Ethiopia Visit Report – 17th February to 2nd March.

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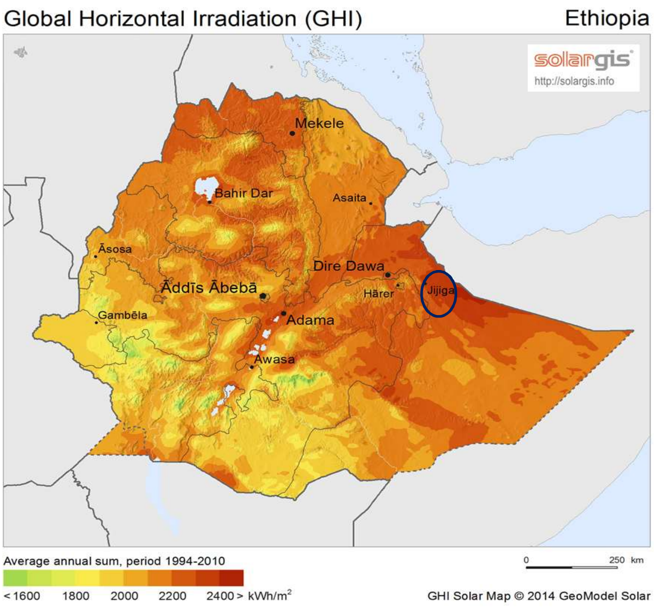
1 - OBJECTIVES OF THE TRIP AND AREA VISITED.

As part of the Global Solar & Water Initiative (see ***Annex A 'Programme Summary'*** for details), a 2-week visit to Ethiopia was carried out with the following objectives:

- Raise water stakeholder awareness and technical capacity in design, O&M of solar water projects.
- Visits schemes in the field to assess work practices.
- Evaluate private sector price range and product quality in order to perform price comparisons.
- Produce recommendations and support implementation of steps to ensure quality use of solar pumping solutions.

In order to complete those objectives, a 5 day visit plan to communities in Somali Region was carried out.

Figure 1: Average annual Solar Irradiation – 1994-2010 and area visited (circled)



Due to vast distances in Somali Region, a limited number of schemes were visited, with different layouts (stand-alone solar, hybrid and stand-alone generator) in order to assess work practices, management models as well as users and WASH Committees perceptions. Together with it, a number of other schemes were technically assessed through collection of data and discussions with managing organizations in Jijiga (see Table 1 and 2 below).

Interviews with Woreda and Regional Water Officers in Somali region and private sector companies in Addis Ababa complemented information gathered in the field.

Additionally, a 3-day technical workshop organized counting with the participation of 35 engineers from 20 organizations was carried out in Addis Ababa. While a similar training was being organized by USAID for partners of the USAID Lowland WASH project, the fact that both trainings registered full participation lists may be an indication of the need and willingness from WASH field engineers to gain better understanding of solar energy solutions.

A last day meeting hosted by UNICEF in Addis Ababa served to discuss some of the findings and to agree in the need of better joint-work among WASH stakeholders. It is believed that the benefits to users coming from the increasing adoption of solar water solutions happening in the country could be in danger if a more comprehensive approach is not adopted.

In this regard, it was agreed a follow up meeting in April to give time and opportunity to interested stakeholders to make inputs and propose actions in this topic. The details of activities carried out during the visit can be found in ***Annex B 'Visit ToR and Training Agenda'.***

Table 1 – Water points with stand-alone generators analysed during the visit.

