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Socio-Economic and Environmental Impacts of Micro-Hydro Power plants (Case Study on Jimma Zone- Shebe Sonbo Leku Woreda, Ethiopia)

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***Abstract*--Electricity is one of the most important inputs for economic development of a country. While the total population living in rural area is huge, more than 85% of the rural population do not have access to electricity in Ethiopia. Micro-Hydro Power Plant (MHP) is an alternative for rural electrification. Micro-hydropower is considered to be the most feasible, decentralized renewable energy option for providing reliable and affordable electricity to the remote and isolated areas of Ethiopia. This study sought to assess socio-economic and environmental impacts of micro hydro power plant situated in the rural area of Leku Woreda in Jimma, Ethiopia. The geological study conducted indicated that there is no risk of soil instability in Leku site and the negative impact on the environment due to the project was found to be negligible based on the capacity of the plants.**

The community of Leku Kebele relied mostly on firewood, kerosene and dry cell batteries as a major source of energy before access to the Micro-hydro power. With the implementation of MHP, traditional kerosene lamps like 'Kerosene lamp' were completely abandoned, and firewood consumption was reduced. Electric lights in households extended the day providing additional hours for accomplishing different activities, such as reading to school children and work. The micro-hydro-power was also used to supply power to modern agro-processing mills in the village, which reduced drudgery for women as they no longer have to use ineffective and distant traditional water mills. Thus, micro-hydro scheme provides clean, affordable and sustainable renewable energy to the community of Leku.

Key words: Renewable energy, micro-hydropower, poverty, rural electrification, socio-economic, Kebele, Woreda

I. INTRODUCTION

Ethiopia has a huge renewable energy (micro-hydro power, solar, biomass and wind energy) potential that has not been used for rural electrification [2]. People in the rural area use the traditional energy sources which could have negative impacts, such as deforestation, soil erosion, emission of greenhouse gasses & production of acidic rain. On the other hand, the noticeable benefits of usable electric power include: improved health care, improved communication system, an improved standard of living and economic stability. Unfortunately, many of the rural areas of Ethiopia have not benefited from these uses of electricity in the same proportion as the more populated urban areas of the country. A major limitation to the development of many rural communities has been the lack of this usable electricity. Due to the remote location and the scattered settlements of the rural communities the traditional means of providing power have proven to be too expensive, undependable, difficult to maintain, and economically unjustifiable. Consequently, many of these communities remain without electricity and may never receive grid power from the utility [2].

The small town of called Leku, in Shebe Sombo Woreda, was one of those rural areas which do not have access to electricity. The community requires electricity for house equipments like TV, Radio player, lighting, day-to-day activities, etc. Micro-Hydro power development was proposed to supply electricity to the community of more than 2,500 people and 250 households, including public institutions such as schools, clinics and religious centers in the base year 2014.

II. DESCRIPTION OF STUDY AREA

Shebe Sonbo Woreda is located between 7º17'-7º44' North Latitudes and 36º17'-36º52'East longitudes, in Jimma Zone, Oromia regional state. It is shares borders with Seka Chokorsa Woreda in the north and northeast, SNNP regional state in the south and southwest and Gera Woreda in west and southwest. The Woreda has a total surface area of 755.43 km^2 that accounted for 3.8% of the total area of Jimma Zone. Currently, It is divided in to 20 Kebeles and one urban centre (Shebe town) with over 2000 people living in Shebe town. Shebe Sombo Woreda has a total population of 112,267 of which 56,810(51%) were male and 55,457(49%) were female. In terms of area residence 107,003(95%) population lives in rural areas while the rest 5,264(5%) live-in urban centers **[5].**

Figure .1 Location Map of the study area

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III. MATERIALS AND METHODS

The methodologies to accomplish this research work is as follows: Standard research and data gathering methods were employed -and included following:

- Site reconnaissance
- Review of existing documentation
- Access to information from relevant agencies
- Primary data through direct interview of the customer.
- Aerial survey
- Detailed site assessments
- Assessment of maps, plans, photographs
- Qualitative and quantitative evaluations
- Impact assessment

Project Socio-economic Impact

Leku Migira is one of the twenty Kebele administrations in S/Sombo Woreda with a total population of 3,985. There are about 782 HHs in 25 villages (Gares) in the Kebele. Major source of income for the people in the Kebele is agriculture, mainly production of coffee and corn. Leku has seven grain mills (2 watermills and 5 diesel mills), 9 tea houses, 6 mosques, a primary school, a health center, a farmers' training center, a cooperative office, a coffee grinding plant and other social institutions to provide services to the community. Spring water is the main source of water supply for the Kebele community while the major sources of energy are Firewood, Kerosene and Dry cell Batteries. Currently, the Kebele has no access to the interconnected grid system (national grid) for power supply. The two watermills which were proposed to be upgraded, namely Hemeto and Boru are located in this Kebele in a close proximity to one another.

