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Modernizing Water Governance in Ethiopia:

Solar Success in Off-Grid Water Service Delivery

Briefing Note, December 2020

The USAID Lowland WASH Activity builds a practical foundation for alternative energy to power water services in the future.

A school tap stand at Phase community in Debub Ari Woreda, SNNPR. Photo Credit: Michael Tewolde.

Field experiences and collaboration with the Ethiopian Institute of Water Resources and the Ministry of Water, Irrigation, and Energy provide rigorous, adaptable tools that improve service options in remote, harsh environments.

KEY INSIGHTS

- The successful national rural water supply program of the Government of the Federal Democratic Republic of Ethiopia (GoE) is open to incorporating new pathways to providing safe water supplies in the most remote and environmentally harsh areas of the country
- The USAID Lowland WASH Activity supported GoE by piloting and refining solar water pumping schemes in the challenging Lowland Regions
- Successful operation of Activity-supported schemes for over three years has established the viability of solar power replacing fossil fuels in the Lowland Regions
- The Activity provided the GoE with technical guidance for incorporating solar power into national guidelines on rural water service delivery
- Local technical academies are using manuals and guidelines produced by the Activity to train the next generation of installers and caretakers of solar water pumping schemes

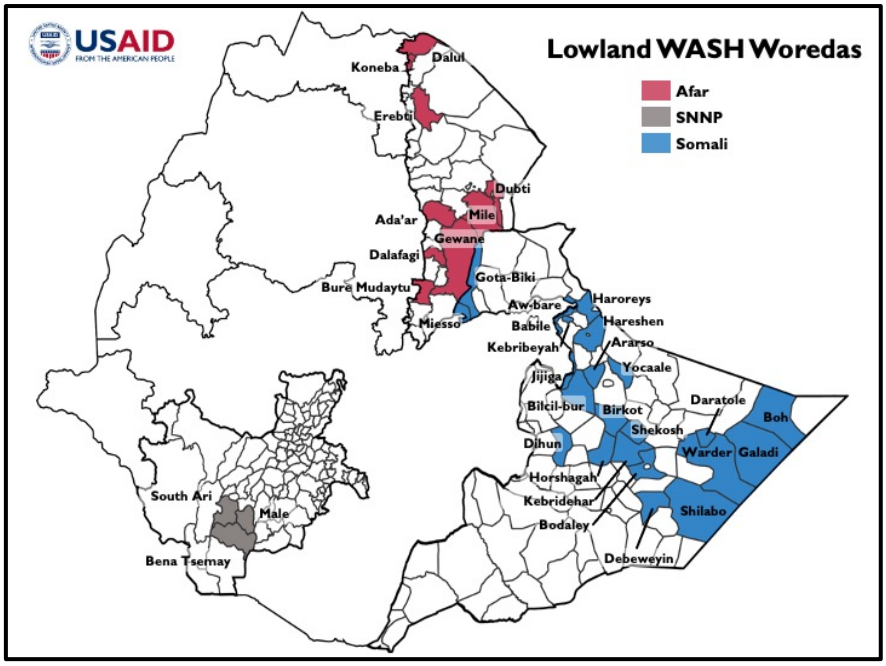
Collaborative Action and Field Successes Lead to Guidelines and Curricula for Designing, Specifying, and Operating Solar Water Pumping Systems

Ethiopia completed the remarkable achievement of meeting the Millennium Development Goal (MDG) for drinking water[1], and it continues to show persistent sector leadership nationally through its One WASH National Program (OWNP). This program provides a well-structured institutional framework and guidelines for rural water supply development from the federal level to remote villages. It includes a strategic framework for operation and maintenance (O&M), the critical element of sustainable delivery of rural water supplies. The OWNP is a living, learning program that regularly refines its guidelines or incorporates information on new or improved technologies.

Even with the successes of the OWNP and on the MDG, millions of Ethiopians still struggle to obtain their daily water. To address this, the Government of the Federal Democratic Republic of Ethiopia (GoE) is reaching into the more challenging and less served corners of the country to further expand water access. The USAID Lowland WASH Activity has supported the GoE's progress in these areas by establishing operational viability of solar powered water supplies and contributing new content to the OWNP.

