DACAAR

WATER EXPERTISE AND TRAINING CENTRE

Action Research on Solar Water Supply Systems

Prepared by: Dr.Shir Ahmad Safi and Leendert Vijselaar

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Paikob-e-Naswar, Wazirabad, PO Box 208, Kabul, Afghanistan
Phone: (+93)(020) 220 17 50 Mobile (+93)(0)70 28 82 32
E-mail: dacaar@dacaar.org **Website:** www.dacaar.org

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EXECUTIVE SUMMARY

This report gives an overview of a Practical Research Project, as done with input from the community on existing community solar pumping systems (SPS). Supported by DACAAR (annex 6.6 – photos)An additional report will deal in details with more technical issues and community involvement issues.

The community was asked about their experience and came with a number of observations and the personnel involved gave pointers to the issues that they encountered. On the other hand some technical details were collected like solar data and measurement of water delivered to the overhead tanks. A number of charts are produced on the basis of the data collected but are only found in the annex as the report is about the perceptions of the community on solar pumping systems.

The community mentioned a number of issues that are directly connected to the limitations that are inherent in a solar pumping system. Personnel who interact with the community members must make clear the strength and weaknesses in such system. Overall the solar pumping system was well received as the operation and maintenance cost can be very low depending on the materials purchased and the technical know-how of the installers.

Some of the communities are better organised and reap the benefits by being more strict about distribution and caring for the solar pumping systems. All the communities were introduced, involved and trained to look after the systems, still differences in care from communities are noted. Therefore more efforts are needed in training and aftercare of the SPS's by the organisation. O&M might be low but the cost of the system are higher than any other system. The operation and maintenance is still there and notably the community will have to pay a caretaker to look after the system. The hand pumps do have caretakers but are not paid for their looking after the hand pump.

1. INTRODUCTION

DACAAR has started several years ago to install solar installations under certain circumstances (for instance water level deeper then possible for Afridev hand pumps to pump). The systems have proven to be successful but some limitations (cloudy days will provide less water, quality of equipment and expertise of installer) have been noted and this action research tries to establish the weak points and advantages.

The Solar Pumping Systems (SPS) are relatively new in Afghanistan and the WET Centre wants to share the findings gathered with others.

The report will detail the experiences of the users, the technical findings on design installation and use of the various suppliers in a general manner, more details can be shared on request. The objective was to evaluate the users perceptions and not so much technical findings. Some of the technical findings will be shared as those were expected to require some in-depth information. Recommendations will be proposed to enable DACAAR and others to continue and expand the SPS.

The report will be of interest to decision makers, NGOs, donors and technical persons as it highlights the implementations over the past years and the research done over the last year.

One of the big advantages of SPS should be, that maintenance and delivery of water could be virtually free of cost. However in reality the community still has to collect funds for the caretaker and the repair of the stand posts as well to look after the system by cleaning the panels periodically and observing on a daily basis if all components of the system are functioning as expected. The paid caretaker could also look after the repairs of stand pipes and the connections after training on-the-job.

There are a number of criteria before DACAAR is installing solar (as the system is costly at the procurement stage) namely: the depth of the water bearing layer is below what a hand pump can deliver, the drilling is too costly in an area to make sufficient water points, then the water bearing layer must be tested if the yield is sufficient for the design of the system. Hand pumps pump up to $3m^3$per day but a submersible system should deliver 6-7 times as much from one borehole, therefore the need for test pumping.

DACAAR installed 36 solar pumping systems from 2009 till December 2013 in Surkh Rood (Chamtala and lower Sheikh Mesri), Behsood (Tangi) and in MomandDara districts of Nanagarhar province and in Centre (Baba SaibDashta) and Qraghia districts (MashalaKamar) of Laghman province. Providers and installers of the system were Afghan Solar, Bakhtar Solar and ETC solar companies funded by three different donors (ROI, IOM and ECHO).

1.1 Research Question

To get proper feedback from the users on performance and reliability, information for designers from the point of view of the community,service delivery and sustainability issues.

1.2 Objectives

1. Identify the users' perception and suggestion for improvement of the system.
2. Soliciting suggestions from the users' their perspective.
3. Identify the efficiency of solar pumping system in different weather conditions;

   Efficiency of solar systems depend on the time of the year as the earth moves through the seasons, perceptions of the community on delivery of water and measuring through observing water meters as placed in the delivery system.

4. Identify the efficiency of tracking system in comparison with non-tracking system;

   The seasons and cloudy weather conditions will affect the output of the solar pumping systems and what are the effects on the community.

2. METHODOLOGY

The following points were part of the methodology to enable DACAAR to answer the objectives:

1. Three solar pumping systems (of the 23 SPSs; criteria of selection from 23 was that those have been functioning for over 1 year) were identified: different manufacturers, locations, depth and tracking systems (Annex 8.3refers).

2. Household surveys (annex 8.1 refers) were conducted once at the beginning of the action research in the three identified systems.
    1) Identified the numbers of functional and non functional Solar Pumping Systems
    2) Solicitedsolutions from the community perspective in respect to their water needs when the weather is cloudy, rainy or/ and if the system is out of order;
    3) Identified the user perception regarding the systems and the degree of their satisfaction with the systems.
3. Flow meter installed on all three solar pumping systems (Annex 8.9 Photo refers).
4. A flow meter reading was conducted once a week for each solar pumping system and read on a two-hourly basis during the day (see annex 8.7).
5. A responsible person read the flow meter and entered the data in ready-made forms and then entered into a spread sheet for analysing the data.