1. Economical comparison

The following table indicates the monthly expenses of a household in Leku sites. These expenses are only energy expenses used for appliance purpose. Leku site most of the people used Kerosene lame ,dry cell and torch Battery for lighting purpose when we compare Dry cell , Kerosene lamp and Micro hydro generation using Energy saving lamp the best and cheapest one , energy saving lamp is choose for rural rectification show in Table 1 the compression of Kerosene lamp Dry Cell and energy saving lamp . micro hydro power generation project is completely changed the life of the community in leku Village.

Table 1. House hold energy consumption (lighting only) before construction and after construction

No	Lighting Device	Fuel type/MHP	Fuel Consumption /COE	Fuel cost	Total Cost/month
1	Kerosene lamp	Kerosene(Nafeta)	0.191USD/Month	25USD/liter	4.762 USD
2	Torch light	Dry cell	0.29 Pcs/month	0.4USD/Pc	2.29 USD
3	Energy saving lamp	MHP	120Wh/d	0.2USD/KWH	0.5123 USD

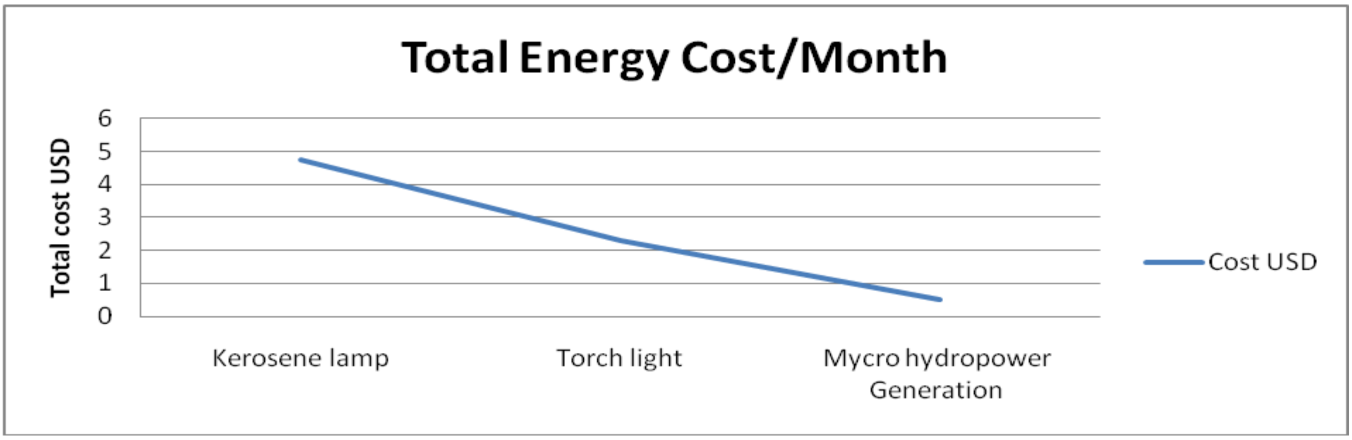

Figure 2. Total Energy Cost/Month

1. Primary Load Estimation for Sebe Sonebo

In this work (study), three ways were used to estimate the primary load: Household load, Community load, and Deferrable load estimate. As a first step, the estimations of electrical appliances are itemized with their power ratings and time of operation during the day to obtain the average energy demand in watt hour per day as shown below in Table 2.

2. Deferrable load

Deferrable load is electrical load that must be met within some time period but the exact timing is not important [1]. Loads are normally classified as deferrable because they have some storage associated with them. The average deferrable load is the rate at which energy leaves the deferrable load storage tank. For this study water pumps are considered as deferrable load.