With 60 percent of the land area and 12-14 percent of the national population – mostly in pastoral communities – the Lowland Regions of Ethiopia (see Figure 1) lag behind the rest of the country on most social and economic indicators[2]. Access to water and sanitation are well below national averages. More severe and frequent droughts render these communities increasingly fragile. But, the Lowland Regions also record some of the highest daily sunlight radiation of any location in the country[3], making them a strong candidate for newly affordable solar technologies.

Figure 1. Areas of Implementation by the USAID Lowland WASH Activity



USAID's Lowland Water, Sanitation, and Hygiene Activity (the Activity) has provided off-grid, solar-powered water supplies for over 25,000 people in one of the harshest and most remote regions of Ethiopia. The Activity has also worked with Ethiopian academics and decision-makers to compile the experience gained into design and operational guidelines that contribute to successful implementation of the OWNP.

The Activity's practical approach to mobilizing solar technologies and its subsequent field achievements are captured in two leading edge publications prepared jointly with the Ministry of Water, Irrigation and

1 USAID (2017)
2 World Bank (2019)
3 Mekonnen, Sharew Anteneh (2007)

Electricity (MoWIE): (1) Design and Implementation Manual for Solar Water Pumping; and (2) Solar Water Pumping System Operation, Maintenance, and Troubleshooting Guideline. In addition, the Activity has delivered a User Guide for a spreadsheet-based Solar Pumping Design Tool for Rural Water Supply Systems that standardizes technical design steps for the benefit of the entire national WASH sector. By translating accomplishments from the Lowland Regions into national programs, the Activity has established a foundation for the scalable application of solar pumping technologies into areas with critical and unique water supply needs and challenges.

Opening the Potential for Scaleable Solar Schemes Through Ethiopia's National Plans and Programs

Ethiopia's Growth and Transformation Plan (GTP) of 2010 recognized the importance of drinking water self-supply and led to development of the OWNP in 2013[4]. As elements and actions detailed in the OWNP initially came into everyday use, application of solar technologies in water supply systems was minimal. Subsequent decreases in pricing, increased reliability, and expanded equipment options created new potential for their contribution to the reliability of off-grid systems. At the same time, the GoE committed to moving away from environmentally and financially expensive diesel-fueled pumping systems toward wider application of these new technologies.

Operator cleaning solar panels at Be'eda *water supply system in Gewane Woreda, Afar region.* Photo Credit: Michael Tewolde.

The GoE has now turned its attention to making progress toward meeting the 2030 Sustainable Development Goals (SDGs). Under its Growth and Transformation Plan II (GTP II), it has expanded its focus in the water sector, incorporating fresh approaches to the delivery of high quality, sustainable services. Under GTP II, Ethiopia's systems are increasingly incorporating new methods that will support achieving SDG 6 – "ensure availability and sustainable management of water and sanitation for all". The USAID Lowland WASH Activity was well timed and positioned to support GoE's forward-looking focus.

Newly Available Solar Water Supply Technologies Needed Proof of Concept Before Operation at Scale

OWNP documents provide guidelines for sector actors and an investment plan that builds on MDG successes. They clarify modalities and responsibilities, establish service delivery standards, present activity sequences, and define programmatic implementation steps for most aspects of rural water supply development and management. For each topic, accountability structures are presented from the federal to community level, key performance indicators (KPIs) are introduced, priority areas for future investment are presented, and region-by-region investment needs to achieve national KPIs are presented. These documents promote solar powered water supply schemes but contain few specifics about their design, installation, operation or performance monitoring. Practical field applications were needed to demonstrate the viability of the proposed move toward solar.

Acknowledging this need, the GoE turned its focus in GTP II to "encourage use of labor intensive, low-cost technologies using renewable energies such as wind and solar." However, the GoE lacked the guidelines necessary to manage the roll out of solar water pumping systems across a country with

4 USAID (2017)

significant regional variations in the skills available to specify components, design solar systems, and ensure their proper maintenance. Concerns also remained as to how quickly solar installations could recover initial capital investment costs that exceeded those for conventional systems.

