Global Solar and Water Initiative

<u>**Kenya Visit Report - 23rd – 26th April 2019**</u>

Photo: Attir borehole in Isiolo

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1. OBJECTIVES OF THE VISIT

As part of the Global Solar & Water Initiative activities, and together with Millennium Water Alliance (MWA), and her partners Food for the Hungry (FH) in Marsabit and Catholic Relief services (CRS) in Isiolo, a 4-day visit to two ASAL counties (Marsabit and Isiolo) was carried out with the following objectives:

- Gauge the technical design and implementation of solar pumping systems in the two ASAL counties of Kenya
- Collect lessons and challenges from community managed schemes
- Produce recommendations and steps to ensure sustainable use of solar pumping solutions

2. BRIEF WATER SECTOR OVERVIEW

The Government of Kenya (GoK) through the Ministry of Water and Sanitation has in the last over 15 years, implemented reforms in the water sector to address gaps which have hindered the effective delivery of water and sanitation services in the country. The result, among others, has seen the decentralization of Water Service Provision to the county governments. New policy under the Water Act 2016 has initiated a second wave of reforms that requires transformation in line with the devolved system of government and ensure the right of access to water for every Kenyan as enshrined in the constitution.

In an endeavor to achieve universal access to water and sanitation, the Ministry has drawn a road map to universal coverage by the year 2030 by undertaking key projects and programs that will connect 200,000 people to water and 350,000 to sewer annually throughout the country. These efforts however continue to neglect rural marginalized communities particularly in the arid and semi-arid (ASAL) counties of Kenya, mainly due to the high cost of piping water to remote areas coupled with the lack of financial resources to do so.

Government efforts for rural communities have traditionally been more reactive than preventive, to a greater extent short sighted e.g. the allocation of KShs650million to the ministry of water (out of Kshs6B allocated for drought mitigation) to be used for emergency water tracking services, repair of boreholes, rehabilitation and extension of water supply pipelines and supply of plastic and collapsible water tanks for the affected communities. Such efforts by far and wide will benefit rural communities minimally in the long term, leaving these communities still vulnerable to future climate induced emergencies such as drought. To counter this, a more resilient approach to programming needs to be adopted.

Rural communities through funding from aid agencies and other development partners continue to rely on standalone water schemes for their water supply needs. Majority of these schemes in the rural areas are based on ground water extraction. Traditionally, these water schemes were either manually operated (hand pumps) or powered with fossil fuels (mainly diesel) but increasingly solar pumping has been adopted primarily due to declining prices of photovoltaic modules, advances in inverter technologies and its associated falling prices, an increase in the number of players within the solar water pumping market offering competitive services and more choices for consumers and conducive policy and regulatory frameworks around solar products put in place by the government (e.g. zero tax on solar equipment) have furthered this uptake.

Compared to other countries in the East and Horn of Africa, Kenya is relatively advanced in its use of solar pumping technology (quality products were found in the sites visited with satisfactory design and workmanship e.g. all the sites visited were found to have correct orientation and tilts except for one site). This points to the private sector being knowledgeable in implementation of SWP schemes. Further the cost of solar PV in Kenya is about 30-40% cheaper than other countries in Eastern Africa. SWP technology is readily accessible to any part of the country. Stocks are usually available at private sector level, meaning even in an emergency response, solar pumping can be deployed very quickly and to the required standard.

While the technology has advanced (robust & reliable equipment, knowledgeable & experienced private sector, competitive prices) gaps remain in

- Financial resources for scale up – solar has a short payback period, low lifetime costs but the capital cost is still higher than traditional diesel/grid systems requiring a higher initial capital outlay

- Institutionalization of the technology – requires horizontal integration of the various policies from the various arms of government and vertical integration to the regional governments
- Management models – poor governance of community managed schemes, private entities and government involvement is minimal
- Operation and Maintenance –Accessibility to technicians and spare parts for solar pumps. County governments have personnel dedicated to O&M but require capacity building to provide services to SWP schemes
- Rationalization of cost recovery structures – communities still believe that since solar is a free resource, water pumped using solar should be accessed free of charge.

In general, stakeholders (government, humanitarian, development, academia, private sector) require having a coordinated approach in mainstreaming the use of solar pumping in water supply projects. As a starting point the Ministry of Water and Sanitation, with financial support from Oxfam Kenya Office and technical back stopping from the Global Solar and Water Initiative, is in the process of coming up with a solar pumping practice manual that will among other things outline the legal and policy issues, process & methodology of SWP implementation, quality assurance issues, design & installation procedures and O&M practices. This will become a reference document for the sector that will contribute towards quality and sustainability.