2.1 Solar Intensity

The [1]MacSolar meter was borrowed to measure the light conditions at specific localities and the measurement is given as the intensity per square meter. Therefore the measurement can be multiplied with the seize of the solar array and the total output is thereafter known.

The measurements done with the MacSolar equipment was done in the following manner: aligned with the panels and then turned directly towards the sun to get the maximum reading. The difference between the two readings will be the loss for the system in potential of capturing the solar intensity.

2.2 Water meter data

Water meters were placed on the three selected systems and readings were taken every month during the day to note the quantity of water produced on a general day throughout the year as the light intensity and duration changes during the year.

The water meters show the relation between clear and cloudy weather as well as the effect of the length of the day (Annex 6.5 refers). This relationship, especially the shorting of days, need to be taken in consideration during the design stage. For the community the fluctuating flow will require management of the water supply to the eligible community members.

3. RESULTS AND DISCUSSION

The community information, solar intensity readings and water meter readings were collated and analyzed, the data can be found in the annexes (Annex 6.1 - 6.6 refer). The findings on social issues were based on a household survey (Annex 8.1 refers) and the additional information collated was based on technical data (annex 8.2 & 8.3 refer) and implementation reporting. The technical issues are divided in collection of

[1](2004) Solar Measuring Device SLM018c-3. Manual Download from www.solar.de/cms/media/downloads

solar data (annex 6.4), water meter data (annex 6.5), observations, procurement and management6

3.1 Community Setting

The 93 households surveyed included 1,247 people –an average of 13 people per household. The range was large - from a minimum of 2 to a maximum of 35 people per household. Male children under five years were ranging from 0 to 7, the average was 1.4 children, while female children under five were ranging from 0 to 6, and the average was 1.5 children per household.

The male children aged 5 to 18 years old were ranging from 0 to 7, the average was 2.4 children, while female children from 5 to 18 years old were ranging from 0 to 11, and the average was 2.6 children per household. The adult men (above 18 years old) were ranging from 1 to 9, the average was 2.6 people and the adult women ranged from 1 to 8, and the average was 2.5 per household. The maximum numbers of families served by Solar Pumping Systems were 300, minimum was 60 and the average was 157 per systems.

3.2 Users' Perceptions

DACAAR did an evaluation between 23 communities who received a Solar Pumping System from 2009 till 2012. The following narrative deals with the outcome.

The data collection for the community views was carried out form 28 to 31 February 2013. Totally, 23 solar pumping systems were assessed, of which 14 were fixed panel systems, 5 with manual tracking and 4 with automatic tracking system. The communities approached had systems that were older than 10 month; the most recent systems were not included in the data collection. A total of 93 families were interviewed, six persons for each system were interviewed, of which three were women and three were men, while only one person was interviewed in the case that the systems were not functional.

The interviewees were asked if they liked the Solar Pumping System or if they are satisfied with Solar Pumping Systems. 98.9% of the interviewees said they liked the systems, when asked why do you like the systems? They mentioned different reasons such as " saving of time and money, privacy for women, provision of safe water, easy access, improvement in health and provision of adequate water.

Again, 94.6% of the interviewees said their health improved after utilization of water produced by Solar Pumping Systems. Although, they were not hundred % satisfied with Solar Pumping Systems as it could not provide them enough water in cloudy and rainy weather and due to decreasing efficiency of the systems year after year.

Problems in the Solar Pumping Systems were also discussed with interviewees, of which 44.6% said they experienced problems in Solar Pumping Systems and 55.4% said they did not experience any problem in the system yet. The magnitude of the problem varied form very small to very large such as damage to pipe or valve and burnt submersible and stealing of panels, which resulted in failure of the solar pumping systems. The duration of the problem varied from a few days to a month, from months to years and some problem existed till now (2012).

A total of 23 solar pumping systems were assessed, of which 9 solar pumping systems had failed and produced nothing. The main reason for failure of Solar Pumping Systems was problem of submersible as mentioned, which was not repairable and procurement of new one was not affordable for the community. In three of the Solar Pumping Systems out of the nine, community installed the electric submersible in the tube well which was powered by a generator and the community provided the fuel for the generator. And in one system people connected 12 batteries to panels and then connected the batteries to the inverter, which convert DC to AC and an electric submersible installed in the tube well, but it worked for a month and then failed to work and people called a technician to repair it again.

Comment: All systems were completely restored and or newly build that were not in working condition, except in the case of the SPS with stolen panels.

3.3 Water sources and time spent for water collection

When we asked the interviewees, from where do you collect your drinking water? Interviewees mentioned that 92.5% collect water from a tap as their current source of water. People whose systems were not functional they said we collect our drinking water from neighbouring taps, 6.5% from hand pumps and 1.1% from river or stream.

