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Research Article

Study of Alternative Energy Based on the Economy and Environmental Pollution, Diesel Engines Will Be Replaced by Solar Water Pump System Power

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Abstract

All the schemes in the western Wollega were collected and analyzed from the motorized water distribution by diesel generator in the village of Nedjoo district, as well as in some rural areas where the solar pumping system already existed. Solar energy options were analyzed using the RET Screen software program. Diesel generators have been evaluated against solar water pumping systems. The economic analysis is based on applying the LCC technique and all necessary procedures. The comparison between the two systems is extended to cover environmental impacts. Environmental impacts were identified and discussed because worldwide there is considerable concern about environmental issues, including greenhouse gas emissions. LCC of Diesel Generator Energy is very expensive, but PV solar energy is very expensive based on four sample locations. Solara Energy is economically better for environmental testing because the present value (PW) of DS is very high and the PW of PV water pumping systems is low, so PV water pumping systems were an option to be considered. depends on the sample location The annual return on investment from DS is higher, while the annual return on AW water pumping system is lower if it is chosen over PV. The cost of water for Diesel Energy units is very high because the maintenance and fuel consumption of the schemes is very high; if the UWC of the schemes is low, it cannot run the service. Existing schemes powered by PV solar water pumping systems cost less to sell 1 m3 of water, so PV systems benefit the community. Because the LCCs of projects are so high, schemes powered by diesel generators do not recoup the charges during the lifetime. Using DG Energy was the highest fuel consumption, but the costs from water sold are the same as PV Energy, with lower operating costs and expected costs, and therefore project gate profits from PV Energy. (average effect of PV solar gate), Output (Only PV system can help you save money.) Outcome of environmental impact assessment of PV and DG water pump systems: PV water pump system reduces GHG emissions but the DG water pump system pollutes the environment. Therefore, PV water pumping system is an economically feasible and attractive technology that is preferred over diesel water pumping system.

Keywords

Economic Analysis, Life-Cycle Cost, Photovoltaic, Sensitivity Analysis

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1. Introduction

There is a great and urgent need to supply environmentally sound technology for the provision of drinking water. Remote water pumping systems are a key component in meeting this need because most people in developing countries live in off-grid areas. Diesel engines have relatively low capital costs but higher operating costs due to their reliance on fossil fuel price fluctuations and exchange rate fluctuations. [1] This is because the short lifespan of diesel engines is highly dependent on the level of maintenance, operating conditions, and quality of the engine and installation. Historically, pumping from the source off-grid areas of Ethiopia was predominantly achieved with diesel pumps [2]. Replacing diesel pump to PV Pumps based on the problems such as: High running costs, Maintenance costs, operation cost, replacement cost and environmental pollution [2]. PV pumping systems have been found to be economically viable [22]. In addition, diesel-based water pumping systems not only require expensive fuels, but also incur high maintenance and operating costs that cause noise and air pollution. In order to reduce pollution and increase energy productivity, preference must be given to energy sources that emit fewer greenhouse gases into the atmosphere [4].

1.1. General Objective

To analyze the economic and technical feasibility of a photovoltaic water pumping system versus a diesel water pumping system and to evaluate the feasibility and reliability of the solar water pumping system and its emission reduction potential in rural Kebeles of the West Wallaga Zone of Oromia State Region, Ethiopia

1.2. Specific Objectives

1) To compare the economic benefits of a solar water pumping system versus a diesel water pumping system.
2) To analysis of the LCC of diesel water pump systems and solar PV water pump systems
3) To estimate of the potential contribution of solar water pumps to reducing GHG emissions

2. Manuscript Formatting

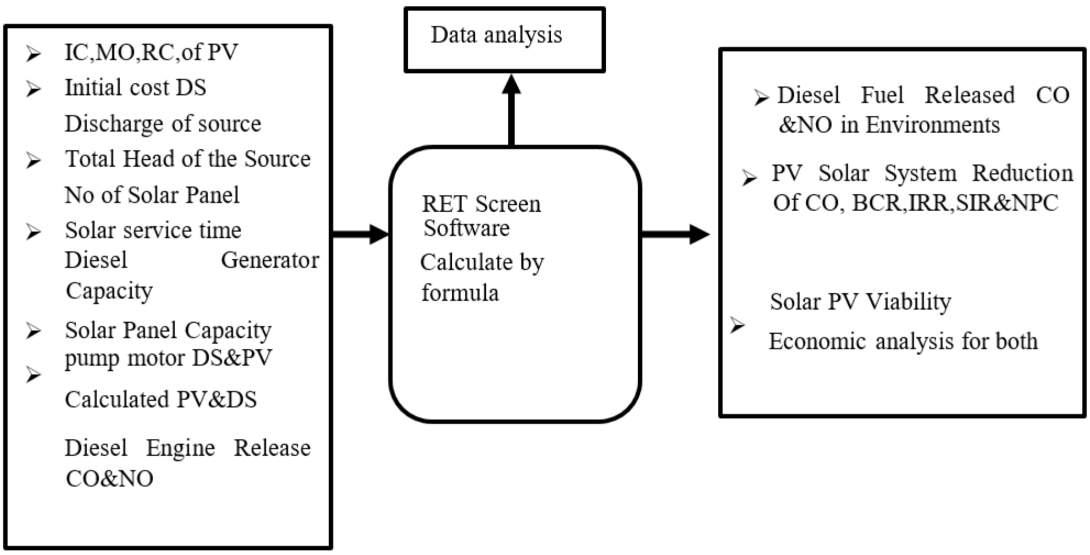
2.1. Methods' of Study

Determined measurement parameters

The economical comparison between photovoltaic system and diesel system needs some parameters such as initial cost, operation cost, maintenance cost, and power generated by those systems. Lifecycle cost calculation analysis. Using parameters that has been determined before, it can be estimated the total amount of cost that should be spent during operation named the lifecycle cost. The lowest lifecycle cost between these systems will be acknowledged as the best system. Analysis using Rescreen Soft Ware simulation. The other method to compare both systems is calculation using Rescreen software. This method will show the ratio of initial capital cost to the energy (kWh) generated by both systems. [3-5]

2.2. Research Design

The method to determine the feasibility of photovoltaic solar water pumping systems in rural areas based on economic analysis and carbon pollution in the case of West Wallaga Zone. [6-11].