3. TECHNICAL ANALYSIS

Both stand-alone solar and solar -diesel hybrid schemes were visited, to assess design practices, management models as well as users and WASH Committees perceptions. Sample representative sites were selected for the visits, the results of which can be applied to other areas. Consideration will be made to visit other counties in consultation with MWA where need arises, or to provide technical support/advice as needed.

Figure 1: Average annual Solar Irradiation – 1994-2015 and areas visited (circled)

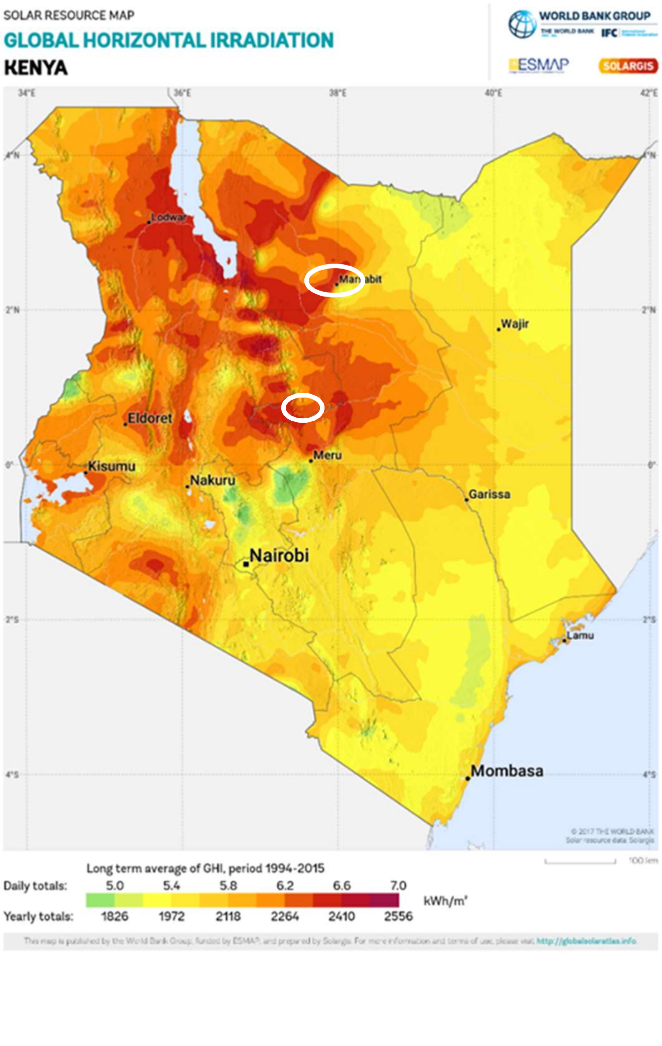

Table 1 – Solarized water points analysed during the visit.

Site Details			Technical Design					
No.	Location	BH ID	Pump Type	Power Pump kW	Solar Power Size (W)	Tested Yield (m^3/hr)	Configuration	Comment /Recommendation
1	Isiolo	Attir	New Grundfos SP17-20	11.0	16380	30.0	Solar Stand alone	According to the Borehole Completion Record, the existing pump is oversized. At 36m TDH and a flow of 20m3/hr, a Grundfos SP17-6 4kW pump would have sufficed. If allowance is given for future drops in water levels (say DWL=40m), an SP17-8 5.5kW pump is sufficient. Consequently the solar PV size is bigger than it would have been.
2	Marsabit	Kubi Qallo II	Existing Grundfos SP17-27	18.5	27825	20.0	Solar + Diesel	The pump is coupled to an over-sized motor (18.5kW instead of 15kW). The motor should be changed to improve operation efficiency. There was insuffient data to do a technical analysis.
3	Marsabit	Kamboe 1	Existing Grundfos SP17-24	13.0	15885	25.0	Solar + Diesel	Insufficient data to do a technical analysis
4	Marsabit	Kamboe 2/ Furmisan	Existing Grundfos SP8A-50	7.5	11660	10.0	Solar + Diesel	Insufficient data to do a technical analysis
5	Marsabit	Dirib Gombo	Existing Grundfos SP8A-50	7.5	9600	14.2	Solar + Diesel + Grid	Insufficient data to do a technical analysis

The boreholes with missing data were drilled by the Road contractor during construction of Merille-Moyale road with no official Borehole completion records at the Water Resources Authority (WRA) i.e. the drilling records were not submitted to the WRA by the contractors. In the absence of such record test pumping should be done to ascertain the capacity of the well for safe abstraction and sustainability.