Further driving the need for alternative power supplies, community water supply managers in the solar-rich Lowland Regions regularly encounter significant obstacles when maintaining conventional, diesel-powered schemes. Regular, preventive maintenance of these schemes is challenging due to the remoteness of communities and the general unavailability of spare parts and skilled technicians. Worse, diesel kits typically underperform manufacturers' operating life claims. In addition, access to fuel serves as a major barrier to reliable, affordable, and sustainable scheme operation. This convergence of direction and need required that the Activity ground truth the viability of solar installations.

The Lowland WASH Activity, the Ethiopian Institute of Water Resources and MoWIE Combined Their Talents to Establish Guidance and a Foundation of Expertise

Peer reviewed publications[5] had concluded that solar pumping in rural Ethiopia could achieve economic advantages over diesel-fueled systems after four years of operations. Subsequent to that analysis, the cost of solar installations decreased while diesel fuel costs incrementally increased, adding favor to alternative energy supplies. Other professional analyses[6] provided to MoWIE drew similarly positive findings that "solar energy development in Ethiopia is fully feasible."

Gender balanced WASHCO members at Gabatoli community solar water supply system in Erebti Woreda, Afar region. Photo Credit: Michael Tewolde.

Upon its launch, USAID's Lowland WASH Activity was in a strong position to realize this potential among remote communities, nomadic populations, and the challenging environment of the Lowland Regions. The Activity began its proof of concept for the application of solar water pumping schemes in off-grid locations in its first year of implementation by rehabilitating a system in the Afar Region to serve 2,800 people with solar power and initiating two additional solar-powered schemes completed in project year 2. The Activity began the work of refreshing national guidelines in year 3 based on an assessment of nonfunctional solar water schemes in Afar and Somali Regions and learnings from the sustainable operation of Activity-installed schemes.

During monitoring of these early investments, the Activity uncovered unanticipated challenges but also validated the hoped-for potential. Observed challenges related to lack of skilled technicians to perform preventive maintenance, the severity of winds that occasionally dislodged solar panels, and the limited familiarity of local authorities with the new technologies. These learnings stimulated a need for the creation of national design guidelines, development of technician curricula, and coordinated efforts to increase awareness of governmental plans and technical options. Overall, the Activity validated the potential of solar water pumping systems in the Lowland Regions with fourteen demonstration installations that are currently operated through WASHCOs (WASH Committees)..

5 Kabade, Asefa; Rajoriya, Abha; and U.C. Chaubey (2013)
6 Hydrochina Corporation (2012)

Adoption and Use of Guidelines Benefit Ethiopia's Rural Water Supply Sector

To institutionalize the Activity's learnings, staff joined with the Ethiopian Institute of Water Resources at Addis Ababa University (EIWR) to develop the needed guidelines and initiate training of technicians. EIWR provides capacity building, conducts research, and performs community outreach to address Ethiopian development challenges through an integrated water resources curriculum and interdisciplinary training. Together with the MoWIE and EIWR, Activity experts filled the national gap in solar water scheme guidance by creating three authoritative documents:

(1) **Design and Implementation Manual for Solar Water Pumping.** This Manual replaced and updated an existing MoWIE document by incorporating fresh data and ensuring its consistency with new technologies and their application. Chapters include (1) Feasibility of Water Supply with Solar Energy, (2) Photovoltaic Water Pump System Components, (3) Solar Water Pump System Design, (6) Installation, and (7) Procurement. Extensive annexes contain national solar resource data, technical specifications, and draft tender documents.

(2) **Solar Water Pumping System Operation, Maintenance, and Troubleshooting Guideline.** Inadequate operation and maintenance (O&M) is clearly one of the main reasons of failure of solar water pumping systems in Ethiopia. The Activity and MoWIE collaboratively developed this new document to assist field personnel responsible for operation, maintenance, and troubleshooting solar water pumping systems used for rural water supplies. It specifically addresses key weaknesses including (1) unclear responsibilities for O&M, (2) inadequate human capacity for care and operation, and (3) ensuring availability of funds for minor and major maintenance and service.