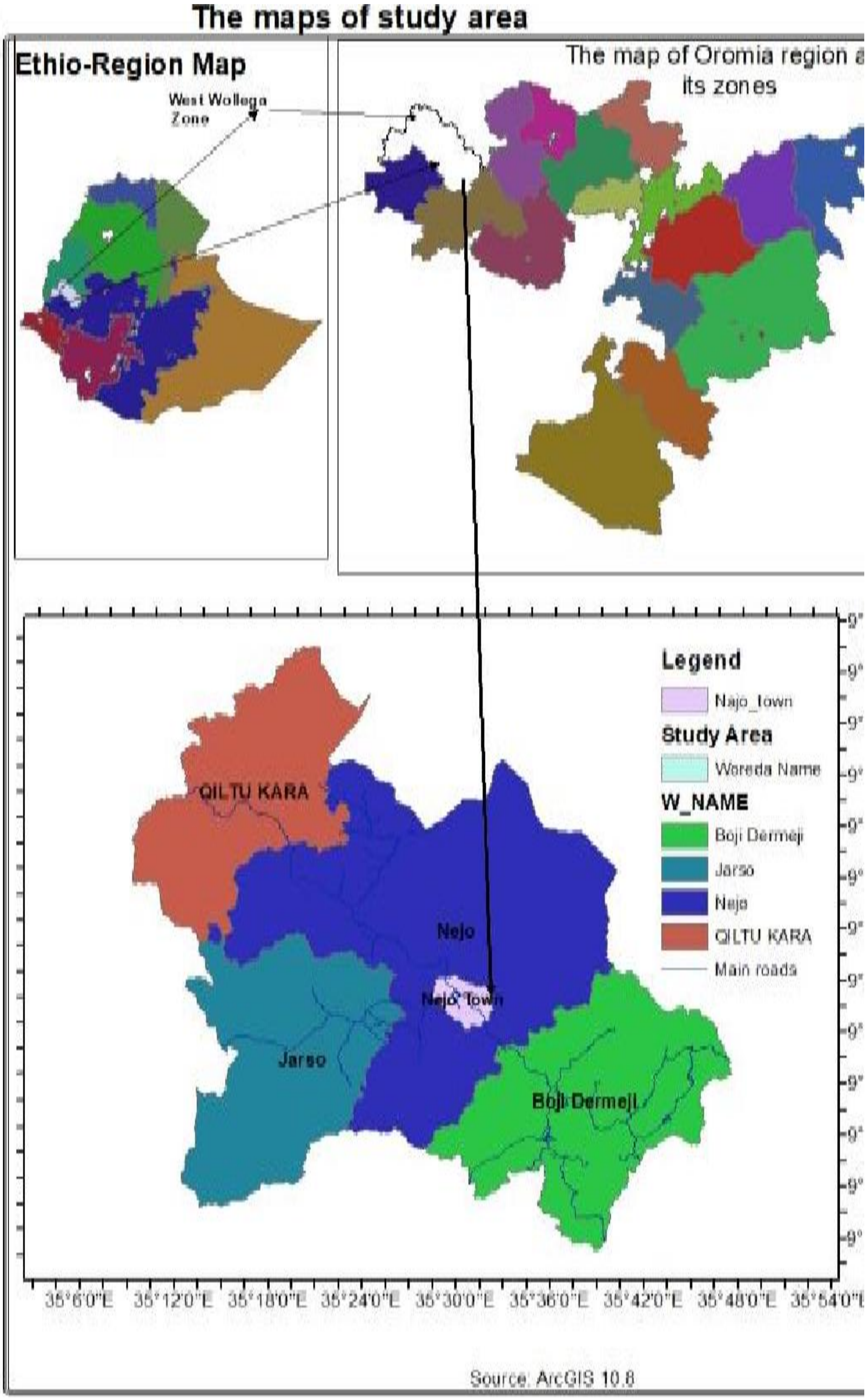


Figure 1. *Area study.*

Methods of Sample Analysis

1) Evaluating the solar photovoltaic water pumping system (SPVWPS) and diesel water pumping system (DWPS) based on water supply schemes existing in the zone PV & DS Pumping system formula calculation. [11-17]
2) Life cycle cost method analysis.

$$LCCA = IC + OC + MC + RC \tag{1}$$

3) Previous study fills the gap to expands PV solar water pump system in the zone.

Table 1. Final PV and Diesel System LCC Value of each Water Scheme.

Costs (US$) factor		Site name							
		Walitate Gida USD/25		Eba Wakayo US$)/25		Kote Genasi US$)/25		Najo Laga Tabota US$) /25	
		PV	DS	PV	DS	PV	DG	PV	DS
1	IC	131,958	40,259	128,120	47,384	109,708	43,504	167,428	93,481
2	OC	1,319.58	54,688	1,281.14	45,399	1,097.03	56,749	1,675	108,950
3	MC	158.35	590,947	153.74	590,947	131.64	590,947	200.97	590,947
4	RC	12,000	10,518.50	11,000	12,767.10	10,000	11,008.50	11,000	82,962.19
	LCC	145,436	696,412	140,555	696,497	120,937	702,208	180,304	876,340
	Total	290,872	1,392,825	281,110	1,392,994	241,874	1,404,417	360,608	1,752,680
	Average	58,174	278,565	56,222	278,599	48,375	280,883	72,122	350,536

PV= photovoltaic, DS=diesel system, IC=Initial Cost, OC= Operations Cost, MC= Maintenance Cost, RC=Replacement Cost Note: - So pv solar water pump system was low cost analysis so it will be choosing.