Site Details			Technical Design						Comment /Recommendation
No.	Location	BH ID	Proposed Power Pump, kW	Proposed Solar Power Size, Wp	Daily Water Demand (m3/day)	Daily Output Solar (m3/day) in average month	Daily Output Generator (m3/day)	Combined Daily Output (m3/day)	
1	Fafen/Jigjiga	Hare II	11.0	18750	84.0	82.7	0.0	82.7	Change existing 15kW pump to 11kW and connect to 75 panels. Change 60kVA to 30kVA generator for fuel efficiency and reduced running cost. Note that same modules, cables, pipes can be used and this will further improve the payback period.
2	Fafen/Awbare	Lefe Isa	4.0	7500	100.0	41.2	58.8	100.0	Solarise this borehole to have solar and diesel. The existing pump should be changed to the recommended smaller pump to avert the frequent failures occuring on the pump
3	Jarar/ Degeh Bur	Sasabane Well	9.2	18750	84.0	57.1	26.9	84.0	Plans for rehabiliatation are underway. The recommended system is indicated.
4	Jarar/ Degeh Bur	Galil	9.2	18750	104.0	127.7	0.0	127.7	Plans for rehabilitation are underway. Solar alone is sufficient to meet the demand. No need for generator. System can supply an additional 23m3/day for 1150 people
5	Jarar/ Degeh Bur	Kuswail (newly drilled BH)	22.0	41250	120.0	263.8	0.0	263.8	Solar alone is sufficient to meet the demand. No need for generator. System can supply an additional 143m3/day for 7150 people
6	Fafen/ Awbare	Laylakal	15.0	22500	100.0	105.8	0.0	105.8	Solar alone is sufficient to meet the demand. No need for generator. System can supply an additional 5.8m3/day for 7290 people
7	Fafen/ Awbare	Dodoti	7.5	11250	100.0	41.4	58.6	100.0	This is a low yielding well. Indicated water demand is higher than it can sustain. The running hours of the generator can be reduced incase demand is lower. This would further improve the payback period.
8	Fafen/ Awbare	Herigele	5.5	11250	100.0	61.7	38.3	100.0	Install solar - hybrid system
9	Fafen/ Keberbaya	Kaho, Rigid	4.0	5250	90.0	27.0	63.0	90.0	This is a low yielding well. Indicated water demand is higher than it can sustain. Possibly install solar stand alone and drill other boreholes to supplement the demand.
10	Fafen/ Babile	Dandamane	4.0	7500	140.0	27.5	112.5	140.0	This is a low yielding well. Indicated water demand is higher than it can sustain. Possibly install solar stand alone and drill other boreholes to supplement the demand.
11	Fafen/ Babile	Obosha	11.0	18750	120.0	81.9	38.1	120.0	Install solar - hybrid system
12	Fafen/ Jigjiga	Horahoud	4.0	7500	108.0	55.0	53.0	108.0	Install solar - hybrid system
13	Fafen/ Awbare	Lafaissa	11.0	18750	144.0	108.3	35.7	144.0	Install solar - hybrid system
14	Fafen/ Awbare	Mohammed Ali, Wedegero	11.0	18750	84.0	99.2	0.0	99.2	Solar alone is sufficient to meet the demand. No need for generator. System can supply an additional 15.2m3/day for 760 people

Table 2 – Solarized water points analysed during the visit.

Site Details				Technical Design						Comment /Recommendation
No.	Location	BH ID	Existing equipment model	Proposed Power Pump, kW	Proposed Solar Power Size, Wp	Daily Water Demand (m3/day)	Daily Output Solar (m3/day) in average month	Daily Output Generator (m3/day)	Combined Daily Output (m3/day)	
1	Fafen/Awbare	Awbare	Lorentz PS1800	1.8	4000	50.0	51.0	0.0	51.0	System is correctly designed. Tank could however be expanded to allow for storage in case of emergency
2	Fafen/Awbare	Awbare OWDA	Grundfos RSI 0100-3L-046-4-X+HMGR	15.0	38880	500.0	199.8	300.2	500.0	Newly installed solar system. 26kW pump is overdesigned. A smaller 15kW pump with 22500kW generator would have sufficed. The system must be operated with generator to meet the demand for 25000 people
3	Fafen/ Awbare/	Haliso	Unknown	3.0	7500	100.0	107.9	0.0	107.9	Existing solar system though equipment details are unknown. There are 38No. modules on site whose size is unknown. Solar stand alone is sufficient to meet the demand.
4	Fafen/ Awbare/	Helingab	Unknown	1.8	2500	112.0	30.0	82.0	112.0	Existing solar system though equipment details are unknown. There are 14No. Modules on site whose size is unknown. The borehole is low yielding and should possibly be installed as solar stand alone and other boreholes drilled to supplement the demand.
5	Fafen/ Babile	El-Geri	Unknown	4.0	6750	115.0	59.0	56.0	115.0	Existing solar system though equipment details are unknown. There are 38No. modules on site whose size is unknown. Should be operated as hybrid to meet the demand.

2 - BRIEF WATER SECTOR OVERVIEW.

The Water-Energy nexus is of such importance in Ethiopia that both falls under the responsibility of the same ministry (Ministry of Water and Energy), with Irrigation (depending on the size of the plots) depending partially from other Ministries. Different responsibilities in the process of design, rehabilitation, maintenance and/or operation cascade down from Regional Water offices to Zonal and Woreda offices into Wash Cos at water point level.

Low water supply levels (with urban-rural disparities and between different regional states), limited financing as well as technical capacity constraints (especially relevant for solar solutions due to the acute shortage of qualified and trained technicians in government offices) are major concerns for the water sector in Ethiopia.