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Figure .2 Internal and External part of Leku site Micro hydropower plant

TOTAL AVERAGE ENERGY CONSUMPTION FOR ONE HH				
Appliance	Quantity	Power (W)	House use per day	Energy W h/day
Light	240	20	6	27,600
Street light	48	25	12	14,400
Television	22	80	5	8,800
Mobile charger	180	5	2	1,800
Radio	150	20	6	18,000
Stove	15	500	3	22,500
DVD player	85	40	6	20,400
Refrigerator	32	200	24	153,600
Total Energy consumption				267,100

Table 2. Total Average Energy Consumption for household

In this work (study) the electrical load estimation is made for 240 households. It was calculated based on the appliance type, quantity of appliances, and the power rating of appliances. The total average energy consumption for a house is about 267,100 kWh. To Simulate the system, the approximate energy consumption for each hour is required. Table 3 shows the energy in (kilowatts) kW , for a 24-hour duration. The energy consumption is for 240 houses.

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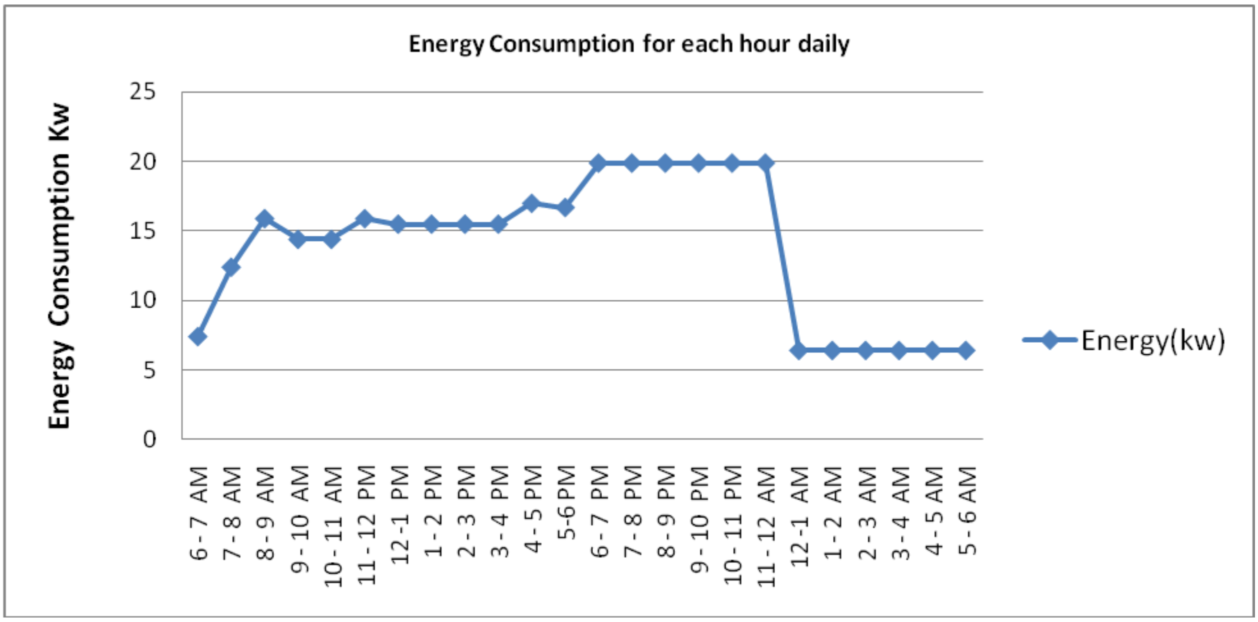

Figure 3. Energy Consumption for each hour daily

From 6 am to 9 am, the energy consumption is least as compared to the other times of the day, the lamp might be off. Are working, so the villagers not in the house. From 9 am to 12pm, the electrical load starts to increase, but during the lunch time form 11-12pm it decreases. The electrical load is at its peak from 6 pm to 12 am while the electrical load starts to decrease from 12 pm to 6 am. Only some lamp at the outside of the house and Refrigerator (if any) might be on. All the consumptions are estimated due to the villagers' lifestyle. The load profile might be changed from time to time. The total population of the villager may increase. Thus, any changes are not valid for this consumption and calculation.