4. ECONOMIC ANALYSIS SOLAR/HYBRID vs GENERATOR

By using the actual price of the installed solar systems, a present-worth life cycle cost (LCC) analysis was done comparing the lifecycle cost of solar and diesel (or hybrid). Results can be seen in table 2 below. There is a considerable cost reduction over life time of equipment (on average -61% reduction). The difference in LCC between the sites can be used to prioritize sites with higher lifetime cost savings in instances where sites are competing for limited funds.

While the capital costs for solar equipment (Attir Borehole) are higher than their equivalent stand-alone generator schemes, the break-even point of the extra investment is about 1.3 year. For four boreholes (Kubi Qallo II, Kamboe 1, Kamboe 2 and Dirib Gombo), solar PV was retrofitted into the existing pumping systems and even though solar is being compared to zero capital cost of diesel, the average break-even point for the four sites is still very short at 1.3 years. The conclusion here is that investment in solar it worth it even for donors with narrow funding windows.

Table 2 – Life Cycle Cost Analysis: Solar/ Hybrid vs equivalent Generator systems.

Site Details						Economic/Life Cycle Analysis					
						Generator stand alone		Solar stand alone or Hybrid		Hybrid/Solar - Diesel Comparison	
No.	Location	BH ID	Configuration	Hours of Operation on Solar	Hours of Operation on Diesel	Initial cost (USD)	Cost over Life Cycle (USD)	Initial cost (USD)	Cost over Life Cycle (USD)	Reduction of expenses Hybrid/Solar vs Genset	Break-even point
1	Isiolo	Attir	Solar Stand alone	8	0	15,000	231,890	34,000	51,660	-78%	1.25 years
2	Marsabit	Kubi Qallo II	Solar + Diesel	8	4	0	532,023	30,391	224,318	-58%	1.1 years
3	Marsabit	Kamboe 1	Solar + Diesel	8	4	0	327,242	24,000	148,057	-55%	1.4 years
4	Marsabit	Kamboe 2/ Furmisan	Solar + Diesel	8	4	0	327,242	20,000	141,221	-57%	1.2 years
5	Marsabit	Dirib Gombo	Solar + Diesel + Grid	8	4	0	327,242	23,500	144,721	-56%	1.4 years

5. PRESENTATION OF MAIN FINDINGS

Solar- Powered groundwater pumping systems are the fore front of pro-poor technologies being used to provide water in the ASAL counties of Kenya. This is mainly due to the high cost associated with expansion of the national grid and connection of water networks to remote regions. Many aid agencies are using the technology to bridge the gap for water service provision in the ASALs through initiatives such as the USAID funded Kenya Rapid, World Bank funded KOSAP and others.

<table>
<tr><td colspan="3">1. Technical: When properly designed, installed and maintained, solar water schemes perform well and tend to be problem free.</td></tr>
<tr><td>Findings</td><td>Strength</td><td>Gaps/Challenges</td></tr>
<tr><td>All the SWP sites visited were designed and implemented through the private sector.</td><td>Quality solar modules, pumps and inverters were found in all the sites.
The private sector is technically experienced in design and implementation.
Quick and easy access to spare parts
No technical problems encountered with all the water schemes visited.</td><td>Better attention could be given to well sustainability even in the absence of complete borehole details. Borehole data provided by the county water office was used to retrofit the existing pumping systems with SWP hardware. Since the county office did not have the borehole completion records for some of the wells, it would have been prudent to conduct a test pumping to ensure the existing equipment was correctly matched to the borehole. This will prevent the borehole from drying up and avert equipment failure.
Lack of chlorination at source. Chlorination was reported to be done at HH level though this could not be verified.</td></tr>
<tr><td colspan="3">2. Management: All the water schemes visited have a management water committee. A well-managed rural water schemes can provide improved water accessibility and contribute to the overall wellbeing of the community.
Case in point is Dirib Gombo borehole which has used water fee collections to purchase a station wagon for medical emergencies, purchase of land for a communal cemetery, construction of classrooms, plans of expansion of the water point etc.
At Kubi Qallo borehole, the community is using water savings to run an education programme where needy students are supported to pursue secondary education.
Success at these schemes was supported by the following factors: -
- Presence of a management committee with good governance
- Consistent revenue collection from water truckers/bowsers, sales to households, livestock watering
- Good financial management of the revenues
- Integration of other activities to the water point such as irrigation.</td></tr>
<tr><td colspan="3">3. Operation and Maintenance: Food for the Hungry is looking to pilot an O&M model in which the community remits 40% of their collections on a monthly basis to the county government of Marsabit, transferring the infrastructure responsibility to the county government.</td></tr>
<tr><td>Findings</td><td>Strength</td><td>Gaps/Challenges</td></tr>
<tr><td>All the water points have a water committee with daily O&M delegated to</td><td>There is good access to the private sector in getting spare parts (compared to other countries visited in EHA region) e.g. the leading SWP provider in Kenya has offices in 8 ASAL towns covering about 9 ASAL counties.</td><td>Theft of modules was reported at two of the sites and the community used the collected savings to procure replacement modules.
The modules in all the sites visited had not been cleaned since installation (some as old as 2017) and follow up training for the users on O&M is necessary.</td></tr>
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<tr><td>a water operator</td><td>The Marsabit county water office has a borehole rapid response team that is well resourced with technicians which can be trained for wider support on SWP systems.</td><td>It appears the community does not have direct links with the service providers with two of the sites reporting that in case of a problem they would contact the donating NGO.</td></tr>
<tr><td colspan="3">4. Cost Recovery: There is a need to pay greater attention to a rational cost recovery plan

