Solarizing Community Water Supply in Ethiopia: Sustainable Private Sector Development Model

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Abstract

Productive uses of renewable energy (PURE) technologies are mature, economical, and offer practical solutions that meet the needs of off-grid regions around the globe. Winrock's Solarizing Community Water Supply project, funded by the Hilton Foundation, is working alongside local partners in Ethiopia to design a new option for rural communities to solarize existing diesel water supply pumps through a lease-to-own model. A local private solar developer covers the upfront investment to supply and install a solar water pump (SWP) and gets paid back by the community over time. Winrock's role is to provide de-risking incentives to the private solar developers and oversee the solar pump technical design and installations in ten pilot communities. We analyze the life cycle economics and SWP leasing approach impacts in Ethiopia rural communities.

Keywords: photovoltaics, solar water pumping, solar leasing, Ethiopia

1. Introduction

In Ethiopia, thousands of rural, off-grid communities have piped drinking water systems with diesel-powered pumps that were installed by the government. These communities collect a tariff (typically ~US$0.50 per liter in 2025) to cover the cost of diesel fuel and operation and set aside a small amount for repairs. Many rural communities face difficulties affording and securing diesel due to increasing costs and fuel shortages. They also tend to pump intermittently, leaving significant unmet demand for drinking water. Over time, the maintenance costs of diesel generators become too large to be covered by the tariff, and systems suffer from increasingly frequent breakdowns. SWPs liberate communities from an unreliable supply of diesel, price volatility, and frequent repairs as the diesel generator ages. In addition, switching to solar pumping is cleaner, healthier, and saves Ethiopia foreign exchange needed for importing diesel.

2. Pilot Phase Solarizing Community Water Supply in Ethiopia

Under the lease-to-own model developed by Winrock, a local private solar vendor covers the costs of installing the solar pump and gets paid back by the community water utility over time at approximately the previous diesel tariff rate the community is already accustomed to.

The following figure shows a typical community solar water pump system. The system includes an array of photovoltaic (PV) panels mounted on a fixed metal frame; a controller which mediates the electricity provided to the pump from the PV panels; a power cable extending from the controller to the pump; a pump (submersible or surface water) which draws power from the PV panels; and a water level sensor which shuts off the pump if the water level is too low. Solar panels are often warrantied for 25 years. Most communities in Ethiopia provide a salary for pump operators who work in shifts to provide continuous security for the pump.

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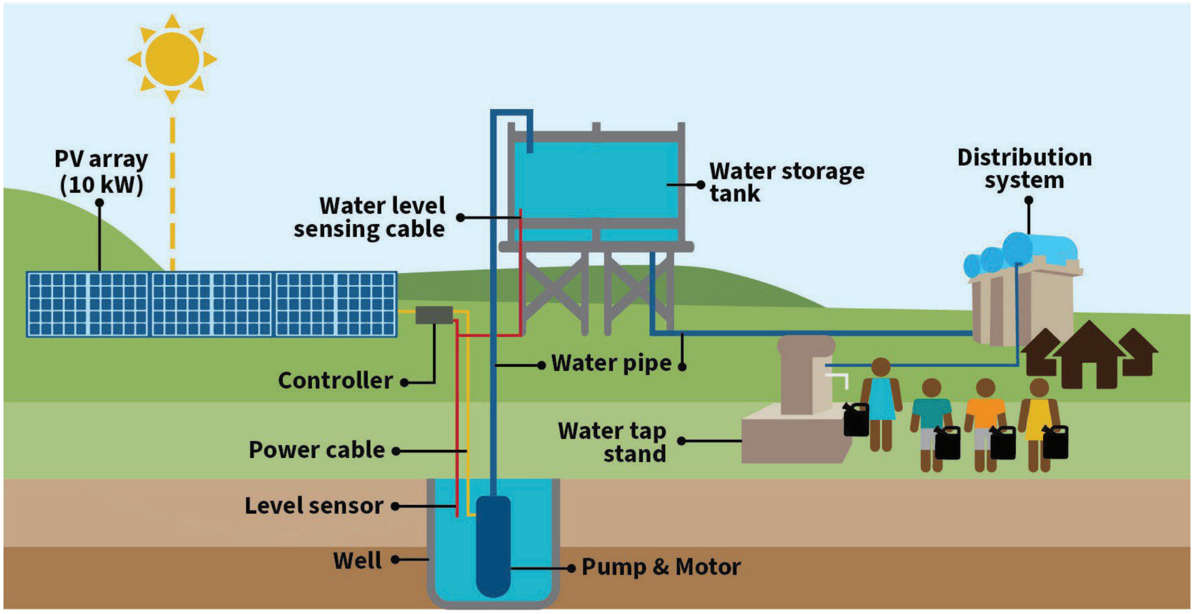