The daily amount of water needed for their families' consumption was ranging from 30 litres to 600 litres, the average was188 litres for a family that had an average of 13 people in a household. Water collection responsibility was mainly placed on women (37.6%), men (31.2%), older girls (19.4%) and older boys (11.8%). The tap water, which was produced by Solar Pumping Systems, was used for drinking, food preparation, washing, bathing and few families used excess for watering of plants and vegetables. The average time go to the tap, collect water and come back was 23 minutes including waiting time, ranging from 8 to 60 minutes.

Before the Solar Pumping Systems installation the main sources of their water were, 59.6% hand pumps, 23.6% tankers, 17.7% river and stream and only 1.1% tap.

3.4 Operation of Solar Pumping System in cloudy and rainy weather

The interviewees were asked if the sky is clear, do the system provide enough water for all the purposes such as drinking, food preparation, washing, and bathing? 71% of the people said yes and 29% no, but most of the interviewees who said yes they were the beneficiaries of recently (more than 8 months) installed tracking solar pumping systems. When asked how do you fulfil your need for water, 70% (of the 29% whose system did provide enough water) said they collect their water from hand pump, 10% from neighbouring tap, 13.3% from river and 6.7% from tanker.

The following question asked what if the weather is cloudy or rainy does the system produce enough water to meet your needs? 93.5% said in cloudy and rainy weather they system does not work properly and cannot produce enough water to fulfil our daily needs and 6.5% said yes. Their alternative sources of water were, 89.9% nearby hand pumps, 9% river and stream and 1.1% tanker. Some people said that they store some water for cloudy and rainy weather period. The mean time for collecting the water from alternative sources was doubled in comparison to water collection time from original sources as mean time was 53 minutes ranging from 4 to 120 minutes.

3.5 Observation of Solar Pumping System

Observations of 23 Solar Pumping Systems were carried out in order to identify if there was any physical damage to the Solar Pumping Systems. 7.5% of the systems had some sort of physical damage such as: in two systems the panels were broken, in one system all the panels were stolen. In one system half of the panels were stolen, in one system few panels were damaged by shooting and holes were present in them and in one system the panels were collected and stored somewhere at home.

3.6 Discussion of Communities Perceptions

In total, 23 systems were assessed of which 9 systems were not functional. The average number of families served by the solar pumping systems were 156.The beneficiaries of the non functional systems were collecting their water from nearby hand pumps, other Solar Pumping Systems, stream and river, but it was time consuming for them as they were spending much more of their time for water collecting from all aforementioned sources in comparison to the their original source.

The main problem that was found in non-functional systems was due to the submersible that was not pumping water because it was burnt or weekend as depth of the tube well was high. People tried their level best to solve the problem but they could not succeed as there was no one in Afghanistan and Pakistan to solve this problems and did not buy a new one as that was not affordable for them, on the other hand those willing to buy another one, they were in doubt about the replacement pump's quality and durability.

In three system out of nine people installed electrical submersible powered by generator and in one systems people bought 12 dry batteries and an inverter to convert DC to AC to power the electrical submersible installed in the tube well, but it worked only for one month then failed to work.

The Solar Pumping Systems installed in the end of 2011 and in 2012 they had some sort of community based operation and maintenance system as they were collecting some money from each family, some of these collected by community paid for guard and some were saved for systems operation and maintenance. It's worth to mention that all the systems had a guard paid by community and their salary range was from 5,000 to 12,000 rupees (Pakistani currency frequently used in Nangarhar).

Community suggested for a system to be in place to collect money from all users and kept for further operation and maintenance of the Solar Pumping Systems. Even though they were complaining about their poor economic situation and difficulties in collection of money for some family for the reason of their poverty. Therefore they were expecting further assistance from NGOs communities and government in this regard.

3.7 Seasonality

Even though the interviewers said thatthe solar water pumping systems were notworking properly in cloudy, fogy and rainy weather, still water will be pumped but of insufficient quantity and the community has to ration the collection by families for drinking water only. On average hourly basis in the clear weather the discharge of tracking system was 6.4 cubic meter while in cloudy and rainy weather it was 2.2 cubic meter. The manual tracking system and fixed system the discharge was less in cloudy and rainy weather in comparison to the automatic system. In clear weather for manual tracking system the discharge was 4.3 cubic meter while in cloudy and rainy weather it was 2.2 cubic meter and for fixed system the discharge in clear weather was 3 cubic meter while in cloudy and rainy weather it was 1.5 cubic meter. The water produced need to be managed by the community committee and members, therefore all members should be aware of the strength and weaknesses of the Solar Pumping System.

3.7.1 Solar Intensity

Three types of solar systems have been deployed, not referring to different solar panel types, only the crystalline panels have been used from various manufacturers. The types of systems installed are totally fixed systems. The fixed systems cannot be adjusted in any manner. The second type is the manual tracking system that can be changed during the seasons to receive an optimal amount of the sunshine, but depends greatly on the expertise of the caretaker. Problems occur when the caretaker changes. The third option is the automatic tracking system, requires less panels but the tracking system is an added cost, but the system start working from early in the morning till late in the evening. The evidence is in the water reading as shown in the next chapter.

DACAAR has a fixed solar array in Kabul and the result of the solar intensity meter is shown in figure 1. When “Aligned” this means that the solar meter was placed in the same angle on the side of the panels; ‘Direct” then the meter was optimally situated to catch the solar intensity at the same time; “Difference” is aligned minus direct and gives a negative figure.