In terms of policy, the government Growth Transformation Plan and the One WASH National Programme (created by the government to improve water, sanitation and hygiene throughout the country) were presented as the main framework documents.

Investments in solar water schemes by donors, NGOs, private sector and agriculture are increasing rapidly. The upcoming national inventory of water points might be used to have an idea of the rate of solarizations achieved so far and to quantify the opportunities –in terms of investment and savings- that a wider adoption of solar water solution could bring about in different regional states.

3 – ECONOMIC ANALYS SOLAR/HYBRID vs GENERTOR.

Prices of pumps, generators, solar panels and other components were gathered and analyzed during the visits from private sector companies and implementing NGOs.

A Present-Worth Life Cycle Cost analysis (see ***Annex C 'Technical Briefing – Cost Analysis'*** for details in methodology) was performed in order to compare diesel generator stand-alone systems with equivalent solar stand-alone or hybrid (solar+generator) systems. Result can be seen in table 3 below, showing that in all cases there is a considerable cost reduction over life time of equipment (average of -47%, ranging from -23% to -72%) when solar solutions are used. The wide difference in terms of potential % cost saving among the different water schemes shows as well how useful cost-analysis could be for decision making in contexts where funding is limited.

For the 19 boreholes analyzed, an capital investment of 264,000 USD to use solar solutions instead of stand-alone generator systems, would mean an overall cost reduction over time of 2.27 million USD, or said in another way, for every 1 dollar invested to apply solar solutions, 8.6 dollars would be saved.

Additionally, while in all cases the capital costs for solar or hybrid equipment are higher than their equivalent stand-alone generator scheme, the break-even point of the extra investment is only 1.4 years on average (ranging from 0.5 to 2.8 years), making the investment worth it even for donors with narrow funding windows.

Finally to note that 1/3 (7 of the 19) of the boreholes analyzed could provide the daily water required with stand-alone solar systems, a proxy indicator of the great potential that solar solutions could offer to free large areas of the Region from its dependency on diesel supply.

Table 3 – Life Cycle Cost Analysis: Solar/ Hybrid vs equivalent Generator systems.

Site Details			Water Output			Economic/Life Cycle Analysis					
						Generator stand alone		Equivalent Solar stand alone or Hybrid		Hybrid/Solar - Diesel Comparison	
No.	Location	BH ID	Daily Output Solar (m3/day) in month with least output	Daily Output Generator (m3/day)	Combined Daily Output (m3/day)	Initial cost (USD)	Cost over Life Cycle (USD)	Initial cost (USD)	Cost over Life Cycle (USD)	Reduction of expenses Hybrid/Solar vs Generator	Break-even point
1	Fafen/Jigjiga	Hare II	82.7	0.0	82.7	$36,116	$210,432	$52,765	$73,729	-65%	1.6 years
2	Fafen/Awbare	Lefe Isa	41.2	58.8	100.0	$17,812	$271,946	$24,309	$193,828	-29%	2.1 years
3	Fafen/Awbare	Awbare	51.0	0.0	51.0	$7,024	$86,087	$12,155	$29,087	-66%	2.2 years
4	Fafen/Awbare	Awbare OWDA	199.8	300.2	500.0	$38,068	$649,718	$77,848	$476,392	-27%	2.8 years
5	Jarar/ Degeh Bur	Sasabane Well	57.1	26.9	84.0	$35,117	$274,631	$52,819	$149,845	-45%	1.7 years
6	Jarar/ Degeh Bur	Galil	127.7	0.0	127.7	$32,657	$200,914	$50,359	$70,599	-65%	1.8 years
7	Jarar/ Degeh Bur	Kuswail (newly drilled BH)	263.8	0.0	263.8	$50,824	$402,900	$90,386	$114,136	-72%	1.7 years
8	Fafen/ Awbare	Laylakal	105.8	0.0	105.8	$43,783	$296,606	$62,433	$84,255	-72%	1.2 years
9	Fafen/ Awbare	Dodoti	41.4	58.6	100.0	$29,579	$377,048	$39,537	$263,924	-30%	0.9 years
10	Fafen/ Awbare	Herigele	61.7	38.3	100.0	$23,034	$254,363	$34,319	$141,393	-44%	1.1 years
11	Fafen/ Keberbaya	Kaho, Rigid	27.0	63.0	90.0	$17,189	$301,214	$19,732	$226,655	-25%	0.5 years
12	Fafen/ Babile	Dandamane	27.5	112.5	140.0	$19,398	$303,423	$24,268	$224,800	-26%	0.9 years
13	Fafen/ Babile	Obosha	81.9	38.1	120.0	$36,471	$298,953	$53,120	$157,830	-47%	1.5 years
14	Fafen/ Awbare	Haliso	107.9	0.0	107.9	$10,424	$109,256	$24,309	$42,303	-61%	2.6 years
15	Fafen/ Awbare	Helingab	30.0	82.0	112.0	$7,024	$230,967	$12,155	$177,890	-23%	1.3 years
16	Fafen/ Babile	El-Geri	59.0	56.0	115.0	$15,716	$205,908	$20,264	$130,327	-37%	0.7 years
17	Fafen/ Jigjiga	Horahoud	55.0	53.0	108.0	$16,679	$213,037	$21,549	$137,547	-35%	0.7 years
18	Fafen/ Awbare	Lafaissa	108.3	35.7	144.0	$33,985	$267,446	$50,635	$125,468	-53%	1.5 years
19	Fafen/ Awbare	Mohammed Ali, Wedegeron	99.2	0.0	99.2	$34,163	$208,692	$46,867	$67,832	-67%	1.3 years
		Totals:	**1628.0**	**923.1**	**2551.1**	**$505,061**	**$5,163,544**	**$769,828**	**$2,887,842**	**-47%**	**1.4 years**

