Solarizing Community Water Supply in Amhara State of Ethiopia

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Abstract

Winrock's Solarizing Community Water Pumps project is working alongside local partners in Ethiopia to design a new option for communities to solarize existing diesel water supply pumps through a community lease-to-own model. Under the lease-to-own model, a local private solar vendor covers the upfront investment to supply and install the solar pump and gets paid back by the community over time. The terms of agreement are specified in a Memorandum of Understanding (MoU) between the community water committee and the private solar vendor. For the initial pilot in nine communities, Winrock's role is to facilitate financing for the private solar vendors to reduce the risk of their investment and oversee the solar pump technical design and installations in nine pilot communities. Winrock's partner, Tufts University's Climate Policy Lab, will conduct baseline and endline surveys to assess community satisfaction with the solar pumps.

Keywords: Photovoltaics, solar water pumps, renewable energy, community water supply

1. Background and Context

The technology of choice for providing water supply to rural communities, even in new government and donor-funded projects currently under development, continues to be diesel-powered pumps, which carry with them significant challenges including high diesel fuel costs, diesel shortages, the need to transport fuel, expensive maintenance, frequent breakdowns, and greenhouse gas emissions. At the same time, the price of solar panels has decreased dramatically over the last decade; today, solar is significantly cheaper than diesel, particularly for applications that require daily use but do not require batteries, such as solar water pumps. To ensure that communities can get reliable water at affordable costs, it is urgent to demonstrate to governments and donors that the technology of choice for rural community water supply should change from diesel to solar, both for retrofits and for new systems.

In Ethiopia, rural, off-grid communities have a history of paying the full cost of diesel fuel to pump drinking water. Communities collect a tariff (typically 2-3 Birr per 20-liter jerrycan, as of 2023) to cover the cost of fuel and operation and set aside a small amount for repairs. While this works well when the diesel generators are new, after 10 years of operation the maintenance costs become too large to be covered by the tariff, and systems suffer from increasingly frequent breakdowns. When this happens, households – most often women and school-age girls – must go back to walking to collect water at the nearest river, which can take up to two hours one way.

In Amhara state, where Winrock is working, solarizing community water pumps is a high priority for communities because of the diesel shortage resulting from the lack of foreign currency, and because many communities have invested in water treatment that relies on a stable pumping system. The current level of community water tariffs in many communities will support a 3-5 year payback period for the solar pump.

The Government of Ethiopia (GoE) has outlined a comprehensive plan under Phase II of the One WASH National Programme (OWNP) that aims to increase water supply and sanitation access. This plan calls for the solarization of 6,352 water supply systems in rural, off-grid communities, including 4,000 systems in Oromia state and 500 systems in Amhara state. Currently, OWNP envisions that solar pumps will be provided to communities using donor funds. Given that community solar water pumps typically cost on the order of US $50,000 for communities with a population of 10,000 – 30,000 people, it may take many years to secure the $300 million in donor funding required to donate solar pump equipment to convert more than 6,000 diesel water supply systems. [1]Recognizing this, the Ministry of Water and Environment (MoWE) is interested to assess the viability of blended and/or private financing models for scale-up. Winrock's Solarizing Community Water Supply project aims to test one commercial model for replacement of diesel community water pumps with solar pumps.

2. Feasibility Study for a Revenue Model for Community Solar Water Pumping in Ethiopia

In 2019, with funding from the Rockefeller Brothers Fund, and in collaboration with the Fletcher School's Climate Policy Lab (CPL) at Tufts University, Winrock completed a market study and financial analysis for a commercial approach to replacement of diesel community water supply pumps with solar pumps. The study showed favorable results for communities living in more remote areas where diesel fuel transport costs are high, as well as communities where old diesel systems have high maintenance costs and frequent breakdowns. The study profiled two villages in Oromia Region: Leman (2,500 households) and Awash (500 households). In Leman, the diesel community water pump was replaced with a solar pump funded by the European Union in 2016. If the solar pump had been commercially purchased, the existing tariffs collected by the community would have paid back the cost in 2.3 years, with a five-year internal rate of return (IRR) of 32% (Table 1). In Awash, where the existing diesel community water pump had been out of service for six months at the time of the study, a solar pump could have been commercially purchased and installed and paid back within three years using the tariffs the community had been paying for their diesel pump when it was operating. For Awash, the projected five-year IRR was 20%. These IRRs served as an indicator that this market segment would be attractive to private developers.