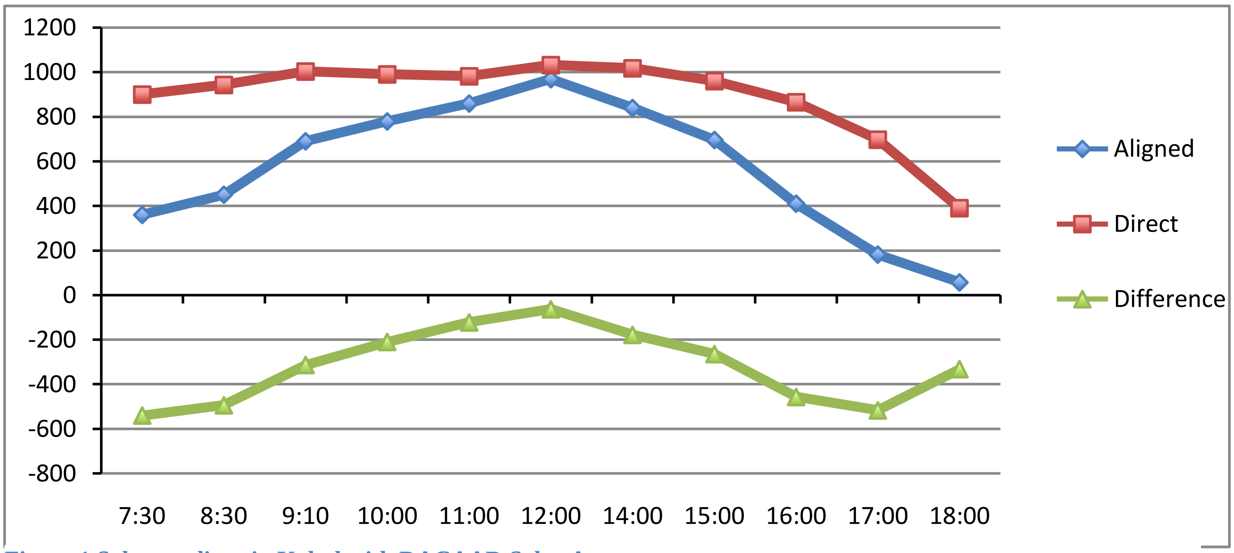

Figure 1 Solar readings in Kabul with DACAAR Solar Array

Automatic tracking system

The automatic tracking system (figure 2 refers) has a clear advantage during the day in comparison with the non-tracking systems. This becomes even clearer when looking at the output over the whole year (Captured in the water meter readings). The manual tracking system (fig 3 refers) has an advantage over the fixed system when properly dealt with but still shows a difference during the day, as there is only one time that the system is optimally placed. The non-tracking system (figure 4 refers) is obviously showing the biggest difference in the red line. Especially in the morning as the system tries to capture the mid-day sunshine and therefore the motorwill start up later then in both other systems.