4 - PRESENTATION OF MAIN FINDINGS.

Given the low electrification rate in the country and the unreliability of the grid, solar water supply solutions are critical in the development of new points or conversion of old diesel powered ones if greater cost-efficiency and sustainability want to be achieved. One WASH program can be used to facilitate and mainstream solar pumping technologies within its overall framework.

Solar water solutions are being extensively used already in Somali region by a range of stakeholders in their efforts to provide sustainable, cost-efficient water supply solutions to rural populations.

The table below summarize the main point specific to the Somali Ethiopian context that are for and against a quality mainstreaming of solar water pumping solutions.

Factors for solar pumping mainstreaming	***Policy & Institutional***	***Technical***	***Financial***	***Social***	***Environmental***
Positive/ Favorable	Enabling favorable framework Government, UN, NGOs already using solar solutions for energy generation and water supply	Presence of high quality solar products in Ethiopian Market Existence of knowledgeable private sector companies General lack of (reliable) electricity grid and/or long distances to fuel points	Lifecycle costs lower for solar Water cost cheaper to users Willingness of users to pay for water	Preference of solar to genset by users	Reduction noise and air pollution High solar radiation in most of country
Challenging/ Need improvement	Slow import process Lack of guidelines, standards, best practices	Lack of expertise among stakeholders Lack of training opportunities in-country Spare parts and knowledge scarce and mostly concentrated in Addis leading to long downtimes	Access to currency affects supply chain of parts Capital costs Wrong perception that solar water is free among users and implementers	Need to adapt/ strengthen existing O&M models to solar specificities Wrong water-for-free perception when solar provided	-

The single most important barrier towards a sustainable solarization of water points in the area visited is the low solar technical expertise of WASH stakeholders involved in the design, implementation, operation and maintenance of solar pumping projects.

Training opportunities for field engineers that want to get expertise on solar pumping in a short period of time are not available at the country yet, although the existing facilities at the Ethiopia Water Technology Institute in Addis Ababa (with whom the USAID LowLand WASH programme already have an MoU) were mentioned as a location where, with proper support, this could be achieved.

In terms of **technical problems**, interviews with stakeholders in Addis Ababa and field visits in Somali region show that, when properly designed, installed and maintain, solar water schemes perform well and tend to be problem free, with most of technical issues reported being related to the invertor/ controller.

Theft and vandalism of solar arrays are rare in Somali region (although this could be different in other regional states). Slow supply of spares (due among others to difficulty of private contractors to access foreign currency) together with limited access to technical expertise outside the capital are major concerns that make diesel generators being still an appreciated solution as the technology –despite being more costly and labor intensive- is well known, the spare part supply chain robust and technicians can be often found at local level. Grid-connected water systems encountered, that faced problems because of irregular electricity supply, were shifted back to generators.

An important number of NGOs with low understanding on issues related to sizing of solar arrays, quality of materials or O&M needs are hiring private contractors to design and install solar schemes, which work mostly unchecked in terms of quality of products used, designs proposed, installation made and others. A technology-focused approach with a rapid handover of solar systems to government water offices is the most common pattern found in Somali region.

Government water offices (Regional and Woreda) reported lacking technical understanding, training and access to spare parts, therefore feeling unable and frustrated to play their role of supporting maintenance and servicing of water schemes when these go faulty. As such, Solar systems that have encountered technical issues in the past suffered from long (several months) downtimes, prompting communities to move to other areas or to revert to the use of unsafe water points.