Table 1: Financial analysis of two community solar water pumps in Oromia state

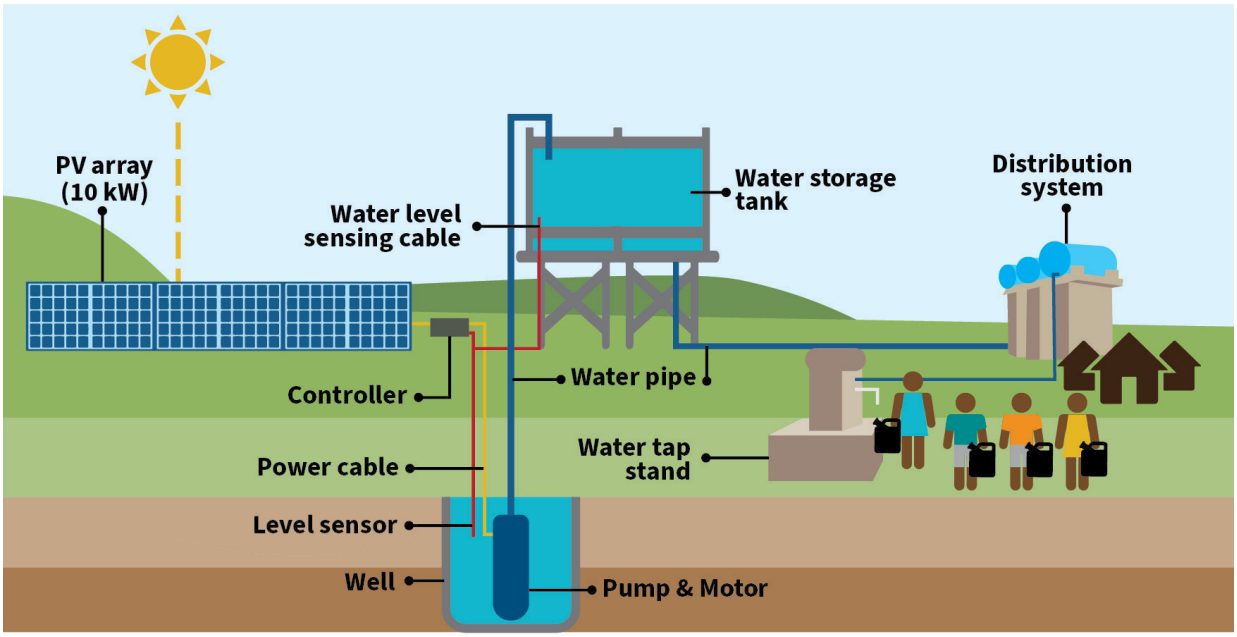
	Leman	Awash
Number of households	2,500	500
Average daily water requirement (m^3/day)	52	25
Total dynamic head (m)	105	134
Water tariff (USD/m^3)	0.78	0.78
Solar water pump system cost (USD)	33,250 (actual)	19,250 (estimated)
Annual gross revenue (USD/year)	14,828	7,129
Annual O&M (USD/year)	640	640
Payback Period (years)	2.3	3.0
5 year IRR	32%	20%

[1] This cost estimate is for solar water pump systems with a total head of 150 meters, producing 3-5 liters/person/day.

3. Community Solar Water Pump Profile

Figure 1 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 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.

Figure 1: Community solar water pump schematic



The installed cost of solar PV panels has decreased significantly over the past decade. Panels for a 9 kW residential system cost US $7.53/Watt (including inverter) in 2010, and decreased to US $2.71 in 2020[2]. This cost decrease in PV panels has made it possible to obtain affordable solar water pump systems at sizes appropriate for off-grid communities.