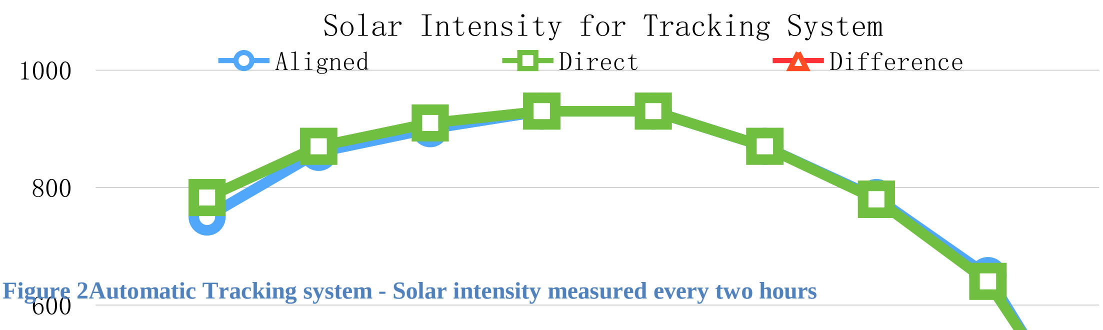

Figure 2Automatic Tracking system - Solar intensity measured every two hours

Manual Tracking

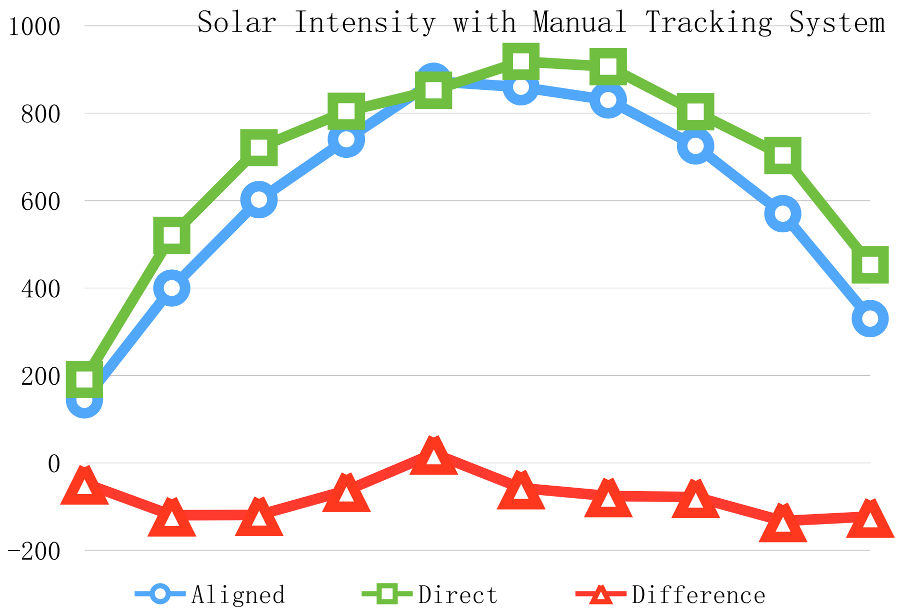

Figure 3 Manual Tracking

Non-Tracking System

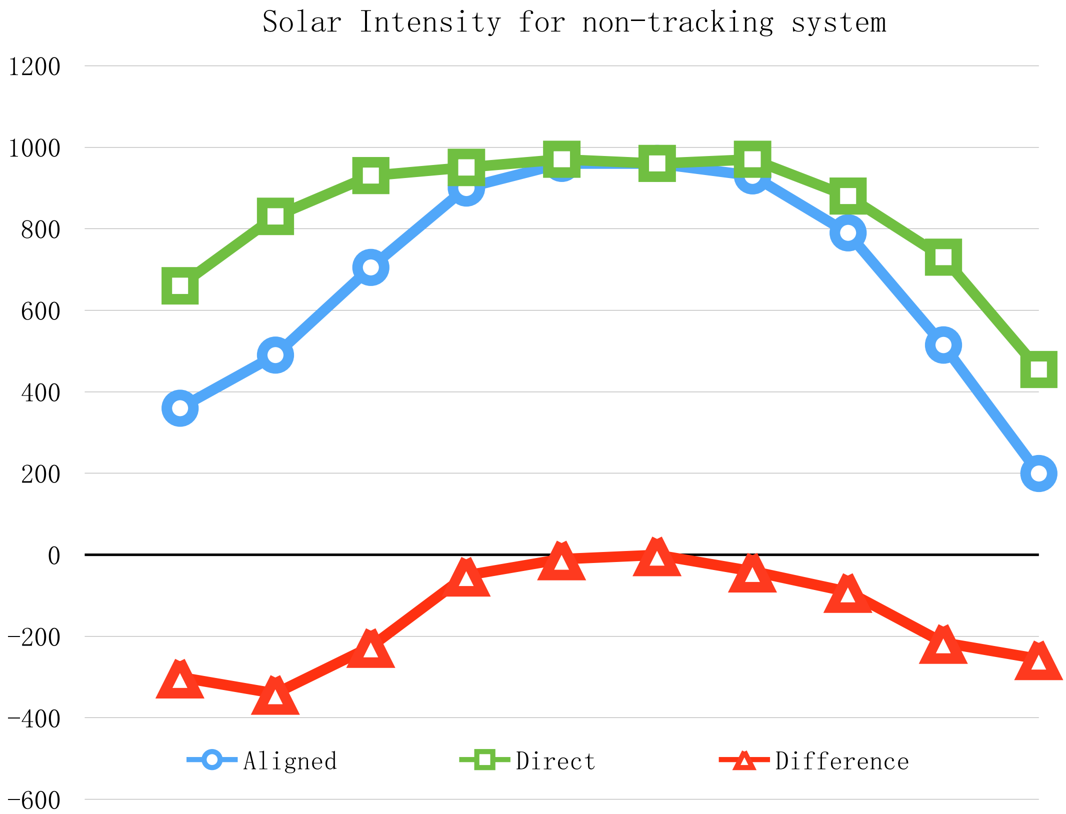

Figure 4 Fixed or non-tracking system

3.7.2 Water Meter Readings

Water meter readings were included as this measurement would show the accumulative output of each of the systems. The graph in figure 5 shows the accumulative output of the systems, but there is a difference in the systems and by putting them on equal footing the graph in figure 6 shows the relative accumulative output.

The first readings were done during September 2012 and last reading during September 2013. The 21 of September 2012, 21 of December 2012, 21 March 2013, 21 June 2013 and 21 September 2013 are used for comparison. The following graph (figure 5) shows the accumulative measurement while the next graph shows the seasonal variations.