Some of the sites are supplying water for free for household consumption, only charging water for livestock and to commercial water truckers. The charges are also low without any rationale behind the tariff. One of the hybridized sites (solar+diesel) supplies water for free on solar and allows those watering livestock to bring in their own diesel when diesel pumping is required. This poses the danger of compromising the operation of the generator due to poor quality diesel, besides the lost revenue.

With a well-crafted water tariff structure that is consistently applied, there is clearly a potential to save enough money for future maintenance as well as improve the water source through expanded water network (more water kiosks and household connections). Some of the sites reported to having savings in the bank ranging from from KShs400k-800k, despite the low tariffs. Use of water ATMS can contribute towards consistency, accountability and transparency in collecting water fees.</td></tr>
<tr><td colspan="3">5. Institutional/policy</td></tr>
<tr><td colspan="2">Strength</td><td>Gaps/Challenges</td></tr>
<tr><td colspan="2">Ministry of Water providing leadership for solar adoption

Favorable Framework - Solar pumping practice manual in the pipeline

Favorable policy at government level e.g. zero tax on solar goods

Solar training available at university level and at vocational level ((Strathmore University, St. Kizito Vocational & Training Institute)</td><td>Fragmented / uncoordinated efforts of the sector with regard to solar water pumping. There is an opportunity for WESCOORD (Water and Environmental Sanitation Coordination) which is under the Ministry of Water and Sanitation to provide such coordination but would require support e.g. through budget allocation to steer a technical working group.

Lack of a central database (e.g. at ministry level) of who is doing what, where regarding SWP</td></tr>
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6. RECOMMENDATIONS AND WAY FORWARD

An evaluation done by the Global Solar and Water Initiative (2017) concluded that SWP in Kenya is ready for mainstreaming. Indeed, many aid agencies are using it as their first-choice technology in providing water to remote communities. However, for sustainability, proper dimensioning is critical, a rational cost recovery plan must be put in place coupled with proper management of the water point.

The main recommendations from this visit are detailed below.

***For NGOs and implementing organizations (including service providers)*:**

- Pay attention to all technical aspects of the system including well characteristics vs pumping system installed. The pump should be matched to the well capacity. In some cases, a new test pumping may be necessary.
- NGOs should ask contractors to provide software based solar design simulations to support their proposals.
- Build the technical capacity of the county water offices (engineers and technicians). Various training opportunities are available in Kenya e.g. at the Strathmore University, liaising with the private sector for in-depth technical troubleshooting and repairs, both on site and in their workshops (e.g. Grundfos, Lorentz, Davis & Shirtliff).
- Link the community with equipment providers for easy and quick after sales support. This can be backed up with a service maintenance plan for the first 1-2 years of the newly installed system

- Ensure training of community and operators is done on basic O&M procedures. Basic tools should also be provided (e.g. tools for panel cleaning). Continuous training should be adopted.
- Educate communities on the importance of paying for water (even when pumping using solar) and support them to come up rational water tariff structures that will ensure sufficient funds are available for future replacements and repairs.

For Government/ Donors:

- Donors can support county governments in putting in place disaster resilient plans for water provision such as those caused by recurrent droughts. This can be done through increased investment in solar powered water schemes and incentivizing government involvement in rural water management models which will ensure sustainability of rural water supplies.
- Favor solar pumping projects at rural level that include **provisions for after-sale service and long term management**.
- Support studies/research/evaluations of actions to **capitalize on experience** and further building up evidence on suitability of solar pumping for the given contexts.

Action points for the Global Solar & Water Initiative team:

- Support Millennium Water Alliance to train county water officers from Marsabit, Isiolo, Turkana, Wajir and Garissa. MWA will cater for the costs and logistics while GSWI will provide the trainers.
- Continue to Provide technical support to the ministry of Water & Sanitation in developing the solar pumping practice manual.