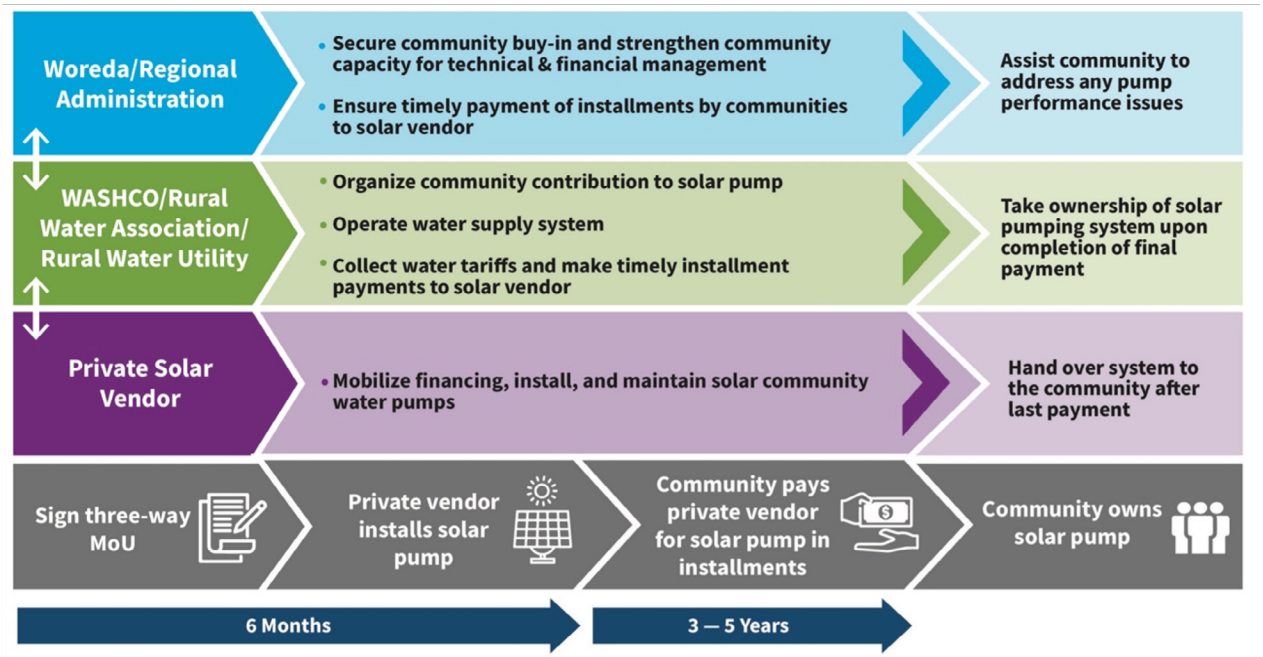
4. Demonstrating a Community Lease-to-Own Model for Community Solar Water Pumps in Ethiopia Project Overview

In 2022 Winrock secured funding from the Conrad N. Hilton Foundation to implement the project Demonstrating A Revenue Model for Community Solar Water Pumping in Ethiopia. The Project aims to launch a commercial market for replacement of diesel pumps with solar. The overall market is expected to be on the order of thousands of systems in Ethiopia, with more in other Sahel and east African countries.

[2] National Renewable Energy Laboratory, U.S. Solar Photo-voltaic System and Energy Storage Cost Benchmark Q1 2020

The Project is currently demonstrating a community lease-to-own model at ten community sites in Ethiopia over a three-year period by facilitating private developers to replace each community's diesel water pump with a solar pump. The Project aims to reach a total of 100,000 beneficiaries. The community lease-to-own model is summarized in Figure 2.

Figure 2: Winrock's proposed community lease-to-own model for solarizing community water pumps



Winrock received bids from eleven local solar developers based in Addis Ababa for providing a solar pump system to a community in Amhara state with 30,000 people and a deep well with 100 meters of total head (from the water level in the well to the reservoir inlet). The bids averaged US $65,000. The total cost of the ten solar pump systems, including installation and staff time spent by the private developers, is estimated to be approximately $500,000.

Community Selection Criteria

In consultation with the Amhara Bureau of Water and Energy and the Water and Energy departments of several woredas (districts) near the city of Bahir Dar, in Amhara state, Winrock conducted an iterative process to identify rural communities with existing diesel-powered water pumps that were interested to participate in this pilot project. We prioritized rural, off-grid communities with a population of 5,000 – 30,000 people that are within 1.5 hours by car from the city of Bahir Dar. Since Winrock's project focuses only on replacing the solar water pump and not on repairing, expanding, or replacing any other components of the community water supply system, we prioritized communities where the existing water supply infrastructure (reservoir, water pipes, borehole, community taps) is in good condition. We conducted water quality tests in each prospective community to ensure that the water quality was acceptable for drinking.