Figure 1: Community solar water pumping layout.

3. Life Cycle Cost Comparison of Diesel vs Solar Water Pumping

Life cycle cost (LCC) analysis is a useful tool that allows for an equal and useful comparison of solar and diesel water pumping technologies. Using this methodology, not just the initial costs, but all the future costs (operation and maintenance, replacements, transportation, and fuel) can yield a comprehensive and comparative view of total system costs over the life of the system.

Using data from the Chiri Sirba pilot site in Oromia state, Winrock conducted a life cycle cost comparison of diesel vs solar water pumping. Below are the general assumptions used for life-cycle cost (LCC) analysis of solar versus diesel water pumping systems for the case of Chiri Sirba.

Assumptions - LCC Analysis

Economic Parameters (for Ethiopia situation)

Discount Rate:	22%/yr
Fuel Inflation Rate:	4%/yr
Inflation:	18%/yr
Differential Fuel Inflation:	12%/yr
Real Discount Rate:	4%/yr

PV System   Conventional System

Replacements

AC Pump :   20 years   Diesel Generator: 7.5 years

Operation and Maintenance

Solar 27.3 kWp	$429 per year
Dieesel (excludes fuel)	$907 per year

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Transportation to Site: Included in delivered diesel fuel price

Fuel Usage
Solar 27.3 kWp None Diesel 80 kVA: 18,217 liters/yr

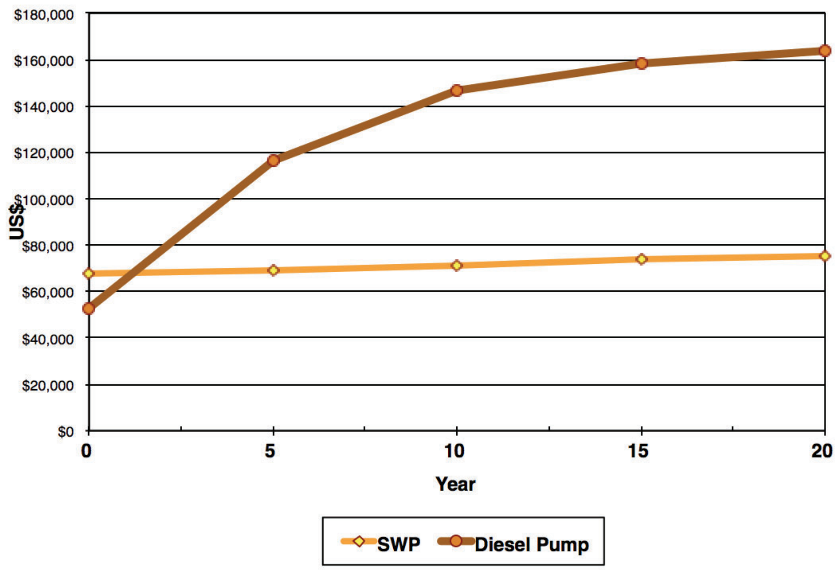

Fig. 4: 20-year Life Cycle Cost Comparison Solar vs Diesel Pumping, Chiri Sirba, Ethiopia