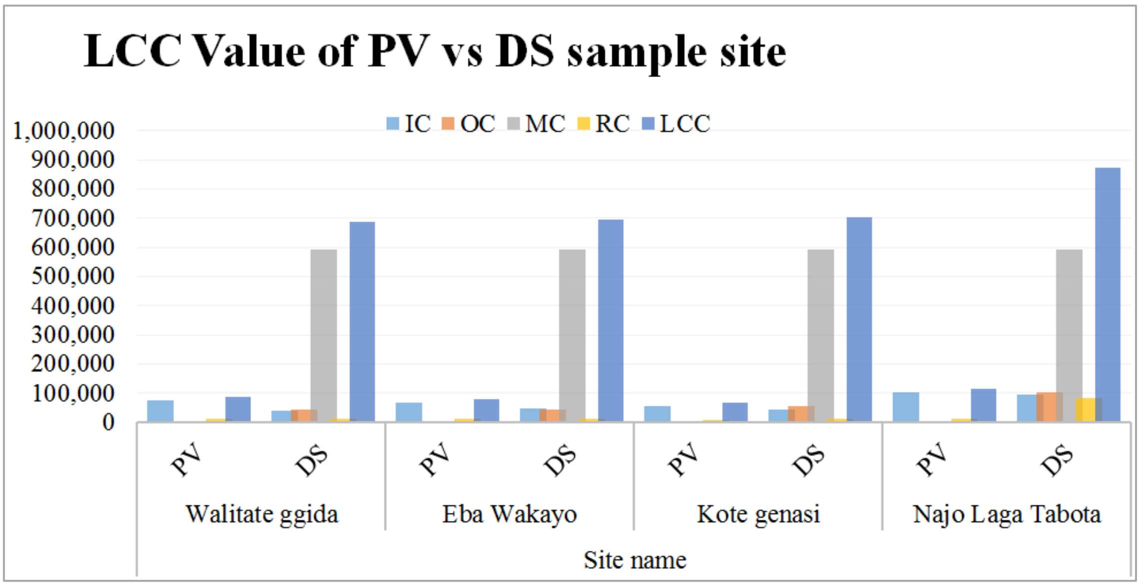


Figure 2. LCC Summary for Power Alternative.

Table 2. Final Average LCC Summaries.

Costs (US$) factor	Site name							
	Walitate Gida (US$) /25		Eba Wakayo (US$)/25		Kote genasi (US$)/25		Najo Laga Tabota (US$) /25	
	PV	DS	PV	DS	PV	DG	PV	DS
Average	58,174	278,565	56,222	278,599	48,375	280,883	72,122	350,536

This figer show as average LCC of above diffirent schemes site

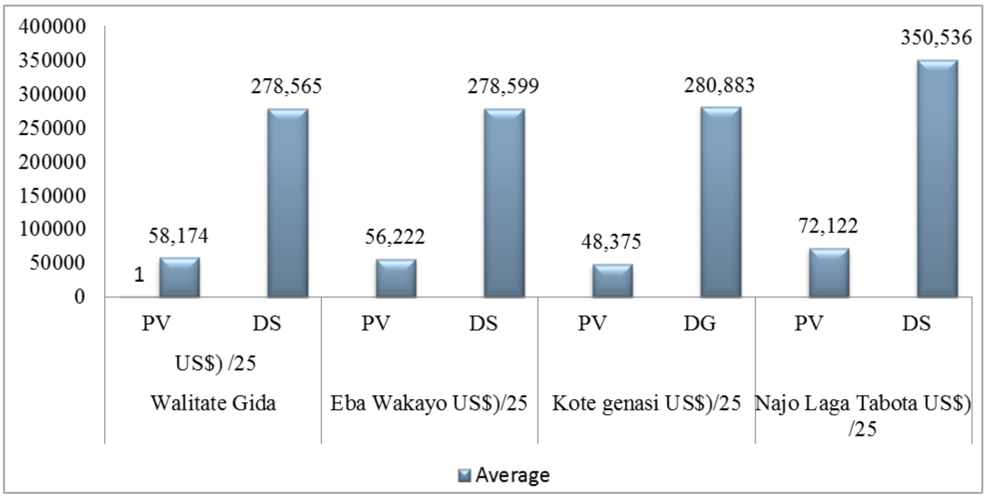


Figure 3. *Final Average LCC Summary.*

2.3. PV Water Pumping System Initial Cost

The main capital costs for the PV water pump system are shown in Table 3. Below are all the accessories and the cost of transport and installation of the equipment. Similarly, the initial cost of the diesel system applies to the rest of the water supply system.

Table 3. *Summery of Capital investment cost DS and PV water pump system.*

Site name	Diesel Water Pump system (USS $)	Solar PV water Pump System (USS $)
Wali Tate Gida	40,259	131,958
Eba Wakayo	47,384	128,120
Kote Genasi	43,504	109,708
Najo Lega Tabota	93,481	167,428

Source: Data collect from the owner of the schemes that's are West wallaga water and energy office and World Vision Ethiopia's Najo program

This finger show that above Table 3 part of power supply initial cost only in different exist schemes.