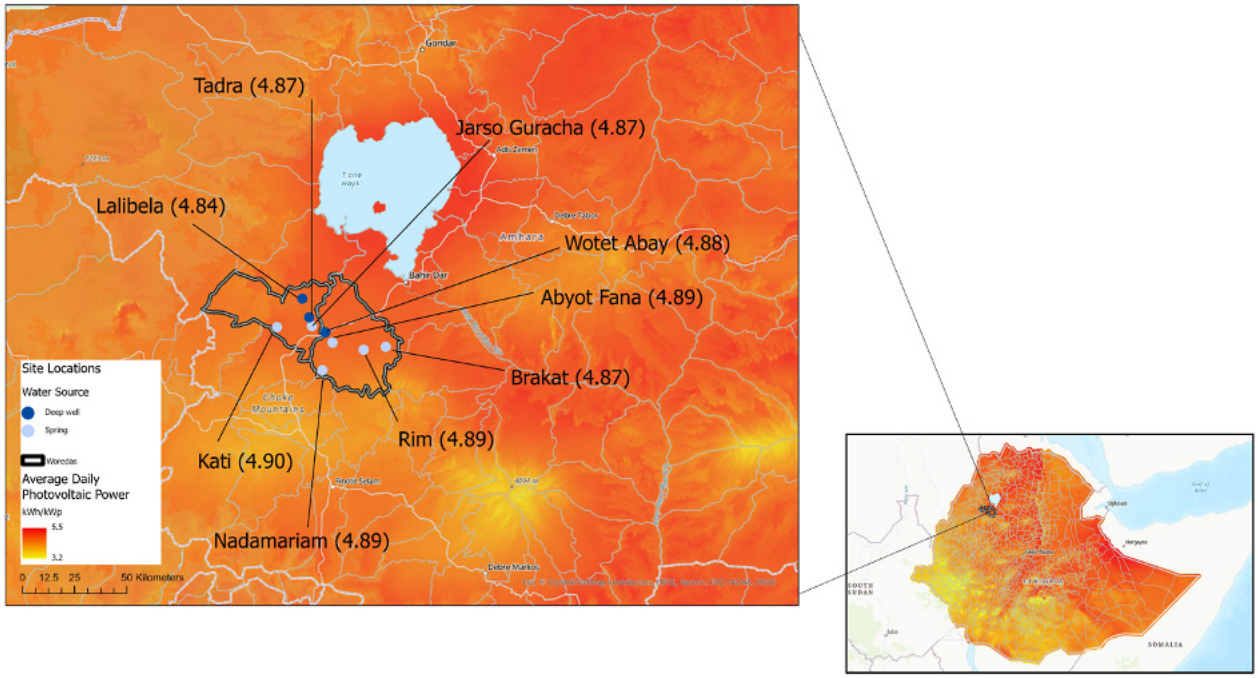
Winrock requested that interested communities provide the following indications of their commitment:

- Commitment letter from the local water committee or water utility which:
  - o Confirms that the community agrees to pay a water tariff between 80 – 120 Birr per m^3 (2-3 Birr per 20-liter jerrycan);
  - o Includes signatures of at least 100 community representatives (elders, area coordinators, and leaders of women's and youth groups, school and health facility officials); and
  - o Confirms that the community will make a down payment toward the total solar pump cost.
- Commitment letter from key water users (schools, health centers, religious institutions) specifying how much water they will purchase each month
- Documentation of the water committee's plans to ensure that people in vulnerable households can access sufficient pumped water.
- Letter from at least one financial institution to provide credit to cover the community in case of a missed or insufficient monthly payment to the solar developer
- Confirmation of at least 200 m^2 of available land near the water pump where solar panels can be installed, including a permit if needed
- Support letter from the woreda administration

Hydrogeology Assessment

Through a competitive tender, Winrock hired a hydrogeology consulting firm to visit each of the 20 community sites to assess the condition of the existing water supply infrastructure, the water supply capacity, and the water quality. Dabus Consulting Plc., an Addis Ababa-based firm, conducted the assessment in June and July of 2023. Based on the assessment results, Winrock identified a total of nine target communities (Figure 3). Six communities source water from springs and three use deep wells.

Figure 3: Pilot sites for replacement of diesel community water pumps with solar



De-Risking Investment in Community Solar Water Pumps Through Results-Based Grants

Winrock is providing results-based grant funds to the local solar developers who will install the pilot solar water pump systems using the community lease-to-own model. Since these are meant to be commercial transactions, the results-based grants are not a subsidy for the cost of the solar pump system, but rather an incentive to reduce the risk of the solar developers.

Solar developers selected through a competitive bidding process will receive an initial tranche of funds upon signing the grant agreement, and the remainder of the grant will be disbursed in installments as they successfully complete each solar pump installation and begin collecting tariffs from the community.

A solar water pump Memorandum of Understanding between each community and the solar developer will specify investment terms and procedures for revenue collection and payment to the private developer. After the developer recoups its investment, it will either hand over the solar water pump system to the community or, if the community desires, add additional services such as water purification.