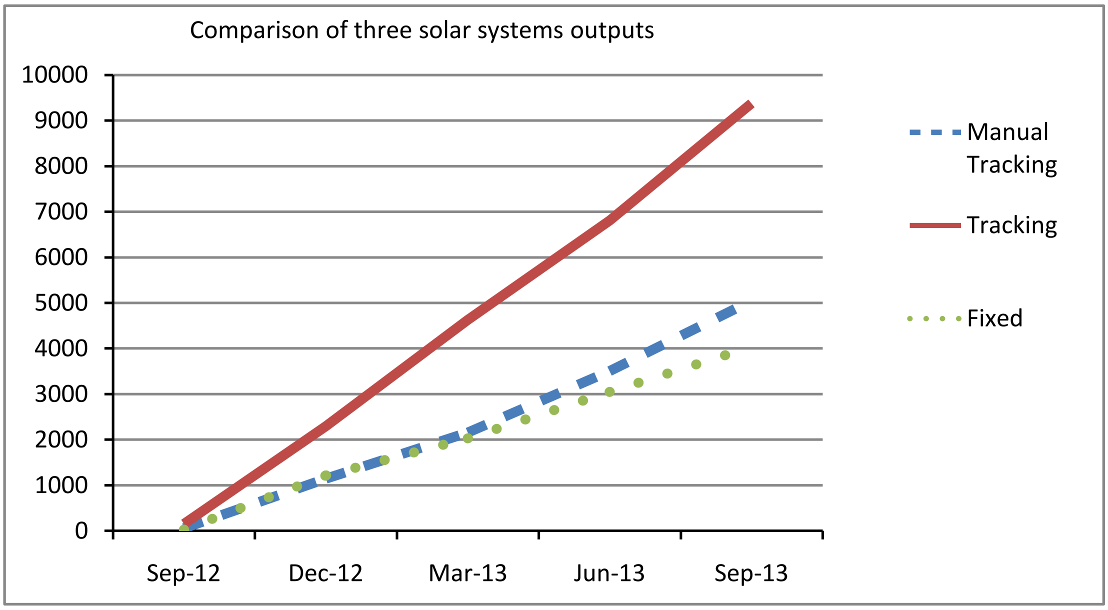

Figure 5 Three solar systems outputs - accumulative and non-adjusted

The following graph (figure 6) shows the same three systems but as Rahat = 2,100 Watt,Amanuallah = 1,800 Watt and Zetullah + 1,350 watt systems, all were brought done to the same level as the Zetullah system and then the outcome is the following graph. The top line (Rahat) is still the preferred system, the manual tracking system (Ziatullah) came second and the fixed last, which is not a surprise but variations in the systems are possible.

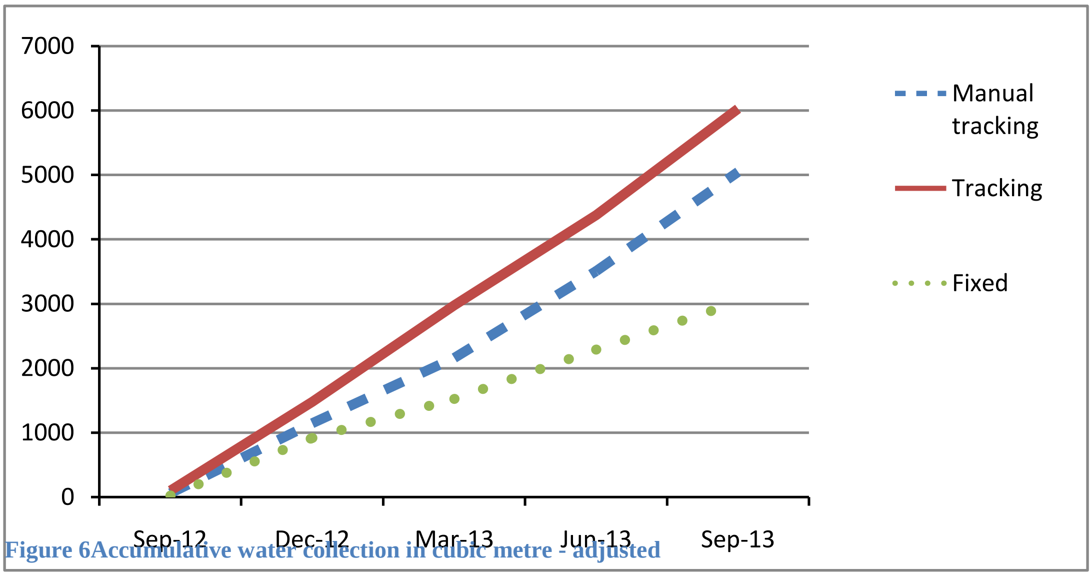

Figure 6Accumulative water collection in cubic metre - adjusted

Seasonal measurements, from the graph below (figure 7) can be concluded that the tracking system has the best output during the year but the manual tracking system could be very similar but requires a dedicated caretaker who is well trained in what to do and what the optimal angels are during the seasons and possible during the day.

The figures in figure 7 are from the recorded water meters from the three systems.