The results of this analysis are consistent with many other LCC studies over the past 20+ years that have shown the cost-competitiveness of solar, which continues to improve as solar panels decrease in price and diesel fuel increases in price. In fact, solar is the most inexpensive water pumping technology of choice anywhere in the world. Our analysis shows that solar water pumps are much more economical than diesel pumps, with a payback time of less than two years (Figure 4). Solar water pumps are even cheaper to operate than on the electric power grid in Ethiopia. All of the pilot sites in this project are using alternating current solar water pumps, which have system lifetimes of more than 25 years.

As shown in Figure 5, the initial capital cost of solar water pumps is not much more than the capital cost to install diesel pumps at only about 28% higher, but solar pumps deliver savings of US $90,000 to communities compared to diesel pumps over 20 years. The PV system investment is fully recuperated after only about 1.5 years. Additional benefits (i.e. externalities) such as the elimination of potential well contamination and health risks from hydrocarbon fuels are not included here and are difficult to reflect in conventional LCC economic analysis (Foster, 1998).

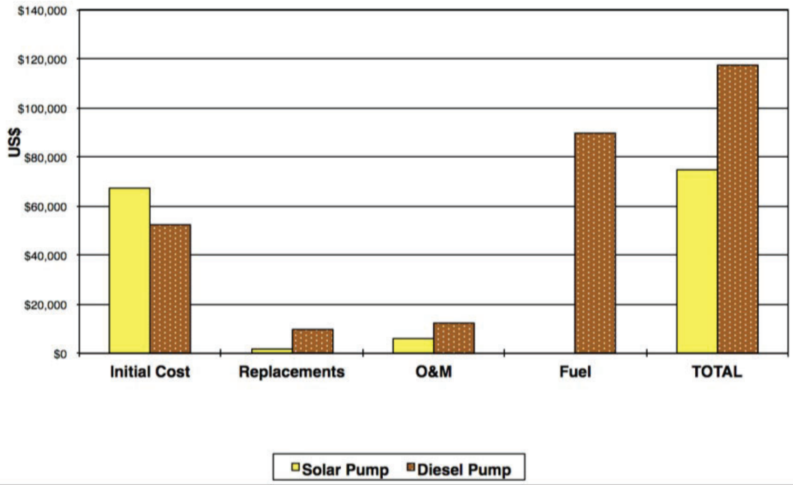

Fig. 5: Cost Comparison Solar Water Pump (SWP) vs Diesel Pump, Chiri Sirba, Ethiopia

The SWP life cycle cost is approximately $0.08/kWh which is comparable to the price of grid electricity nationally and 50% of the diesel pump life cycle cost. For water pumping, the solar pump life cycle cost is about $0.10/m^3 which is comparable to the price of pumping water using grid electricity at 150 meters total dynamic head. The life cycle cost of diesel water pumping is approximately $0.43/m^3.

The lease-to-own model allows communities to pay off the cost of the solar water pump over three years while paying an equivalent price to diesel pumping, but reduces to $0.009/m^3 for the remaining solar pump system life, expected to be at least 20 years. The solar panels should function for over 40 years. Solar water pumps liberate communities from unreliable supply of diesel, price volatility, and frequent repairs as the diesel generator ages. In addition, switching to solar pumping saves Ethiopia foreign exchange needed for importing diesel throughout the life of the diesel pump.

4. Conclusions

The Winrock project successfully introduced new and innovative sustainable PURE SWP technology to Oromia and Amhara regional states in Ethiopia. The project has verified that the interest for solarization for water supply is high from the private sector and from rural communities. Eight pilot SWP installations have been installed on a Lease-to-Own model by local solar developers. Success requires a strong commitment from the government, enabling a favorable regulatory environment and motivating private sector developers.

5. References

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