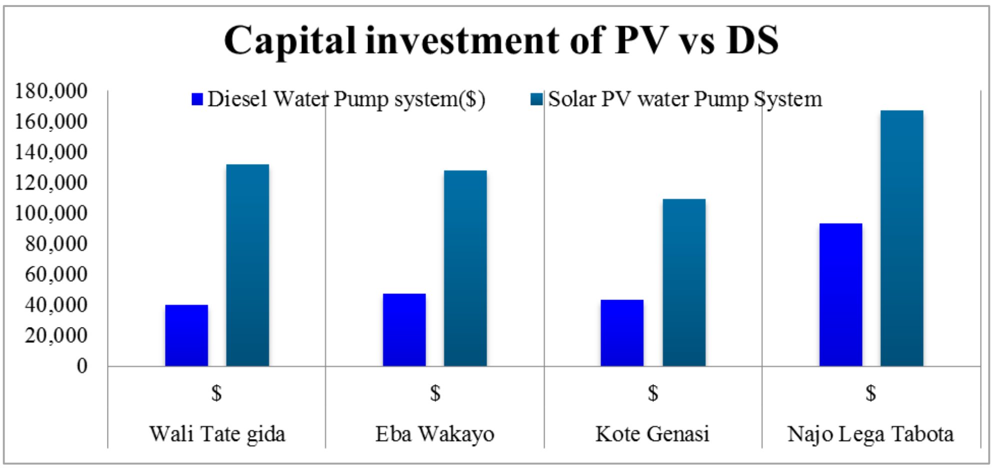


Figure 4. *Capital investment of PV vs DS.*

2.4. Results and Discussions

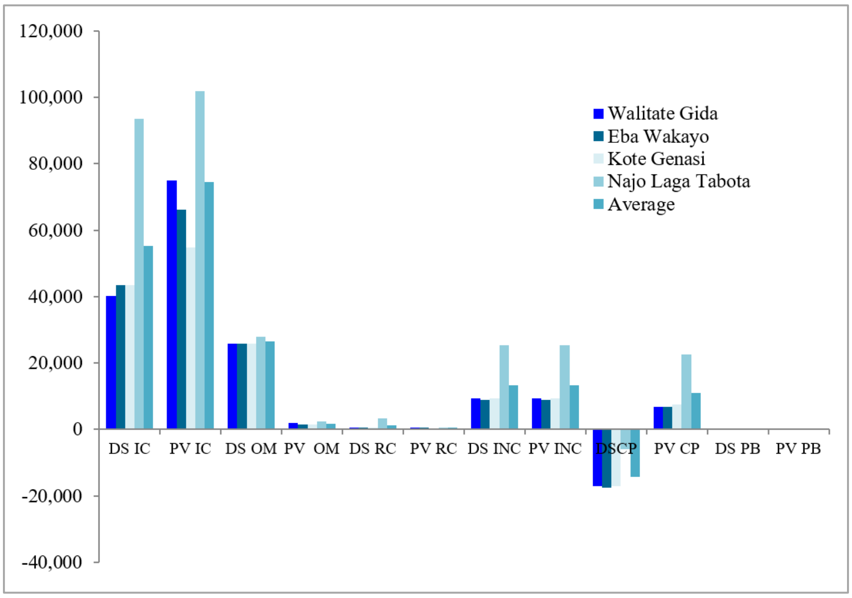


Figure 5. *Cost flow break down chart PV and DS.*

Table 4. *Summery of cash outflow for solar pv pumping system.*

Site Name	Summary of Diesel and Solar PV Water Pump System Cost US /Year											
	1		2		3		4		5			
	DS IC	PV IC	DS OM	PV OM	DS RC	PV RC	DS WPC	PVWPC	DSCP	PV CP	DS PB	PV PB
Walitate Gida	40,259	131,958	25,825	1,880	421	480	9,251	9,251	-16,995	6,950	No pay Back	19
Eba Wakayo	43,504	128,120	25,908	1,515	440	440	8,788	8,788	-17,560	6,833	No pay Back	19
Kote Genasi	43,504	109,708	25,908	1,459	440	400	9,251	9,251	-17,097	7,352	No pay Back	15
Najo Laga Tabota	93,481	167,428	27,996	2,342	3,319	440	25,439	25,439	-5,876	19,778	No pay Back	8
Average	55,187	134,304	26,409	1,799	1,155	440	13,182	13,182	-14,382	10,228	No pay Back	15

2.4.1. Discussions of the Study's

The capital cost of the solar PV water pumping system can be considered the main obstacle to applying the system in a developing country like Ethiopia. PV water pump system in life cycle span it is economical viable. Economics Analysis of Diesel and Solar Water Pumping System Parameters: Operation Cost, Maintenance Cost, and Replacement Cost [15]. To calculate all costs in today's US$, the future costs were discounted to present value using a discount rate. Therefore, LCC is the sum of the capital cost and the present value of the recurring and replacement costs [20, 22]. The Life Cycle Cost (LCC) has been calculated over a 25 year period considering initial cost, operating cost, maintenance cost and replacement One of the most comprehensive recent studies comparing solar and diesel pumps is the [18-21] Feasibility Assessment for the Replacement of Diesel Water Pumps with Solar Water Pumps, issued by the Ministry of Mines and Energy of Namibia and prepared by Em Con Advisory Group. According to this study, solar energy has been used for pumping in Namibia for over 25 years, and 669 solar powered wells were installed from 2001 to 2006, creating a large field of study. This report provides overwhelming evidence for small to medium-sized sources. But according to of our research study has not limited the power of solar water pumps. In order to reduce pollution and increase energy productivity, preference must be given to energy sources that emit fewer greenhouse gases into the atmosphere [26].

Ultimately, this study can help fill the gap by evaluating the viability and reliability, Economic analyses of the solar water pumping system and its emission reduction potential in rural Kebeles of West Wallaga Zone of Oromia Regional State, Ethiopia.

A Techno economic analysis has been done in the case study of the West Wollega rural village. Various parameters are considered for the comparison of the two water pumping system for Water Supply schemes that is the diesel and PV system. As shows blow the table the parameters considered for comparison of the two for the life cycle cost evaluation. The cost of PV system initially is although higher than the diesel one but the life cycle cost of the PV system is lower. The fuel and replacement cost for solar pump is not there which is a positive part of it and thus reduces the LCC In the calculations to be performed, water pumping systems with solar cells (PV) is feasible if the lifecycle cost is lower than the other power supply system, which is diesel. Although wind turbines and electricity on the grid could also be an alternative power supplier but these are beyond the limits of research conducted.