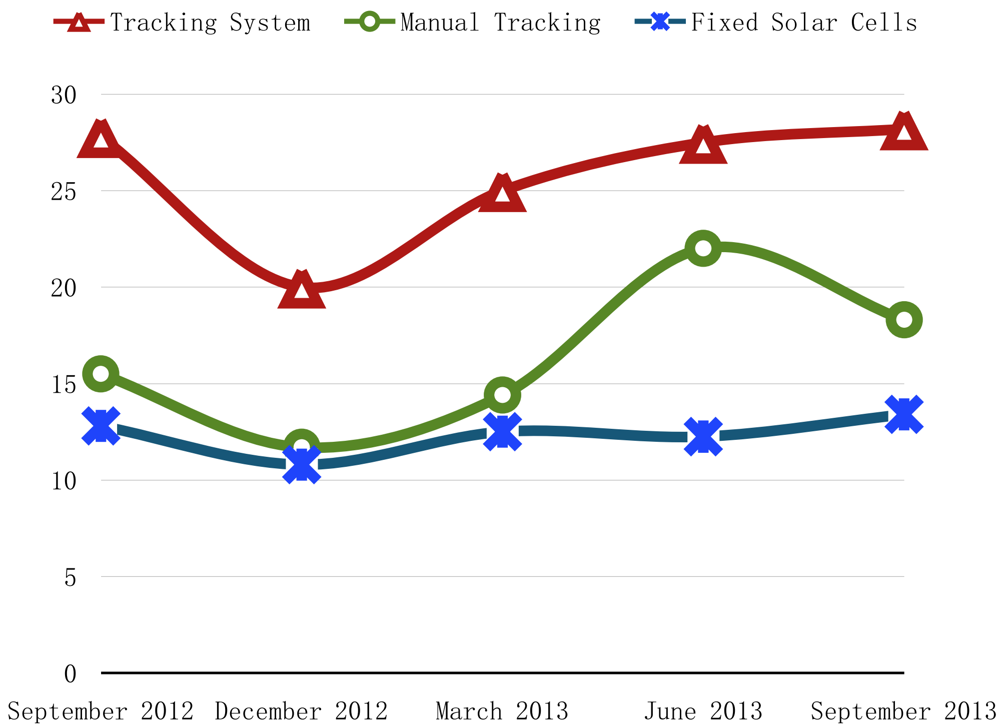

Figure 7 Daily variations of output during the year

5. RECOMMENDATIONS

The Solar Pumping System has proven to be a viable option for vulnerable communities. There are still many obstacles before the system will be used more generally, and the most obvious obstacle is the cost involved of the purchase of the system and the technical know-how of installation. A number of other potential obstacles have been identified from design to misuse of the system, or damages from stones (use of different type of panels - make the system less efficient) to bullet holes. The more systems that will be made available to the communities, then more entrepreneurs will become interested to supply such systems and avail better technical services and making replacement parts available more generally and might become therefore accessible all over the country.

In general the Solar Pumping Systems are still poorly understood as the solar panels deliver DC voltage that is then transformed by an electronic box into AC voltage. To make the Solar Pumping Systems even more complicated to understand, there are also systems that deliver DC voltage to specific DC pumps. But DC pumps are fewer available and appear to be less efficient (require thicker electrical cables). Therefore specific pumps are fabricated for Solar Pumping Systems.

Panels is another issue, there are different types of panels on the market and it is essential to take those with a high output, but those are more costly per panel, but less panels are needed and more durable.

1. Best option is to select a tracking device that allows the sun to shine on the panels fully, if an automatic system cannot be afforded the next best option is a seasonal adjustable system that can be turned by the caretaker.
2. The management committee must be trained in all aspects of the system and know what they are supposed to do; the initial training will have to be repeated and reinforced. All systems that deliver water for communities need to be managed so that the live cycle can be optimal, but require motivation and follow-up as otherwise the system sustainability will be easily compromised.
3. If there is the likelihood of damage to the solar panels, in areas with stones and children used to throw those on roofs, then solar cannot be an option or otherwise an other panel type to be selected that can still function after such damages.
4. For optimal functioning of the solar panels dust must be removed, but in such a manner that the panels will not get scratched or damaged in any other manner.

6. ANNEXES

6.1 Annex Questionnaire Users Solar Pumps

Solar Pumping System Evaluation Questionnaire,Nangarhar

Name of Interviewer	
Date of Interview	
Household Code	
Province	
District	
Village	
Name of the chief of the family	
Q1. Was verbal consent given?	1. Yes **2.** No
Q2. Does the solar pumping system appear to be functioning?	1. Yes **2.** No
Q3. If not what is the problem with system? Please explain:	
Q4. Where do you get your drinking water now from?	1. Well 2. Piped/ Tap (system) 3. Canal, river or stream 4. Rain 5. Tanker 6. Other (specify) ----------------
Q5. How long does it take you to go to your water source, get water and come back?	Time in minutes:
Q6. Who is primarily responsible for collecting water?	1. Men 2. Women 3. Older girl 4. Older boy 5. All of the above
Q7. How much water do you collect every day?	In liters:
Q8. How many people are living in this house?	Number of people:

Q9. How long have you been using this source?	Month:
Q10. Since you started using this source, do you think your family's health has improved, stayed the same, or become worse?	1. Improved 2. Stayed the same 3. Worse
Q11. Did the system has any problem since the installation?	1. Yes **2.** No
Q12. If yes, then what was your alternative source of water?	1. Well 2. Piped/ Tap 3. Canal, river or stream 4. Rain 5. Tanker Other (specify) ----------------
Q13. If yes, which part had problem and how did you repair it? Please explain:	
Q14. How much was the repair cost?	
Q15. What are all the purposes you use water for?	1. Drinking 2. Food preparation 3. Both of the above 4. Washing 5. Bathing 6. All of the above 7. Other ______________
Q16. Did the system provide enough water for all the purposes mentioned above?	1. Yes **2.** No
Q17. If not, why is it not providing enough water?	
Q18. How many families collect water from the system?	Number of families:
Q19. What was your previous source of water before the system installation?	1. Well 2. Piped/ Tap 3. Canal, river or stream 4. Rain 5. Tanker

	6. Other (specify) ----------------
Q20. Dose the system work in cloudy/rainy weather properly?	1. Yes 2. No
Q21. If not, then where do you get your water?	1. Well 2. Piped/ Tap 3. Canal, river or stream 4. Rain 5. Tanker 6. Other (specify) ----------------
Q22. What do you suggest for the improvement of the system?	Explain:
Q23. Do you have any guard for the system?	
Q24. Who pay the salary of the guard?	
Q26. And how much is his salary?	
Q27. Do you like the system?	1. Yes 2. No
Q28. If yes, why please explain?	
Q29. If not, then why not, please explain?	

