPV

Risk analysis

Perform analysis on: Net Present Value (NPV)

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	NGN	904,342,000	30%	633,039,400	1,175,644,600
O&M	NGN	18,086,840	30%	12,660,788	23,512,892
Electricity export rate	NGN/MWh	25,000.00	30%	17,500.00	32,500.00
Debt ratio	%	70%	30%	49%	91%
Debt interest rate	%	13.00%	30%	9.10%	16.90%
Debt term	yr	12	30%	8.4	15.6

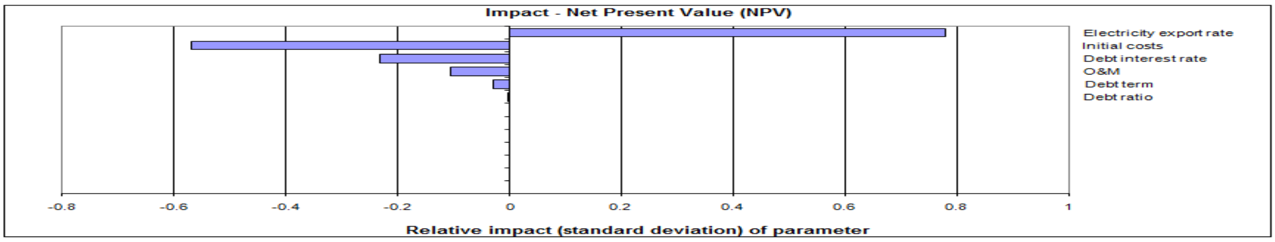

Figure 4: Impact graph outcome from Monte Carlo simulation (NPV)

Figure 3 shows the outcome of the sensitivity analysis done for the NPV of the project to be ₦69,334,308 by increasing the initial cost by 30%, while the debt interest ratio was reduced by 30% at a threshold of zero, since a project becomes viable at a positive NPV above the zero threshold.

The increase in the initial cost of the project is what every investor tries to avoid, since it can throw the NPV values for the project into negative, but reduction in the debt interest rate is healthy for investment. The outcome of the analysis at NPV ₦69,334,308 still makes the project viable. Similarly a reduction in the project cost by 30% which favors investors and increase of the debt interest ratio by 30% which is not healthy for investment is also financially viable at a positive NPV of ₦399,565,083. Thus the project NPV is sensitive to both the debt interest rate and the initial cost of the project as variation in cost above 30% will throw the project into a negative NPV. Figure 4 shows the result of the risk analysis as displayed on the Tonado/impact chart. From Figure 4 the electricity exported to the grid, initial cost and debt interest rate in that order strongly influenced the project in terms of the possible outcomes of the NPV, though there impact are opposite in sign however.

4.0 CONCLUSION

The study carried out a feasibility analysis of the viability of Aku SHP project using the RETScreen software. The software accurately calculated the potential annual energy generated by the plant, financial cost of the project, financial analysis, the quantity of GHG emission that will be reduced annually, GHG offsets equivalents, GHG reduction revenue that will be generated during the project life and its impact on the profitability of the project and the sensitivity analysis of the project. The project from our analysis will generate an annual electricity of 6,434,000kWh at an initial investment cost of N904, 342,000. The project PBP of 6.3 years is timely enough for investors to recoup their capital for a project with minimum span life of 35 years and a useful life of over 50 years.

The NPV of N203, 565,758, shows the ability of the project paying for its debt and still makes returns. The study also estimated that implementation of the project will avoid power generation by fossil fuel and hence the associated GHG is reduced by 4,310.7tCO2. The GHG reduction income improved the project revenue and performance indicators with the PBP and IRR as 5.7years and 21.8% respectively. Sensitivity/risk analysis was conducted on the project response capability in the variations of key input parameters. The result shows that the project is most sensitive to the electricity export rate, initial cost and debt interest rate in the order of their significance. Hence investors and project developer should be more concern in the outcomes or variation from these variables since they can make or mar the project gains and returns.

5.0 RECOMMENDATION

The study has demonstrated that the development of the potential of the Aku river would be a feasible venture. Hence the Aku SHP project is recommended for implementation, provided that the project cost is managed not to exceed 30% of initial budget. It is also recommended to negotiate a single digit debt interest rate to boost project gains. There is need to also push for carbon credit financing of the project to boost income and reduce cost of electricity sales to locals.

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