Lifecycle cost consists of capital costs, maintenance costs, operational costs, fuel costs and equipment salvage value.

2.4.2. Result of the Study

The results produced in the economic analysis show that the PV system in all three cases is highly economically feasible

1) Internal Rate of Return,
2) pay back Benefit cost Ratio
3) Total Annual Saving
4) Net present value
5) GHG Reduction

Cash flow from water production sell for DS water pump system the same production with PV water pump system, pv water pump system +ve cash flow and DS water pump system -ve cash flow.

1) PV water pump system are Economical Viable.
2) Net present value (NPV)

Cash flow of the schemes capital cost and net saving cost, Capital cost -ve and net saving cost +ve value, if sum of both are greater than 1 the projects are economic viability.

1) So PV water pump system NPV are greater than 1 from RET Screen software of the result
2) IRR (intern rate return)
3) In the PV water pump system IRR greater than discount rate of the schemes, the result gain from

RET Screen soft ware

1) So the schemes are economic viability
2) Benefit cost Ratio; this expression of the relative profitable of the schemes if the BC are greater than 1 the schemes are economic viability
3) Total Annual Saving and Income The total annual saving and income represents the annual saving and/or income realized due to the implementation of the proposed case system
4) GHG Reduction PV water pump system Reducing GHG Emission cost (RC) represents the nominal cost to be incurred for each tone of GHG avoided. [23, 24]
5) Calculate LCC by manual
6) Initial Cost (IC)
7) Operation cost (OM)
8) Maintenances Cost (MC)
9) Replacing cost (RC)

PV solar water pump system Renewable energy source. So LCC of PV is cheaper than LCC of DS W P S (aver- cost equals the sum of the present values of all cost age of sample scheme s are 297,145< 58,723.25 LCC of payments, DS & PV Water pump system.

3. Sampling Frequency

3.1. Analysis Present Worth Approach

In the West Wallaga zone, there are 121 potable rural water The present value is the value on a given date of a schemes exist. In rural Village schemes, sampling sites from future cost (or series of costs), given an interest the source, four sampling sites from the Nejo district's where rate or a discount rate to reflect the changing value the current solar water pump system existed. From this sum-of money over time. A cost to be paid with annual, scheme data was collected from the solar panel, total water amortizations can be considered as a sum of costs, term head, and water discharge. For Diesel generators, data one for each year, where the present value of the was collected from the west Wallaga zone water and energy office: fuel consumption, generator capacity at the same capacity as existing PV in the zone, initial cost, maintenance cost, operation cost, and replacement of the spare part.

The collecting data from the office by following appropriate procedures. [25]

3.2. Sampling Procedures and Techniques

The method of data collection from each sampling location was according to LCC benefit analysis, depending on guidelines for environmental pollution [26]. Data was taken from locations that are representative of the water distribution system (the sources and household). Systematic observation of the site taken the measurement and random household interview method.

3.3. Methods of Data Analysis

First, the information recorded on the mobile phone and the notes from the informal discussion and field observation were transcribed and translated from the local language (Afan Oromo) into English. Secondly, by reading through all the qualitative and quantitative data, they were reviewed and organized to develop a general understanding of the data set, and short memos were created that best help in organizing and categorizing the data into concepts.

3.4. Methods of Life Cycle Cost Analysis for PV and DS Water Pump System

Calculating using the formula Life Cycle Cost analysis (LCCA) method was used for quantitative data collected for economic analysis to find the most viable alternative, i.e. to determine which pumping option alternative provides the maximum benefit at the lowest cost. [28-30]

Initial investment: The capital expenditure required for purchasing and installing the system, including the cost of the equipment, installation, and any necessary infrastructure modifications.

Operating costs: The ongoing expenses incurred during the operation of the system, including fuel costs (in the case of diesel pumps), electricity costs (for PV systems), maintenance and repair costs, and any other operational expenses. *Maintenance expenses*: The costs associated with regular maintenance activities, such as routine inspections, servicing, parts replacement, and repairs. These costs can vary depending on the complexity and reliability of the system.

Disposal or replacement costs: The potential costs related to disposing of or replacing the system at the end of its useful life. This can include decommissioning costs, equipment removal, and any expenses associated with transitioning to a new system.

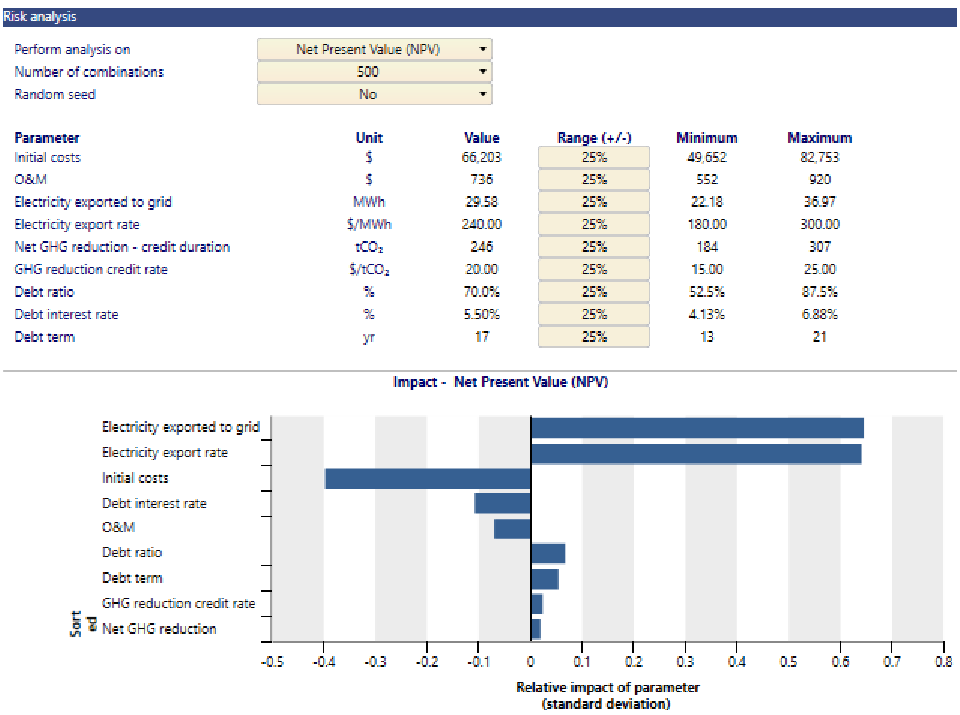
By analyzing the life cycle costs of diesel water pump systems and solar PV water pump systems, decision-makers can make informed choices based on the long-term financial Analysis.