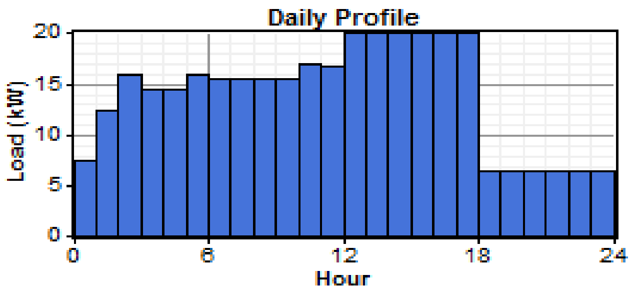

Figure 4. Daily Profile

Project Environmental Impact

From the site observation (visit) extending from power house to the diversion structure, there is a point where water is diverted by the community of neighboring village for use. Diverting a considerable amount of water to the powerhouse, abandoning and creating shortage of water at the point of diversion of the neighboring community might result in water use conflict. As electricity is not expected to reach the HHs in this neighboring village, negotiation and awareness creation is required, if the implemented scheme need to serve its purpose. Though no access to electricity, the community using the water use point located on the power canal is from the same village to the community planned to be served by electricity; hence it is assumed that the community will be willing to use another water use point for different domestic purposes as the electricity generated will help them indirectly by facilitating urbanization. The site was also checked if there is any danger of flooding and land sliding and was concluded as there will not be any risk in these regards. Actually the sites have been functioning for more than one year without any risks of failure. Micro-hydro project environment impacts assessment during construction and operation time are categorized as per details given in the chart.

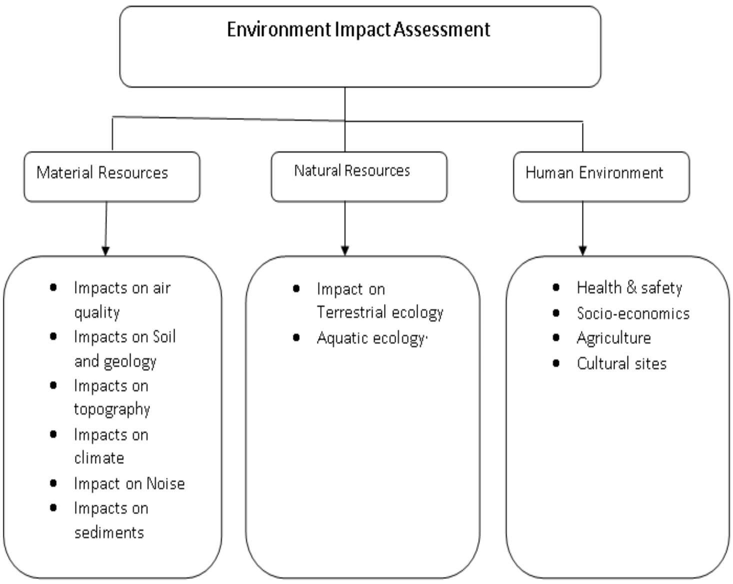

Figure.5 Environment Impact Assessments

Benefit of the people

Now the people The desire to enjoy modern lifestyles by way of modern energy to operate lamps, radios, TV sets, DVD players and other appliances is a very high motivation to pay for energy supply in rural areas. A more recent push factor

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for rural electrification was found to be the spread of mobile phones in even the most remote areas of the country along with the need for these phones to be charged on a regular basis. Because mobile phone owners are ready to pay for recharging services, this has become a business opportunity and local entrepreneurs are actively searching for ways to satisfy that demand (see last section). These business people may not have been aware of micro-hydro before but have come across it while actively looking for the most cost-effective solutions. They was traveled around 12km per two days for mobile charging now the day the people are enjoying nearby station using my micro hydro power generation, Helping the cooperative for sustainability of the project the government (kebele) should be oriented to encourage the cooperative to function assigning the operator so money collection, the society is well trained how to operate Micro hydro power generation.

Figure .3 picture indicating implementing of Training

V.CONCLUSION

With the introduction of a micro-hydro power in Leku Woreda in Jimma, Ethiopia, there has been a great positive impact in terms of the community's socio-economic aspect. There has been a shift from traditional to modern way of living, and an efficient way of generating income which in turn increased their savings. As per the geological study conducted, it was seen that there is negligible effect on the environmental aspect. There has been no indication of risk of soil instability that would adversely affect the community and to the environment itself.

In general, micro-hydro power generation scheme provides clean, affordable, sustainable and environmental-friendly renewable energy to remote and isolated areas in Ethiopia.

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