(3) **Solar Pumping Design Tool for Rural Water Supply Systems; user guide.** The USAID Lowland WASH Activity adapted good practices from borehole system design to create a tool that allows easy, fast, and consistent assessment of solar potential and the size of the solar panel array needed for a specific system at an identified location. Worksheets included in this spreadsheet-based tool cover (1) location, (2) water demand, (3) solar resource, (4) water source, (5) total head, (6) pump and solar sizing, and (7) array configuration. The primary advantage of this tool over previous design guides is its inclusion of solar irradiance data for Lowland Regions embedded in workbooks. Additionally, it is adaptable for both solar panels currently in local markets and those that may come to the market in future. To optimize convenience, the Design Tool works offline and without a need for external resources. It fully aligns with the Design and Implementation Manual for Solar Water Pumping referenced above.

Solar panels installed at a water supply scheme in Afar region. Photo Credit: Lowland WASH Team.

EIWR committed its own resources to incorporate these three documents into a new curriculum available through the Institute combining technical skills and capacity building. The Activity staff provided collaborative training sessions on Manual use for EIWR colleagues to ensure comprehensive and practical use in field installations and the classroom. The Manual and Guideline are being used in three Activity-facilitated regional governmental planning and decision-making processes addressing organization and structure of solar installation management. Based on learnings from solar water systems installed by the Activity and applying the new guidelines to their own investments in sustainable service delivery, the

Government of SNNP, South Omo Zone, established a demonstration solar water-pumping scheme, which led to additional installation of over 10 systems in this Lowland Zone.

With Viability Validated, the Focus Turns Toward Reducing Costs and Increasing Expertise

The next steps in firmly establishing solar water pumping systems as a mainstreamed practice in Ethiopia involve (1) reducing the time required for solar installations to recover initial capital investment costs, and (2) ensuring a pool of expertise, knowledgeable on current technology options and able to stay current with what is expected to be rapid evolution of solar system components and the associated needs for operation and maintenance. USAID's Lowland WASH Activity and local government partners have begun to apply the principles of life-cycle costing to solar systems, and initial studies have identified avoidable costs and risks. For example, the cost of the system control panel (RSI) has proven to be a primary driver of lengthy capital cost recovery. Further study of tariffs (which are currently set in consultation with user communities and local government)The work of EIWR was a significant step toward establishing a cadre of skilled technicians to provide high-quality installation, troubleshooting, and maintenance of solar water pumping systems. The manuals, guides, and related curricula give structure to the development of this cadre. But, EIWR will require ongoing support to maintain the quality of their programs, and the national guidelines will need further support to become institutionalized at local levels across the country as an integrated component of the OWNP.

Resources

Aguaconsult and WaterAid (2018). Management Models for Piped Water Supply Services: a decision-making resource for rural and small-town context.

Hydrochina Corporation (2012). Master Plan Report of Wind and Solar Energy in the Federal Democratic Republic of Ethiopia.

Kabade, Asefa; Rajoriya, Abha; and U.C. Chaubey (2013). Solar Pump Application in Rural Water Supply – a case study from Ethiopia.

Mekonnen, Sharew Anteneh (2007). Solar Energy Assessment in Ethiopia: modeling and measurement. Master of Science thesis in Environmental Science, School of Graduate Studies, Addis Ababa University.

USAID (2017). Africa, WASH, and the Millennium Development Goals: a local systems case study of how Ethiopia achieved MDG target 7c.

ABOUT

The USAID Lowland Water, Sanitation and Hygiene (Lowland WASH) Activity: USAID/Ethiopia's flagship WASH activity delivers technical assistance, develops small-scale infrastructure, and builds the capacity of national and regional governments and stakeholders in the lowland Somali, Afar and Southern Nations, Nationalities and Peoples (SNNP) regions. In support of the Government of Ethiopia's Growth and Transformation Plan and One WASH National Program, it aims at (1) increasing access to improved drinking water supply sources on a sustainable basis; (2) increasing adoption of key hygiene behaviors and increased access to improved, sustainable sanitation; (3) improving efficiency and sustainability of food production from irrigated and rain-fed agricultural systems; and (4) improving water governance and data management. For more information, contact Petros Birhane, Chief of Party, at **pbirhane@lowash.com.**

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