Aside from providing results-based grants, Winrock is taking additional steps to decrease the private solar developer's risks related to investment in community solar water pumps:

1. Conducted **hydrogeology and WASH assessments** to confirm that the water system infrastructure is in good condition, test the water quality, and verify the volume of water currently being purchased by the community;
2. Secured a **down payment commitment from each community** (to be finalized during the MoU negotiations);
3. Created a template for the **community lease-to-own Memorandum of Agreement** between the community, the Woreda (district government), and the private solar developer;
4. Secured support from the Amhara Bureau of Water and Energy (ABoWE), a government bureau with a mission to improve the living standard of peoples in Amhara National Regional State by increasing access to sustainable, high quality potable water and energy sources. ABoWE pledged to support the Project by helping to identify interested woredas and communities; convening a regional task force to monitor project progress and participate in planning and decision making; supporting the private solar developers on tax incentives and priority access to foreign exchange; exploring the possibility of making funds available to vulnerable groups within communities that cannot afford the water tariff required to cover the cost of the solar pump; and co-hosting a workshop with Winrock to disseminate project results and lessons learned to the Ethiopia One Wash National Program and Ministry of Water and Environment.

Identifying Local Solar Developers Interested to Enter the Community Lease-to-Own Market

Winrock solicited competitive offers from private solar developers stating what amount of grant funds they would require to de-risk their investment in solarizing the first four community sites. Applicants were asked to:

- Use the data in Table 2 to estimate the cost of procuring, installing, and maintaining each solar pump system;
- Calculate the tariff (Birr/m^3) that would be needed from the community to pay back the cost of the pump within five years; and
- Specify the amount of results-based grant funds they would request for each site.

Figure 3: Pilot sites for replacement of diesel community water pumps with solar

	Site 1 – Abyot Fana	Site 2 – Jarso Gurach	Site 3 – Lalibela	Site 4 – Wetet Abay
Well type	Spring	Spring	Borehole	Borehole
Distance from Bahir Dar (km)	49	68	80	51
Total daily water consumption (m3/day) (including all users – households, schools, health centers, etc.)	50	75	100	100
Total dynamic head from water table to reservoir, including friction losses (m)	87	109	132	178
Depth of borehole (m)	N/A	N/A	80	104
Reservoir capacity (m^3)	50	75	200	100
Flow rate of water source (litres/s)	5	4	5.25	8.50

Winrock selected two applicants out of eleven companies who demonstrated the interest and capability to expand work in this sub-sector, requested reasonable results-based grants, and provided the best quality and value to the community.

Community Contracting Process

Winrock has developed a community contracting process which has two goals: 1) to ensure that women and people from vulnerable groups in each community take part in the decision to enter into a solar water pump lease-to-own agreement; and 2) to allow each community to select which of the two solar developers they want to provide the solar pump.

To address the first goal, a one-day gender and social inclusion (GESI) workshop for each community will include representatives of the Water Committee, Kebele Administration, schools, health facilities, religious institutions, elders, women's groups, youth groups, and other vulnerable groups. The workshops will document participants' questions, comments, and recommendations for ensuring that the new solar water pump system meets their needs.

To address the second goal, Winrock will facilitate a one-day community contracting workshop for each community, during which the two selected solar developers to make an in-person presentation to each community; the community will select one of the developers; and the community and solar developer will sign the community contract, entering into a lease-to-own agreement for the solar water pump system.

In collaboration with the community Water Committees and the selected solar developers, Winrock created a community contract document which complies with local procurement rules. The community contract includes the solar pump technical and performance specifications; financial agreement and terms of payment; provisions in case of issues with pump performance or monthly lease payments; and roles and responsibilities of the community and the solar developer. Winrock will adjust the community contract to reflect the feedback from each workshop.

Monitoring and Evaluation

The project's goal is: Ten diesel community water pumps are replaced with solar by private local developer partners, with cost recovery through water tariffs to provide more cost effective and consistent water services. Within this goal the project is pursuing four outcomes:

- $200,000 in private financing mobilized from private developers for conversion of diesel community water pumps to solar.
- Ten communities (100,000 people) receive an equal or higher volume of water from the solar pump as they did from the diesel pump.
- Ten communities report an overall increase in satisfaction with the cost effectiveness and consistency of water services.
- An average of 90% of planned tariff payments are made by the community Water Committee to the solar pump developer, as specified in each community contract.