At community level, while solar pumping offers the possibility of lower water tariffs to users, Somali communities that were used to pay for their water when this was provided through handpumps or diesel generators, stopped doing so when the systems were converted into solar, leaving WASHCOs with no funds to react in case of problems or failures. The wrong idea that water pumped with solar should be free is extended among users and implementers and might put in danger the sustainability of the water systems, leading as well to over exploitation of aquifers.

Communities were there was a 'champion' household that benefited from solar pumping for their garden and livestock (typically the one owning the land around the water point and/or the water point operator) were found to be taking good care of water points, making sure proper operation of the system, timely reporting any problem to the corresponding office and even paying from their own pocket repairs. Training of this operators on basic maintenance of the system is of paramount importance but it is not provided by all implementing partners. A lack of community knowledge about the technology is also a primary concern.

The private sector is building solar pumping experience rapidly, but it is constrained by access to foreign currency (necessary to buy equipment and stock parts) and by slow equipment importation processes that hinder project implementation. It is important to point out that, while low quality products are abundant in the national market, the highest quality brands of solar panels, invertors and pumps can also be found in Addis Ababa making quality product knowledge a key point for implementing organizations.

Solarization of water schemes represent a huge business opportunity for the national private sector, which is not being used by other WASH stakeholders as a leverage to encourage private sector to ensure stronger supply chains for spare parts or raise the technical knowledge of the relief community. After-sale service agreements is a tool used in other countries to warranty rapid servicing of failures that however seems to be absent in humanitarian solarization projects in Somali region.

In general, stakeholders in both, humanitarian and development projects, face a range of common challenges when using solar pumping solutions for which it would make sense to look at those in a unified, coordinated way. In this sense, the work developed within the USAID Lowland WASH project (including ongoing work on guidelines, curriculum and intention to work on Standards) seem to be quite advanced in terms of production of reference material as well as actions related to training initiatives and could serve as a reference point for all other stakeholders to develop some of the recommendations of this report.

The lack of reference documents agreed among implementing partners detailing policy, favorable circumstances to solar water solutions, capitalization of experiences or best practices make more difficult to WASH stakeholders to guide and improve their decision making process and operations in the field.

A final significant finding regarding **finance** is that for the systems surveyed, solar pumps always supply lower life cycle costs than diesel pumps, with average cost reductions of -47% and average break even period of 1.4 years, implying savings of 8.6 dollars for every 1 dollar invested to solarize water schemes. This could be extrapolated to other parts of the country taking into account that diesel costs are higher in remote regions where delivery of diesel is more expensive, however solar cost of water will be consistent among all sites, no matter how remote.

5 – RECOMMENDATIONS AND WAY FORWARD.

From the findings, there is a clear and unique opportunity to mainstream solar pumping into motorized water supply plans for rural communities, at least in Somali Region. The main recommendations from this visit are detailed below.

***For NGOs and implementing organizations*:**

- Seek for **options to build technical capacity** of wash engineers in order to know what designs, products, qualities and layouts are the best suited for every water scheme.

- **Invest in after-sale support** of solar systems by making provision in budget to support stock/purchase of critical spare parts and/ or provide rapid technical support when needed.

- Ensure **training and basic tools are provided at WASH Co/ water operators** in order to properly operate and basic maintain solar equipment (eg tools for panel cleaning). Gauge possibilities to include some benefit for water point operators/ WASHCo members (eg access to water for gardening, livestock) to incentivize proper operation, good maintenance and timely reporting of problems. Ensure communities understand the opportunities and risks associated to solar systems.

For coordinating organizations:

- **Create a solar task force** to reinforce inter-agency collaboration, in order to build up internal technical capacity, define standards, guidance and best practices for the Ethiopian context. Use expertise available at country level or in neighboring Kenya (Energy Center at Strathmore University) to organize workshops and trainings and raise technical expertise among relevant NGOs and government technical staff.

- Assess the possibility to **buy solar panels in bulk** in order to reduce capital costs and allow private sector to have more foreign currency cash flow to speed project implementation and stock of parts.

- Use the upcoming water point inventory to **estimate cost incurred** by use of diesel generators **and saving potential** in mainstreaming of solar solutions. Utilize results to advocate for solar if relevant to management and donors.

For Government/ Donors:

- Support **establishment of a solar training center** at University level, as the one existing in Nairobi, that would serve as a reference for regular training of both government, NGO, UN technical staff as well as for private sector actors.

- 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:

- Follow up outcome from the upcoming April solar meeting to be called by UNICEF WASH team.

- Discuss with relevant WASH stakeholders remote support that could be provided to implement action points.

- Agree with UNICEF WASH team dates of next visit and training of team and partners.