3.5. Life Cycle Cost Analysis Methodology for Solar PV Water Pumps

By using the computer program Rescreen software, it compares solar and diesel water pumps, covering a range of heads (10m to 250m) and a range of daily flow rates (3,000 to 158,400 liters). The Life Cycle Cost (LCC) has been calculated over a 25 year period considering initial cost, operating cost, maintenance cost and replacement [26]. LCC is the sum of the capital cost and the present value of the recurring and replacement costs around different systems. To compare value of the benefit to the present value of the costs is enthuse of equal performance of the life cycle cost approach is mined. If the benefit-to-cost ratio is greater than one, the used, which allows systems to be compared on an equal project can be considered desirable from an economic point sis by reducing any future costs incurred at different time.

3.6. Payback Period

LCC or Project Future costs, including running costs The payback period, also known as the project investment cost (diesel consumption, transport), maintenance costs (engine payback period, is defined as the time it takes for the fuel cost savings to equal the total initial investment of a project. [31] The oil, filters, brushes, valves, rotor, impellers, labour, transport payback period of an investment considering the time value of etc.) and spare parts (diesel engine, pump, motor, inverter, money is given by the expression. labor and transport).


Risk analysis

Perform analysis on: Net Present Value (NPV)
Number of combinations: 500
Random seed: No

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	66,203	25%	49,652	82,753
O&M	$	736	25%	552	920
Electricity exported to grid	MWh	29.58	25%	22.18	36.97
Electricity export rate	$/MWh	240.00	25%	180.00	300.00
Net GHG reduction - credit duration	tCO_2	246	25%	184	307
GHG reduction credit rate	$/$tCO_2$	20.00	25%	15.00	25.00
Debt ratio	%	70.0%	25%	52.5%	87.5%
Debt interest rate	%	5.50%	25%	4.13%	6.88%
Debt term	yr	17	25%	13	21

Figure 6. *Net Present Value.*

The NPV method calculates the present value of all annual environmental pollution analysis cash flows (i.e. cost of capital and net savings) incurred or evaluating the economic analysis of the solar photovoltaic accrued over the life of a project and totals them. Capital water pumping system using RET Screen, software and by cost is represented as a negative value and savings as a positive value. The sum of all cash values is referred to as Net Present Value (NPV). The higher cash value, the more attractive the proposed project. If the resulting NPV is greater than zero, a project is deemed economically viable.

3.7. Internal Rate of Return

Specifies the discount rate at which the present value of the net benefit stream equals the present value of the net cost stream. If the resulting IRR is greater than the discount rate chosen, the project is considered economically viable. [31]

3.8. Benefit-Cost Ratio

Compare total discounted benefits to total discounted costs as a ratio and gives an indication of the magnitude of the return on the investment. If the benefit-to-cost ratio is greater than one, the project can be considered desirable from an economic point of view. [25, 30]

Then, the required power for the motor is calculated from the hydraulic power requirement and the motor efficiency as follows. Motor Power in our environment Averagely 20.44KWh/Day Motor power 20.44/0.65 = 31.44KW Fuel consumed per hour 9 Lit

1) Fuel Consumed in One Day Discharge in liters/sec (consider normal pump operating time which is 8 hours/day)
2) FC/day = 9X8= 72Littir
3) FC/Year =72lx365 =26,280Littr Fuel Consumed Per Year in West Wallaga Zone only using Diesel Fuel in Remote Village. For Rural Water Supply pump system was 26,280litx121scheme = 3,179,880lit

That Fuel Produce CO by diesel engine to pump water the 2 content of CO in one liter of diesel is equivalent to 22.67k (0.00267ton) (Global petrolprice.com) so that in our zone CO_2 can be produced in one year 0.00267x3,179,880= 8490.3Ton. The existing DPS consumed 3,179,880 liter/year which is equivalent to 8,490.3 tons of CO per.

Summary of unit water cost pv and ds water pump system

The cost of PV system initially is although higher than the diesel one but the life cycle cost of the PV system is lower.

Table 5. Economical& technical analysis of Samples from existing scheme economical and technical Test Results for schemes.

S/N	Site	B-C	ALCS [$/year}	AS & In-caming [$/year}	RC [$/tco2]	PBP [year]		IRR [%]		UWC [$/m^3]	
						Simple	Equity	Asset	Equity	DS	PV
1	Wali Tate Gida	2.10	9,605	2,845	184	10.00	7.2	5.2	16.5	37.5	1.00
2	Kote Genasi	1.90	6,753	1,625	136	9.00	7.2	5.7	17.3	39.5	0.99
3	Najo Lega Tabota	4.30	16,556	10,305	525	7.00	3.4	11.6	36.4	37.5	0.82
4	Eba Wakayo	2.10	7344	2201	179	10.00	6.4	11.8	37.3	14.3	0.44

Table 6. Financial Viability Analysis of Samples from existing schemes.