Other comments and observations:

6.2 Annex Technical Research

Question	Answer	Comments
Amount of solar panels		Count panels
Manufacturer of Solar panels		Look at back of the panel
Manufacturer of Pump		Order or control box will give name
Type of pump		Refer to specifications in next annex
Depth of well		Refer to report when drilled
Static Water Level		Refer to report when drilled
Draw down		If available, or make reference to water pump test
Water meter to be placed after the pump		Good quality meter, measure monthly, community members can do it.
Measuring the output voltage of the panels during different seasons, measure angle, change angle to be optimal for time of the year, measure under different angles.		Measure the influence of the sun on the panels, especially with fixed panel angle to measure the influence of the angle, seasonal and during the day.
Influence of shading on the panel, put hand on panel.		Especially noticeable with panels that are made from multi-crystaline
Influence of dust on the panels, measure electricity flow during pumping, clean panels and measure again.		Quality of electrical output will diminish with a lot of dust on the panels.

6.3 Technical details of the three systems

The technical details are from the three systems followed during one year.

Solar # 1: ChamtalaETC Tracking System
Rahat: 12 x 175 = 2,100 Watt

- Company: ETC
- System type: Tracking system
- # of panel: 12 panels, made in Germany
- Panel peak power: 175 W
- # of Stand Posts: 7
- # of Families: 138
- Well depth: 90m
- Pump depth: 80m
- Out let pipe: 1.5 inches
- Reservoir volume: 12 m^3
- Type of reservoir: Elevated

Solar # 2: ChamtalaBakhater Solar Non tracking System
Amanullah: 24 x 75 = 1,800 Watt

- Company: Bakhater Solar/ Mono
- System type: Non tracking system
- # of panel: 24 panels, made in Germany
- # of Stand Posts: 7
- Panel peak power: 75 W
- # of Families: ?
- Well depth: 82m
- Pump depth: 78m
- Out let pipe: 1.5 inches
- Reservoir volume: 12 m^3
- Type of reservoir: Elevated

Solar # 3: Baghbani Afghan Solar Non tracking System (Manually Moveable)
Zetullah: 18 x 75 = 1,350 Watt

- Company: Afghan Solar/ Grundfoss
- System type: Non tracking system
- # of panel: 18 panels, made in India
- # of Stand Posts: 5
- Panel peak power: 75 W
- # of Families: 99
- Well depth: 94.5m
- Pump depth: 70m
- Outlet pipe: 1 inch
- Reservoir volume: 12 m^3
- Type of reservoir: Elevated

6.4 Annex Table to Measure Solar Intensity

The following table was used to measure the aligned and direct intensity of the sun at the particular times of the day. Alignment refers to putting the measurement device in the same position as the solar panels. The direct measurement refers to align the measurement device with the sun and get the optimal measurement.

Time	Aligned	Direct	Difference
7:30	360	900	-540
8:30	450	943	-493
9:10	690	1,003	-313
10:00	780	990	-210
11:00	860	982	-122
12:00	969	1,032	-63
14:00	840	1,018	-178
15:00	696	960	-264
16:00	410	866	-456
17:00	182	698	-516
18:00	58	390	-332

6.5 Annex Form Readings Water Meters

The following form was used to fill in the water meter reading.

DACAAR Program/WETC

Discharge measurement of solar pumping system installed

Province: District Data recorded by:

Monitored by: Sunrise: Sunset: Date:

Measurement				Pump Discharge				
Last Time	Cubic metre	Current time	Cubic Metre	Duration hours	Volume m^3	M^3/hr	Litre/ second	Atmospheric Conditions

6.6 Photos

Photos of different Solar Pumping System

Figure 8 Fixed Solar module system

Figure 2 Manual Tracking System

Figure 9 Installation of Flow Meter

Figure 10 Training in Data Reading & Recording

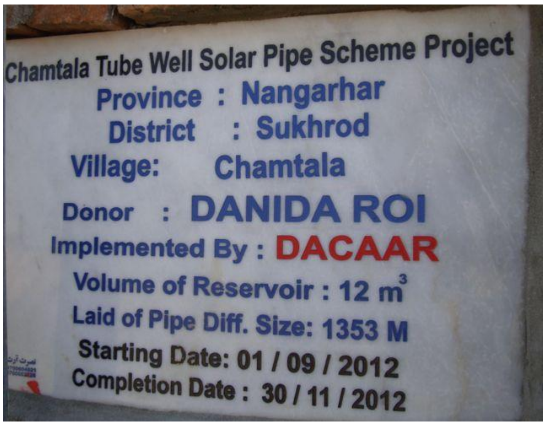

Figure 11 Plate on Solar Pumping System with Information

Figure 5 Automatic Tracking System

Figure 6 Stand Post


Figure 7 Fixed Solar Module System DACAAR Office Kabul