Economical Analysis factor	Diesel Generator Water Pump System USD	PV Solar water pump system USD
Life cycle cost	742864.39	146808
Present worth	7,254,522	189,033
Annual worth	797,997	20,794
Unit water cost sell of water (USD/m^3)	32.2	0.8125
Pay back in (year)	No pay back	13
Cost profit (average for scheme)	-14,382	10,943

Economical Analysis factor	Diesel Generator Water Pump System USD	PV Solar water pump system USD
Benefit cost ratio	0	2.6
Annual Life Cycle Save	0	10,064.5
Annual Save &Income	0	4244
GHG emission reduction	-255	+255

Cash flow from water production sell for DS water pump system the same production with PV water pump system, pV water pump system +ve cash flow and DS water pump system -ve cash flow. PV solar water pump system.

Renewable energy source. So LCC of PV is cheaper than LCC of DS W P S (average of sample scheme s are 297,145< 58,723.25 LCC of DS & PV Water pump system.

Table 7. LCC Value of PV Vs DS sample site.

Costs (US$) factor	Site name							
	Walitate Gida US$) /25		Eba Wakayo US$)/25		Kote genasi US$)/25		Najo Laga Tabota US$) /25	
	PV	DS	PV	DS	PV	DS	PV	DS
IC	131,958	40,259	128,120	47,384	109,708	43,504	167,428	93,481
OC	1,319.58	54,688	1,281.14	45,399	1,097.03	56,749	1,675	108,950
MC	158.35	590,947	153.74	590,947	131.64	590,947	200.97	590,947
RC	12,000	10,518.50	11,000	12,767.10	10,000	11,008.50	11,000	82,962.19
LCC	145,436	696,412	140,555	696,497	120,937	702,208	180,304	876,340
	Total	Average						
PV	587,231	146,808						
DS	2,971,458	742,864.39						

PV solar water pump system running cost from the water produced annually averagely USD cost /Year 13,182. The sum of Annual operation, Maintenance and Inverter replacing costs are average 2,239 USD. Cash profits from the scheme samples are incoming costs-out coming cost, = average 10,943.05USD cost /year. The project initial cost pay back in 25-year life span can be calculate IC/profit cost annually were averagely 15years

Lifecycle cost consists of capital costs, maintenance costs, operational costs, fuel costs and equipment salvage value

Detail it shows blow table

Table 8. Scheme caption.

Site Name	Component of Diesel Water Pump System Cost US /Year					
	1	2	3	4	5	
	IC	AO&M	IRC	Incoming cost	Save cost Annual (4-(2+3))	Investment Cost Payback (Iteam1/5)

Site Name	Component of Diesel Water Pump System Cost US /Year					
	1	2	3	4	5	
	IC	AO&M	IRC	Incoming cost	Save cost Annual (4-(2+3))	Investment Cost Payback (Iteam1/5)
Walitate Gida	40,259.00	25,825	421	9,250.56	-16,995.58	No pay back
Eba Wakayo	43,504.00	25,908	440	8,788.03	-17,559.81	No pay back
Kote Genasi	43,504.00	25,908	440	9,250.56	-17,097.28	No pay back
Najo Laga Tabota	93,481.00	27,996	3,319	25,439.04	-5,875.34	No pay back
Average	55,187.00	26,409.24	1,154.81	13,182.05	-14,382.00	No pay back

4. Materials and Methods

The method is to determine the feasibility of photovoltaic solar water pumping systems in rural areas based on economic analysis and carbon pollution in the case of West Wallaga Zone [18]. Depending on the existing solar water pump system schemes in the Nejo district. Data for Walitate Gida, Kote Genasi, Nejo laga Tabota, and Eba Wakayo were obtained from Ethiopia's World Vision nedjo AP, From the existing Table 8. *Cash flow break down* schemes initial cost of solar water pump, from the observation on the site interview reliability of solar water pump system, collect data Capacity of solar water pump, Total Head of the water, Discharge of the water, number of the panel. Diesel generator water pump system of data collect from west Wallaga water and energy office: initial cost, maintenance cost, operation cost, replacing period of the generator, then compared with each other economic benefit and environmental pollution analysis. First, the information recorded on the mobile phone and the notes from the informal discussion and field observation were transcribed and translated from the local language (Afan Oromo) into English. Secondly, by reading through all the qualitative and quantitative data, they were reviewed and organized to develop a general understanding of the data set, and short memos were created that best help in organizing and categorizing the data into concepts. Then, through the narrative description, the results of the entire quantitative and qualitative data were organized, analyzed and interpreted in such a way that the answers for the semi-structured questionnaire were processed and coded first. Then a computer program was used to analyze tabulated data using the RET Screen software program.

5. Results

A Techno economic analysis has been done in the case study of the Weat wollega zone village. Various parameters are considered for the comparison of the two water pumping system for Water Supply schemes that is the diesel and PV system. The cost of PV system initially is although higher than the diesel one but the life cycle cost of the PV system is lower. The fuel and replacement cost for solar pump is not there which is a positive part of it and thus reduces the LCC In the calculations to be performed, water pumping systems with solar cells (PV) is feasible if the lifecycle cost is lower than the other power supply system, which is diesel. Although wind turbines and electricity on the grid could also be an alternative power supplier but these are beyond the limits of research conducted. Lifecycle cost consists of capital costs, maintenance costs, operational costs, fuel costs and equipment salvage value The economic and technical feasibility of a photovoltaic water pumping system versus a diesel pumping system, to evaluate the energy to economic benefit and its GHG emission reduction potential in rural *Village* of West Wallaga Zone of Oromia regional State, Took from 4 (four) existing rural water supply schemes sample (Walitate Gida, Kote Genasi, Laga Tabota and Eba wakayo schemes) In Table 8 show Diesel engines are specifically mentioned for solar water compressor with in the table listed parameter

6. Discussion

The following recommendations are drawn based on the findings of the current research:

The research has examined the economic and technical viability of photovoltaic solar water pumping systems and their emission reduction potential in rural areas. Assessment of PV generators to replace diesel generators in West Wallaga Zone indicates that the area has a huge potential for solar energy for water pumping. There are, however, some challenges, like the low purchasing power of the community and the lower energy conversion of PV cells, towards the development and adaptation of PV water pumping technologies. However, because of the high initial cost of the system and the fact that people in such rural locations are usually low income earners, they should not be expected to pay for their off-grid electricity supply systems. It is thus recommended that the provision of capital subsidies is imperative, and hence enough grant funds must be mobilized by the government, NGOs, and development partners to create the PV infrastructure while the beneficiary communities must also be willing to pay realistic water tariffs to enable operational cost recovery in order to prolong the reliability of the system. The government, non-governmental organizations, and the public should make concerted efforts to overcome these challenges by using more flexible approaches to improve the current state of the PV water pumping system in Ethiopia. It is also recommended that solar pumping systems be implemented in all off-grid areas if possible. It would be better for the spare parts supply, as solar pumping equipment cannot be purchased everywhere in the country yet. Maintenance and repair of the pumps would then also have lower costs as there would be less need to travel between the schemes. to recommend that the National Meteorological Agency of Ethiopia (NMAE) make available the solar data in the form required for researchers in the country and install direct solar energy measuring instruments at least in some areas of the country that are supposed to have higher potential for solar energy. Finally, I recommend that, to know the exact solar resource potential of Ethiopia to replace the conventional diesel energy and to solve the problems of utilizing PV for water pumping in the country, more studies be conducted in the future.

7. Conclusions

1) The study focuses on the analysis of the alternative energy of rural water supply pumping system based on the economy and environmental pollution, diesel engines will be replaced by solar power in rural areas of the West Wallaga Zone of Oromia. The reliability of solar water pumping systems for domestic water supply in rural Based on the results obtained from this study, the following conclusions are drawn:
2) The major disadvantage of the DG over the PV system is the higher O&M cost and environmental impact.
3) The initial cost of the PV system is considered the only disadvantage over the diesel system; however, particularly in remote areas, the higher initial cost of the PV system could still be justified by the savings in the lower O&M cost as well as the increased reliability throughout the useful life of the PV system.
4) The life cycle cost method was used for the economic evaluation of the solar water pumping system compared with the diesel pumping system and shows that there are very distinct differences between the two power sources in terms of cost.
5) The average initial cost of four sample sites (134,312.75 US$) of a solar water pumping system was found to be higher than that of a diesel water pumping system (56,157 US$), but its recurrent cost proved to decline over time. The operation, replacement, repair, and maintenance costs are higher for the diesel pumping system in contrast to the solar pumping system, and it was considered that the result from sensitivity analysis shows that the key parameters such as discount rates and fuel price inflation rate have a significant impact on the LCC of the diesel pumping system than the solar pumping system. This is as a result of the fact that most of the costs of a diesel pumping system are future costs.

Therefore, PV water pumping systems were found to be an economically viable and attractive technology that was chosen over diesel water pumping systems in all sampled Village of the West Wallaga Zone. Further, the potential contribution of solar water pumps towards emission reduction was determined.

As a result, 3,179,880 liters of diesel fuel were saved in the West Wallaga Zone, for a total of 8,490. Throughout the system's life cycle operation, 3 tons of CO_2 emissions were avoided. CO2 emissions can be greatly reduced through the use of a solar water pumping system, which is already cost-effective with fossil fuels in many situations. Thus, PV water pumping systems are an Abbreviations.

Abbreviations

PV	Photovoltaic
DG	Diesel Generator
DS	Diesel System
AP	Area Program
CSP	Concentrated Solar Power
GHG	Greenhouse Gas
GW	Giga Watt
kW	Kilo Watt
W	Watt
KWh	Kilo Watt Hour
NOx	Nitrous Oxide
NASA	National Aeronautics and Space Administration
Si	Silicon
DC	Direct Current
AC	Alternate Current
V	Volt

Author Contributions

Tujuba Soressa Kiltu is the sole author. The author read and approved the final manuscript.

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Conflicts of Interest

The author declares no conflicts of interest.

Appendix

Walitate Gida SPV water photo

Figure 7. *Existing Solar Water Pump for Nedjo water supply.*

Figure 9. *Existing Diesel water pump System.*

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Biography

Tujuba Soressa Kiltu The author was born in 1990 GC in Oromia region, West Wallaga zone, Nedjo Woreda, Sombo Dora Village. He attended his elementary school at Gida Wanda Biyo Elementary School and his high school education at Nedjo Comprehensive Secondary School in Nedjo City, West Wallaga Zone. He then joined Haramaya University, Faculty of Water Supply and Environmental Engineering, Department of Soil and Water Engineering for the course in 2009 and graduated in 2013/14 with BSc degree in 2014. After graduating, he was employed by Oromia Water, Mineral and Energy office in the West Wallaga Zone and worked in various positions in the Zone until 2021. Studying hydraulic engineering. Tujuba Soressa It is hereby certified thesis entitled “study alternative energy of rural water supply pumping system based on the economy and environmental pollution, diesel engines will be replaced b solar power (A case of West Wallaga Zone Water Supply, Ethiopia)” has been accepted in partial fulfilment o the requirements for the award of the Master of Science in Hydraulic Engineering through the School of Graduate Studies of Wallaga University through the College of Engineering and Technology conducted by Tujuba Soress Kiltu is a genuine work conducted by him under our guidance. The facts embodied in the thesis have not previously been submitted for the award of an academic de green or diploma. The support and assistance received during this investigation were duly acknowledged. Therefore, we recommend that it can be accepted as meeting the requirements for the research work. Invited as a Keynote Speaker, Technical Committee Member, Session Chair, and Judge at international conferences.

Research Field

Tujuba Soressa Kiltu: A review on solar powered reciprocating water pump (India), Modeling of Lead Acid Batteries in PolyVoltaic Systems (Algeria), Solar powered water pumping systems (Turkey)